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School of Education

The Development of Inquiry-Based Pedagogy in Beginning Teachers of Science

by

Michelle McKie

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Signed:

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ABSTRACT

Inquiry-based science teaching is considered a key means of improving scientific literacy. Although 'inquiry' is a prominent feature in curriculum documents internationally, 'inquiry-teaching' has proved difficult to define in operational terms. In approach, it implies elements of scientific authenticity, including open-endedness of practical activity and real-world relevance, and is associated with the development of critical skills and positive pupil outcomes, demonstrating the potential to reduce the achievement gap in science classrooms. Whilst many teachers subscribe to the philosophies of inquiry, many feel reluctant to adopt this approach. It is especially challenging for beginners who have yet to develop their teacher-identity and establish a confident classroom repertoire which accommodates creativity and flexibility. Thus, despite reform efforts, inquiry remains a peripheral pedagogy. This multiple case study (*n=15*) uses a longitudinal design to explore the development of new teachers of science in Scotland, in relation to the acquisition of investigative pedagogy. Commencing in May 2010, data collected through focus groups, semi-structured interviews and reflective journals was analysed using a general inductive approach to examine beginning teachers' conceptualisations of 'inquiry' in the classroom and identify those elements of early development which are required to facilitate authentic investigative experiences. Given the Scottish context, the Teacher Induction Scheme and Curriculum for Excellence were of particular relevance to this study. The various ways in which inquiry found expression in these beginners' classrooms are presented; insights gained from their discourse point to the interaction of personal and institutional factors for novices' developing pedagogy and teacher identity. Recommendations pertaining to teacher candidate selection, learning experiences during ITE and induction, and curriculum implementation are made with the aim of strengthening new teachers' commitment to an inquiry-based approach. (278)

Keywords: inquiry, science, new teachers, learning, teacher-identity

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Abbreviations

AifL	Assessment is for Learning
CfE	Curriculum for Excellence
EPL	Early Professional Learning
EU	European Union
GTCS	General Teaching Council for Scotland
HE	Higher Education
HMIe	Her Majesty’s Inspectorate - Education
HoD	Head of Department
IBST	Inquiry Based Science Teaching
IEP	Individualised Education Plan
ITE	Initial Teacher Education
LA	Local Authority
NOS	Nature of Science
NQT	Newly Qualified Teacher
NSES	National Science Education Standards
PCK	Pedagogical Content Knowledge
PISA	Programme for International Student Assessment
PT	Principal Teacher
SITE	Standard for Initial Teacher Education
SFR	Standard for Full Registration
S-TEAM	Science Teacher Education Advanced Methods
STEM	Science, Technology, Mathematics and Engineering
TE	Teacher Education
TIMSS	Trends in International Mathematics and Science Study

CHAPTER 1 - INTRODUCTION

Investigative, or inquiry-based, teaching in science has long been advocated as a key means of developing authentic scientific literacy in schoolchildren and over the last half-century it has become an increasingly dominant feature of science curricula worldwide. The rationale is that by introducing children to the processes and problems of scientific inquiry, thereby giving children the experience close to that of working like a scientist, children can begin to understand the nature of science and develop attitudes and competencies which can lead to deeper understanding of major scientific concepts and principles, guide future life choices and allow participation in public science arenas. Although this reform movement is apparently grounded in education research, it is an area of teaching and of learning to teach that is a perennial and ubiquitous difficulty. As a consequence of conceptual and operational difficulties, reform efforts are often met with resistance and it is argued that inquiry remains an enigma for most teachers, new teachers especially.

Initial Teacher Education (ITE) offers a unique opportunity to address this. By developing courses of ITE which address (at least some of) these conceptual and operational difficulties, it is hoped that beginners will go out into the field feeling more prepared to teach in a way that aligns with reform efforts.

In order to develop such courses it is important to understand beginners' early experience of teaching and respond to their needs. In terms of inquiry-based teaching, this means understanding not only how beginners define and conceptualise inquiry but also how it manifests in practice as contextual factors come into play. This knowledge will help providers of ITE to tailor the learning and experiences of new teachers so that they gain confidence in their understanding of inquiry and how to implement such an approach, and go some way towards preparing them for the various barriers they may face.

The aim of this research was to arrive at such knowledge.

Outline of Thesis

This chapter presents the background to the study; the historical and geographical context, relevance for education and implications for Initial Teacher Education. Chapters 2 and 3 provide an outline of the existing literature on *Inquiry Based Teaching* and *The Early Professional Development of New Teachers* respectively, two very fertile areas of educational research. The intersection of these two literatures, and the focus of this research - *Inquiry for Beginning Teachers* - will be considered in Chapter 4.

Chapter 5 discusses the rationale for the current study before outlining the general research strategy and specific methods used. It also describes the analytical approaches used as well as measures taken to ensure trustworthiness.

The five chapters following Chapter 5 present different aspects of the data generated. Chapter 6 introduces 'The Cases' - the research participants. Using longitudinal data, a profile is presented for each participant which attempts to portray their specific situation and how they coped with the context they found themselves in. Following each participant profile is a table showing that participant's perceived barriers to inquiry over the course of their induction year. Chapters 7 – 10 present and discuss interview data on participants' ideas of inquiry, perceived barriers, their school context and their early professional learning respectively.

Chapter 11 provides a concluding discussion and makes recommendations to support the propagation of inquiry oriented pedagogy as well as calls for further research.

Contexts

Historical Background

The beginning of science education reform with its focus on inquiry is often associated with the work of Schwab (1940s-60s), however, its roots can be traced back to early in the C20th and the philosophical writings of John Dewey (1910). Dewey argued that scientific knowledge develops as a product of inquiry and that problems to be studied must be related to students' experiences and within their intellectual capability (Dewey, 1938a). Dewey was involved principally in elementary (primary) level science education, however his ideas formed the basis of *Science in Secondary Education* (1937; USA) which gave rise to curricular reform.

The launching of Sputnik in 1957 sowed the seeds for a new wave of science education reform in the 1960s which emphasised 'thinking like a scientist'. At this time Schwab's dissatisfaction with the idea of science as a "rhetoric of conclusions" (Schwab, 1962, p. 25) and his 'new' vision for science education permeated academic circles globally. He argued that science should be taught in a way that was consistent with how modern science operates, firmly advocating laboratory work for the learning of science concepts and recommending that science be taught through inquiry. However, a variety of studies of practice (Jones et al.,1992, UK; Welch et al.,1981, USA) concluded that the effort invested in teacher training and curricular development had done little to advance classroom practice – inquiry was not a popular approach. At the heart of the problem seemed to be a tension between aspiration, facility, accountability... and time.

Around the turn of the century, prompted by indicators of low achievement in science (eg. TIMSS), a decline in numbers studying science subjects in the post-compulsory period of schooling and taking up science based careers, and the naïve, and generally negative, public perception of science, many nations sought to modernise and revitalise their science education programmes to engage a wider audience. Publication of *The National Science Education Standards* (NRC, 1996, USA), and the follow-up publication, *Inquiry and the National Science Education Standards* (NRC, 2000 - described as a 'practical guide to teaching inquiry and teaching through inquiry'), provided the impetus and curricular template for many other nations to follow. They claimed to emphasise “a new way of teaching and learning about science that reflects how science itself is done, emphasising inquiry as a way of achieving knowledge and understanding about the world” (NRC, 2000, p. ix), however, as this was the aspiration of John Dewey nearly a century earlier, it constituted not so much a ‘new’ way of teaching and learning but a ‘renewed’ effort in achieving scientific literacy for all, again with a very firm emphasis on inquiry.

Inquiry continues to be the focus of science education reform - the ‘‘central strategy for teaching science’’ (NRC, 1996, p. 31).

European Context

Dissatisfied with the state of science education across Europe, and questioning the adequacy of existing European Teacher Professional Development systems, in May 2009 the European Union (EU) granted three years funding to S-TEAM[1], a project involving 26 partners from 15 nations, aimed at increasing motivation and engagement with science, and in turn creating more scientifically literate citizens and encouraging more students into STEM careers. This goal was to be met by disseminating inquiry-based science teaching (IBST) methods through existing structures, agencies and actors to the widest possible range of teachers and teacher educators across Europe. Its objectives summarised: pupil engagement, teacher empowerment and teacher education.

The author of this thesis is affiliated with S-TEAM, her university being one of the partner institutions, and her supervisor being the main co-ordinator from that university charged with ‘ensuring that pre-service teachers receive the best grounding in investigative methods’ (WP5)[2]. As such, knowledge exchange has been reciprocal, with the research being informed by and feeding into the S-TEAM project.

[1] S-TEAM – Science Teacher Education Advanced Methods – a project funded by the European Union charged with ‘firing up science education’.

[2] WP5 – Work Package 5; Work packages are project ‘deliverables’, each one covering a distinctive area within science and teacher education.

Scottish Significance

The Scottish context for the study is significant for two reasons. Firstly, the New Teacher Induction Scheme was introduced in Scotland in 2002-3 to address concerns over differential experiences by many new teachers, a situation not unique to Scotland (Flores, 2006; Tickle, 2000). Managed jointly by the Scottish Government and the General Teaching Council for Scotland (GTCS), it provides a one-year salaried training post to newly qualified teachers. Inherent support includes an experienced in-school mentor, a framework of early professional learning (The Standard for Full Registration; SFR), organised CPD activities, and a timetable which accommodates development - although it is acknowledged that individual experience of such support is variable.

Secondly, the research participants were entering teaching at a time of curricular transition. In response to The National Debate on Education in 2002 and results of international student performance surveys around that time (PISA and TIMSS), A Curriculum for Excellence, CfE, was conceived in 2004. Although this new curriculum had been rolled out in phases to schools across Scotland since its conception in 2004, the year that data was collected for this study (academic year 2010-2011) saw its widespread introduction in earnest. CfE is an innovative curriculum, ambitious and enterprising in its approach, whose underlying philosophies seem to support current reform efforts. For example, reduced 'content load' permits a balance between depth and breadth of coverage, allowing more time to follow pupils' interests. Learning outcomes are written from pupils' perspectives to promote responsibility for learning, confidence and independent thinking, collaboration and problem solving, and application of knowledge. Further it takes a different approach to assessment, relaxing requirements in S1-3 to foster positive attitudes to learning and skills development. New teachers are being familiarised with the new curriculum during ITE and ongoing support and training is being offered in schools across the country.

Whilst this study is situated with the Scottish context and specifically at a time of curricular change, extensive reference is made to a much wider literature on science education and inquiry-based learning, as reform efforts are paralleled, by and large, the world over.

Sector Issues

This research spans both Primary and Secondary sectors. The reason for this is to provide insight into how vastly different experiences in terms of background, teacher preparation and teaching contexts (structure of the teaching day, degree of integration of curricular areas, educational goals and values, access to resources, parental involvement) may impact on beginners' capacity to implement the science curriculum as intended.

A recurring theme in the literature about science education is the lack of priority given to science within the primary sector generally. In Britain, the slow rate of uptake of science into primary schools is very much in evidence. For example, a survey by Her Majesty's Inspectors (HMI, 1978) of primary schools in England found that "few primary schools visited ... had effective programmes for the teaching of science" (p.58) and that, in general, teachers lacked "a working knowledge of elementary science appropriate to children of this age" resulting in "some teachers being so short of confidence in their own abilities that they make no attempt to include science in the curriculum" (p.62). This report led to a series of government initiatives (from which came *Science 5—16: A statement of policy;* HMSO, 1985) and ultimately the introduction of a new national curriculum in 1989 in which Science was a core curriculum subject. Scotland followed suit with the introduction of *The 5-14 Curriculum* in 1991, in which Science was a major component of the Environmental Studies strand.

A longitudinal study (Carré & Carter, 1990, 1993) found that, after an initial period of insecurity following the introduction of the National Curriculum (Science), primary teachers' own perceptions of competence in teaching science was increasing. However, Russell et al. (1995) found that, although designated a 'core' subject, the status and priority given to science within the curriculum fell far below that of English and Mathematics. Subsequently, a survey of 300 primary teachers from schools across the UK (Murphy & Beggs, 2005) revealed that the main factor underpinning their apparent reluctance to teach science to be lack of knowledge, expertise and confidence in science, although lack of resources to support science and curricular time allocation were also acknowledged.

Over the years not much has changed. Despite curricular reform and associated teacher education, primary teachers' limited knowledge of scientific content and process remains a fundamental impediment to the realisation of policy aspirations for science education. However, it would be illuminating to know if there is evidence of conflict between the intended and the implemented curriculum in other areas of the primary curriculum also. If it is the case that teachers – including beginning teachers – are more able to implement an inquiry approach in, say, the social sciences or mathematics than in science, then we can begin to speculate as to what it is about these other subjects that lend themselves to such an approach. For example Spoehr and Spoehr (1994) posit that thinking as a historian is quite different from thinking as a scientist as it invokes personal experience, or at least imagining oneself in a particular situation, and the language of the discipline is the spoken or written word, which is much less abstract than scientific or mathematic symbols and operations. Other possible reasons include teachers' understanding of the subject, the organisation of curricular materials, access to resources, collegiate support and timetabling.

In terms of secondary science education, secondary schools are charged with maximising student achievement in 'the sciences' and encouraging students into science-based careers. Although 'achievement' is beginning to take on a much wider definition in educational contexts, historically it has meant passing exams. Consequently teachers have operated largely within a 'textbook culture' (Anderson, 2002) where rote learning of facts is valued over developing skills and understanding, and teachers are held accountable for the quality of children's learning as judged by their academic achievements. Thus, historically the structure and purpose of science education has not accommodated an inquiry approach; enactment of the curriculum has been dominated by content, driven by assessment and constrained by time and resources.

Relevance and Implications of Study

A scientifically literate populace is an internationally shared aim. This involves not only knowledge of facts and understanding of concepts, but an appreciation of the nature of science (NOS) and the development of scientific 'habits of mind'. For this aim to be realised it is generally accepted that school children need opportunities to work like scientists; to observe, question, explore, investigate, reason, explain ... and so forth. To this end, many science curricula internationally advocate active engagement with science, with emphasis on (collaborative) inquiry and practical investigations.

However, successful implementation of such curricula depends on teachers themselves holding an informed view of science and having the competence to translate this into classroom practice. It also relies on teachers' confidence in their ability to manage such pupil-centred open-ended activities which, after all, constitute a major shift from traditional teacher/pupil roles and therefore may be perceived as somewhat risky.

This is where new teacher preparation programmes are key. Developing courses of Initial Teacher Education which successfully prepare beginners for the uncertain work which is teaching, and in a way that aligns with current educational initiatives, is dependent upon not only listening to their experiences, and responding to the needs of those individuals themselves, but also depends on understanding beginners' conceptualisations of teaching, including inquiry based teaching (Ireland *et al*. (2012) recognise that failure of CPD to impact on practice may be due to failure of teacher educators to explore and understand teachers' conceptions of the phenomenon in the first place).

This study followed the experiences of 15 new teachers of science, from across sectors and disciplines, through their induction year. It elicited their conceptions of inquiry but also explored how they interacted with their professional contexts generally, revealing how the nature of those interactions impacted on their confidence and influenced pedagogical possibilities. Also, by acknowledging that their ideas of inquiry were likely to be shaped over time by their experiences, it allowed an exploration of what, and how, they were learning in their efforts to develop effective inquiry/investigative teaching. There was no classroom observation or effort to measure participants' practice against accepted theoretical models of inquiry teaching; rather the focus was on how participants' discussed inquiry and their perceptions of what was possible for them in their context and at that point in their professional development.

It is hoped that the insights gained from the collective discourse of these new teachers may prove to be useful in shaping teacher preparation programmes in the future. For instance, by revealing the temporal relevance of different types of knowledge, the relative importance of formal and informal learning and the relationship between knowledge acquisition and confidence to incorporate an investigative pedagogy, this study may inform the nature and ordering of learning experiences provided by ITE.

Research Questions

This study explores the experience of new teachers of science, particularly in relation to the acquisition of investigative pedagogy, at a time of curricular reform. Specifically it is concerned with (1) beginning teachers' conceptualisations of 'inquiry' in the context of the classroom, the extent to which they are manifest in practice and how stable they are; and (2) developing an understanding of the conditions and early professional learning needed not only to enable new teachers to facilitate inquiry experiences, but also to strengthen their commitment to this teaching approach.

These questions, which are at this stage an area of exploration, will be restated and developed following an examination of the literature on Inquiry, New Teacher Professional learning and, the intersection of these two literatures, Inquiry for Beginning Teachers.

CHAPTER 2 - INQUIRY: FROM CONCEPT TO PRACTICE

Academic writing on the subject of inquiry in education can be traced back to the early works of John Dewey (1910, 1938b), yet it remains an extremely rich and fertile literature with many unresolved debates and fresh perspectives emerging, particularly concerning the definition and characterisation of inquiry, and the perceived merits of such an approach.

The argument for an inquiry-based, or investigative, approach to teaching and learning in science has its theoretical underpinnings not only in the philosophical writings of Dewey, but also in constructivist learning theory, initially delineated by Piaget during the 1960s, and later developed by Vygotsky and Bruner to acknowledge the social dimension of learning. Widely considered to be a key means of improving scientific literacy in school children (a claim borne out by accumulating empirical evidence), inquiry has increasingly featured in science curricula internationally, albeit in various guises over the years. The impact of this focus, however, has been questionable. Following a decade of reform efforts in the USA, a comprehensive report concluded that, despite ten years of development and in-service teacher education, “the desired state for science education [was] not being achieved...[and]...there are a number of specific instances where the observed current status represents a particularly poor showing” (Welch et al., 1981, p. 41). Perceived barriers included safety issues, lack of equipment, management difficulties, and the need to teach a mandated curriculum. Further, teachers felt the scientist-designed curricula of the 1970s did not engage or meet the needs of most of their students. Not much has changed. Despite its prominence in reform documents, research suggests that inquiry is rare in practice (Hudson et al., 2002; Osborne & Dillon, 2008; Weiss et al., 2003).

In the early 1990s, in an attempt to involve pupils in authentic inquiry, the formal investigation was introduced in schools across the UK as an assessed component of science courses. Before this time investigations were not compulsory so pupils’ experience of ‘doing science’ varied greatly around the country. However, in his report on investigative work in schools in the UK around that time, Jones and colleagues suggested that inquiry was "well beyond the practice and confidence of most [science] teachers" (Jones et al., 1992, p. 3). Indeed, following up on the initiative a decade later, an audit of science education in Scotland found that in general “teaching approaches often restricted pupils’ initiative and independence in carrying out practical investigations” (HMIE, 2005, p.9). It seems the policy vision was not being translated as intended. A similar situation exists in various countries. In Canada, Goldman-Francoeur (1984) reported a resistance to inquiry instruction and the reliance on textbooks and a transmission style of instruction; and, in terms of practical investigations, Hodson (1993) pointed to a contradiction between teachers’ espoused belief in the value of a pupil-led, open-ended approach, and their teaching practices in the laboratory. In Australia, Hill (1985) recounted teachers’ apparent insecurity when faced with new inquiry-oriented materials. They reasoned that the materials were pitched above the children’s ability level, but, as Hill suggested, the real problem may be rooted in their own lack of understanding, perhaps due to a limited experience of scientific inquiry. Indeed Hill found that teachers themselves felt inadequately prepared to teach in this way. Whilst factors endogenous to the teacher – beliefs, understanding and confidence – are likely to influence classroom practice, other more ‘external’ barriers are often cited to explain the persistence of more traditional teaching approaches. For instance, in a recent report to the Nuffield Foundation, Osborne and Dillon (2008) acceded that not only were teachers inadequately prepared for reform-oriented science teaching, but that existing curricula and examination arrangements did not accommodate such an approach.

This chapter explores the literature on inquiry in the context of the classroom, beginning with why, as Anderson suggests (Abell & Lederman, 2007), inquiry should be an organising theme for science curricula, and then the difficulties associated with its implementation, including both conceptual and operational barriers.

Inquiry – A Curricular Imperative

Science is an integral part of the curriculum throughout the world because it is relevant to all people. Science and technology are increasingly impacting on our lives (both personal and social) so it is important to educate the up-and-coming generation in order that they may extend and apply knowledge of the natural world for their own benefit and that of humankind. Contemporary science education, therefore, must be a double-edged sword, for it is charged with the twin goals of generating the scientists of the future to promote scientific and technological innovation, and creating a scientifically literate citizenry, prepared for life in the twenty-first century and capable of contributing to discussion and debate on issues of social, economic and environmental importance.

Historically concerned with preparation for higher study, this tendency towards 'science for all' represents a relatively new direction for science education in schools. Prompted by indicators of low achievement in science (eg. TIMSS), a decline in numbers studying science subjects in the post-compulsory period of schooling, and the naïve, and generally negative, public perception of science, around the turn of the century many nations sought to modernise and revitalise their science education programmes to engage a wider audience. This triggered a new wave of legislation emphasising inclusion and accountability[3], although paradoxically this very legislation may be seriously hampering reform efforts (Anderson 2012; Blanchard et al., 2010).

It is widely held that the type of scientific literacy demanded by progressive nations involves not only the learning of scientific 'facts', concepts and theories, but also an understanding of the nature of science and how science proceeds in the pursuit of new knowledge (including the rules governing scientific inquiry and the criteria for evaluating evidence); in other words, the processes as well as the products of science. Inquiry-based instruction is a central strategy for developing scientific literacy in this broader sense. The intuitive, theoretical and empirical arguments for this will now be discussed.

Authentic, Holistic and Relevant to Learners

> *"Like real scientists, students should study the natural world, make their own observations, and propose explanations based on the evidence of their own work."*
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> *(NSES, NRC, 1996, p. 350)*

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[3]Examples of legislation include: No Child Left Behind (USA, Act of Congress, 2001); Every Child Matters (UK, Government Green Paper, 2003); Count Us In (Scotland, 2002 - following Standards in Scotland's Schools etc. (Scotland) Act 2000).

Educationalists and policy makers intuit that the best way for children to learn (about) science is to emulate the activity of scientists ... and this is where inquiry is key. Inquiry is at the very heart of scientific endeavour. It is driven by innate human curiosity and the 'need to know', and leads to the generation of useful knowledge. However, curiosity is not the preserve of scientists, it is inherent in all of us. Lunetta et al. (2007) highlight the parallels between how scientists generate knowledge of the world and how we as individuals attempt to make sense of the world, constructing ideas based on observations of objects and their interactions. These ideas become linked to other ideas and are tested against the understanding of others with the result that some ideas and concepts are retained and others are revised or rejected. Thus, as Lunetta and colleagues suggest, inquiry is a very natural human activity.

This is not to suggest that we inherently know HOW to conduct more formalised scientific inquiry (if, indeed, it needs to be formalised), or have the requisite skills. Like driving a car (or writing a thesis!), there are conventions which must be learned, skills which must be developed and performance-related attitudes and dispositions which must be nurtured, outcomes which may be achieved through experience and with guidance. However, in terms of scientific inquiry, the nature of that experience and the level of guidance provided are crucial. One could no more expect a student to become a proficient investigator by carrying out prescribed practical experiments with instructions (to verify what's already been taught), any more than one could expect someone to become a proficient driver by reading a manual alone. Such learning is de-contextualised, unconnected, superficial, and lacks relevance. Yet, largely due to a focus on 'science content', these verification labs seem to be the mainstay of school science laboratories.

Of course, students must learn content, and routine practical work (involving setting up equipments, measuring, manipulating data and practicing important techniques) has an important place in the science class. However, as Bell (2009) argues, both aspects are better addressed in the context of more authentic scientific investigations. That is, attending to 'real' questions and problems that arise in the course of lessons or from students' own observations and interests. Arguably, the problems that we are most motivated to solve are not those which are thrust upon us by others, but those which arise naturally in the course of our lives, particularly when they are at odds with previous knowledge or experience. Taking this approach in the science classroom makes the learning more relevant and worthwhile from the students' perspective and therefore more likely to enhance engagement and motivation (O'Neill & Polman, 2004). Through their own efforts, individually and collaboratively, students come to know something they did not know before they started. And "… even when [the] investigation fails to find the answer, at least the inquiry should have yielded a greater understanding of factors that are involved in the solution" (Minstrell, 2000, cited in Barrow, 2006, p. 265). To experience false starts, overcome technical and practical difficulties, explain errant results and reconcile conflicting findings, is to experience science as it is - collaborative, creative and constructive. Students learn that science does not proceed by a straightforward linear process - results are often ambiguous, or at best, inconclusive, and resulting knowledge tentative - and they develop 'scientific habits of mind' such as respect for evidence, perseverance, creative thinking, and critical evaluation. Also, by giving students the opportunity to see the problem through from start to finish - to conceptualise and discuss the problem, devise methods to investigate, collect and analyse data, explain results and make connections, draw conclusions and communicate findings (activities which, in essence, reflect the essential features of inquiry in NSES) – students have a basis for their decisions and actions, learning is more holistic and skills more easily transferred to other arenas (Hodson, 1992). Thus authentic inquiry promotes engagement, application of knowledge and "enduring understanding" (Aaron et al., 2006) as opposed to routine and recall.

Consistent with Learning Theory

(Socio-)constructivism has been the dominant learning theory informing educational practices for several decades. It asserts that, although we possess an innate potential for learning in terms of cognitive architecture, knowledge itself is constructed within the individual (rather than passively received), and past experience and social context have a strong bearing on meanings created.

John Dewey, the academic and philosopher most widely credited with pioneering the inquiry revolution, believed that learning in science should involve more than the mere memorisation of facts and accumulation of 'inert knowledge' (a term coined by Whitehead (1929) to signify a lack of connection to either prior understandings or wider concepts). Indeed Dewey argued that scientific knowledge develops as a product of inquiry; that giving children the opportunity to work like 'real scientists' develops not only their understanding of scientific processes and the nature of science, but also enhances their conceptual knowledge and understanding. Since inquiry is based on 'real' problems it invokes prior knowledge and often involves 'cognitive conflict', necessitating the modification of their existing knowledge framework to accommodate new discoveries. This essentially describes Piaget's process of adaptation through 'assimilation and accommodation'; assimilation being the process whereby new information is perceived in light of what is already 'known', and accommodation, the modification of existing mental schemas to fit with new information. Knowledge of the world is constructed and re-constructed in this way through a series of experiences, influenced by social and physical setting.

Wynn Harlen (former Director of the Scottish Council for Research in Education and prolific writer in the area of Science Education) maintains that we should not simply concentrate on building new knowledge but use the little ideas that learners bring with them to school - the unscientific ideas and/or misconceptions which they have constructed from their own experiences - and build upon them to create bigger, more scientific ideas through investigations and other collaborative activities (see Harlen in Black & Lucas, Eds, 1993). This is in accordance with socio-constructivist learning theories which purport that resolution of cognitive conflict through social interaction and discussion deepens learning and helps individuals achieve greater understandings than they could achieve on their own. Through dialogue and shared activity pupils are exposed to a variety of perspectives – some of which may be at odds with their own – offering the potential to arrive at shared deeper understandings, which, with strategic scaffolding by the teacher, may be more scientifically sound than their original conceptions. This potential for cognitive transition is known as the 'Zone of Proximal Development' (Vygotsky, 1978), a concept which has helped elucidate the positive effects of collaborative learning experiences, and provided the rationale for the co-operative learning revolution currently sweeping educational circles.[4]

In terms of the contribution of inquiry within this 'zone', Lindfors fervently offers:

> *"I believe that there is no single human activity more fundamental and powerful in one's learning than inquiry. We hear much about the Zone of Proximal Development*

[4] Some common collaborative learning structures include 'Jigsaw', 'Carousel', 'Three Stay-One Stray', 'Think-Pair-Share' and its counterpart 'Team-Pair-Solo'.

these days, that particularly promising cognitive area where a child can go further with another's help. This is where inquiry lies. Vygotsky points out that it is neither what the child can do independently already, nor what is way beyond the child's current ability, that is most promising for the child's learning at any given moment. Rather, the place of promise is that area just beyond the child's reach. Acts of inquiry occur at this very place. The child controls the zone through his or her acts of inquiry. These acts bring the helping other – often the teacher – to that perfect place, the going-beyond-with-help place." *(Lindfors, 1999, p. 20)*

Positive Outcomes

The argument for inquiry in science education reform has intuitive logic and theoretical basis but is this argument borne out by empirical evidence?

A huge body of evidence exists in support of an inquiry-approach to teaching science in school. For example, a large-scale meta-analysis of the science education literature conducted 20 years ago (Anderson, 1983) found that inquiry produced significant cognitive gains; two other studies around the same time yielded similar findings (Bredderman, 1982; Weinstein, Boulanger, & Walberg, 1982). A decade later, inquiry was found to improve scientific literacy as reflected in improved learning of science processes and vocabulary, conceptual understanding, critical thinking and attitudes towards science (Haury, 1993). More recently, Hand et al. (2004) reported that pupils involved in inquiry demonstrated a developing understanding of the nature of science and the processes of scientific inquiry, and Akkus et al. (2007), using an experimental design and combining both observational data and test scores, found that implementation of high quality investigative pedagogy not only had a positive impact on student learning, but engaged a wider pupil audience, effectively reducing the achievement gap in science classrooms.[5]

[5] Both studies (Hand, 2004; Akkus, 2007) are based on collaborative inquiry using the Science Writing Heuristic, an instructional tool developed by Keys et al. (1999) which encourages reflection in order to derive meaning from laboratory investigations.

Further evidence for the potential of inquiry-based instruction to engage a wider audience comes from a recent large-scale quantitative study involving 1,700 middle/high school students in the USA. Blanchard and colleagues (2010) administered pre-, post-, and delayed post-tests to compare guided inquiry–based instruction[6] to more traditional, verification laboratory instruction for the learning of content, process and nature of science. Factoring in Reformed Teaching Observation Protocol (RTOP) scores, it was found that, regardless of school level or socio-economic status, 'inquiry students' out-performed those who experienced more traditional instruction in both post- and delayed-post tests. This suggests both the immediate and the longer term benefit of inquiry-based learning, but also implies that the science reform agenda is not incompatible with the inclusion/accountability agenda discussed earlier.

Evidence suggests that the potential positive effects of an inquiry-based approach are not confined to school-age learners. Using an experimental design with first year university students in Sweden, Berg and colleagues (2003) found that, compared to the expository mode, an open-inquiry version of a chemistry laboratory experiment led to more positive outcomes in terms of both learning and attitude. Analysis of questions provided insight into students' thinking during laboratory work and demonstrated deeper understanding and greater reflection among 'open-inquiry students'.

However, not all significant parties are convinced that these objectives are as important as more specific knowledge of vocabulary and facts, or that inquiry and expository approaches are necessarily mutually exclusive. Flick (1995), for instance, explored research on both explicit instruction and inquiry-oriented instruction and reported major gains in student achievement on selected kinds of instructional objectives from explicit teaching (factual aspects of science and learning specific skills). Gains in student achievement through an inquiry approach, on the other hand, are invariably qualified by specific contextual criteria, such as learner characteristics, class dynamic, adequate materials, complexity of the phenomenon under investigation, appropriate structuring of the learning environment, and an 'understanding of basic principles and key procedures', most likely arrived at through

[6]Characterisation of Guided (Level 2) Inquiry: Teacher provides the question but students have responsibility for devising method and interpreting results.

explicit instruction. Thus Flick problematises the dichotomy between inquiry and traditional instruction, 'typical classrooms' being at the heart of his argument.

Inquiry – A Problematic Pedagogy

Whilst the current thrust of science education reform is to firmly establish 'authentic scientific inquiry' as the foundation of science curricula, this vision is proving problematic in both conceptual and operational terms. Conceptually, what constitutes authentic inquiry, the extent to which it is accommodated in 'typical classrooms' and the range of learning goals that it satisfies are contentious issues (Flick, 1995). There are various brands of 'inquiry' described in the literature and 'inquiry teaching' has proved difficult to define (Barrow, 2006). Further, teachers' own notions of scientific inquiry are likely to be framed by their memories of learning science, their (often limited) experience of working science, representations of science in the media, and their own, more recent, teaching experience (Brickhouse, 1990). In operational terms, even assuming an understanding of inquiry which aligns with national policy and science education reform efforts, teachers' practice will inevitably be determined by the various agendas which operate in any school: the management's, the community's, the pupils', and of course their own.

The remainder of the chapter offers a more detailed overview of the literature in relation to conceptual and operational barriers to inquiry.

Conceptual Crisis

The ambiguity surrounding the term *Inquiry*, particularly in terms of what it means for classroom practice, is well acknowledged in the literature. Although Settlage (2003) suggests that there is a commonly held framework for science inquiry which starts with a question based on observations and ends with a conclusion based on evidence, he holds that the term is "one of the most confounding terms within science education" (p. 34).

Towards the end of the last century, driven to improve the quality and equity of the curriculum, the USA's science education reform agenda was explicitly set out in the form of 'Standards' (the National Science Education Standards, NRC, 1996) which conveyed a vision of ‘science for citizenship’ and in which the central position of inquiry in science education was absolutely clear. They further attempted a degree of clarity by proposing the following operational definition of inquiry:

> *Inquiry is a multifaceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in light of experimental evidence; using tools to gather, analyze, and interpret data; proposing answers, explanations, and predictions; and communicating the results.*
>
> *(National Science Education Standards, NRC, 1996, p. 23)*

Having set this agenda, a set of guidelines was subsequently produced aimed at supporting practitioners and informing new teacher education, restating the ‘essential features’ of inquiry (NRC, 2000; see Table 1 below). These documents have been very influential in the global science education arena, however, almost a decade after their publication, Abd-El-Khalick et al. (2004) demonstrated an enduring lack of consensus on inquiry in terms of both philosophy (how it relates to the *Nature of Science* and *Scientific Literacy*) and practice (how it is manifest in materials and practices), as well as its purpose in the enterprise of science education. Contributors at the symposium (upon which their report was based) provided images of inquiry from their respective countries (including Taiwan, Australia, Israel, USA and South America – no European perspective!) and discussed how inquiry-based science was either fostered or hindered in their various educational contexts. Whilst it was found that inquiry was a major theme internationally, the initial assumption that symposium contributors held common ideas about inquiry in science education was challenged.

Bell et al. (2009) argue that different notions of inquiry exist due to conflation with other approaches. Many brands of inquiry have been described over the years – discovery learning, experiential learning, project-based learning, and inquiry-based learning – often assumed to be synonymous in terms of approach. However, on closer scrutiny we can infer different practices in each, ultimately determined by learning goals and shaped by prominent leaning theories of the time. For instance, following the popularisation of Piaget’s work on constructivism during the 1960s and its emphasis on individual construction of understanding, discovery learning was advocated. Subsequently, with the publication of works by social constructivist proponents, including Vygotsky and Bruner during the 1970s, classroom practices began to reflect more collaborative learning structures. Even assuming a more co-operative learning environment, descriptions of inquiry reflect different 'degrees of concretion' (Bell et al., 2009) both in terms of learner autonomy and procedural constraints. For instance, Hassard and Dias (2009) characterise inquiry as either 'guided' or 'open' depending on teacher contribution, particularly the origin of the problem under investigation, however, they see both approaches as perfectly legitimate depending on the complexity of the problem and the intended learning objectives. This classification reflects the top two tiers of the 4-level model of inquiry developed by Rezba, Auldridge and Rhea (1999, discussed in Bell et al., 2005) which was based on the degree of structure imposed: confirmatory, structured, guided, open. The omission of 'confirmatory' and 'structured' categories from the more contemporary model perhaps reflects a view that only those activities which involve students in a degree of independent thinking, decision making and logical reasoning may be classed as inquiry.

Gyllenpalm (2010) argues that another source of confusion arises from the various ways in which inquiry is discussed in reform rhetoric. Major reform-oriented documents advocate learning science by inquiry, learning about inquiry, or learning to do inquiry – three quite distinct goals. Anderson (2002) points to the three ways in which the term inquiry is discussed in the NSES: 1) scientific inquiry, 2) inquiry learning, and 3) inquiry teaching (NRC, 1996). In Scotland, the terms 'investigation' and 'inquiry' both appear in the rhetoric of Curriculum for Excellence, however, although inquiry may be thought of as an investigative process, the terms in this reform-oriented document do not seem to be interchangeable. For example, the section entitled Science: Principles and Practice discusses "inquiry and investigative skills", which implies a subtle difference between those skills associated with inquiry and those needed for investigations. Similarly, listing "scientific investigations, inquiry and analytical thinking" separately suggests that each involves distinct cognitive processes.

Given the widespread perplexity and variety of perspectives on inquiry it is crucial that any discussion thereof involves a clear characterisation of the approach in terms of both practice and learning intentions as, arguably, the perceived educational merits of an inquiry-based approach depend entirely on how inquiry is defined. To illustrate, Kirschner et al. (2006) review a small number of studies and conclude the ineffectiveness of inquiry as an instructional approach. The authors, however, characterise inquiry as 'minimally guided instruction', synonymous with discovery learning (Bruner, 1961) and experiential learning (Boud, Keogh & Walker, 1985), essentially unguided approaches where learning is 'constructed' by the individual from the experience of interacting with materials provided in a given context. Kirschner and colleagues argue cogently against such tactics based on current understandings of human cognitive architecture, expert-novice differences and cognitive load, and present an array of supporting evidence, including how 'discovery learning' in particular can lead to false starts, frustration and errant learning (Brown & Campione, 1994). One might contest, however, the characterisation of inquiry as a minimally guided approach. Hmelo-Silver et al. (2007) counter that inquiry based teaching is quite distinct from discovery learning in that it relies strongly not only on strategic scaffolding but also on direct instruction to support learning. Kirschner and colleagues fail to take into account the description of inquiry in major reform oriented documents, such as those listed in Table 1 (below).

Inquiry and the National Science Education Standards (NRC, 2000, p29) Learner …	Curriculum for Excellence: Principles and Practice Sciences: Inquiry and Investigative Skills Learner …
• engages in scientifically oriented **questions**	• asks questions and generates hypotheses
• gives priority to **evidence** in responding to questions	• plans and designs procedures and experiments • selects appropriate samples, equipment and other resources • carries out experiments • uses practical analytical techniques • observes, collects, measures and records evidence, taking account of safety and controlling risk and hazards
• formulates **explanations** from evidence	• presents, analyses and interprets data to draw conclusions
• **connects** explanations to scientific knowledge	•
• **communicates** and justifies explanations	• reviews and evaluates results to identify limitations and improvements • presents and reports on findings

Table 1 - Comparison of Essential Features of Inquiry as described in NSES and CfE documentation

From the descriptions in Table 1, a definition of inquiry begins to emerge. At its most basic it involves pupils seeking to answer scientifically oriented questions using evidence to explain and justify their conclusions; yet the skills required to engage in such activity – for example planning, reasoning and argumentation - are far from basic. There can be no suggestion that the vision of inquiry portrayed in the above documents is an unguided process. However, the question remains as to how best to support both the development of inquiry practices in schools and to nurture the requisite skills in young learners.

Schwab (1962) originally envisaged introducing inquiry incrementally using 3 distinct levels, each requiring greater pupil background knowledge and skill: level 1 - present problem with suggestions for solving the problem; level 2 - problem posed without methodological suggestions; and level 3 - problem identification on particular phenomenon (see Herron, 1971). NSES and CfE take a similar tack in developing skills through progressively increasing the demands inherent in the task (NRC, 2000, p. 29; Scottish Government, 2008) Notably neither Schwab's educational aspirations nor the more contemporary reform papers include teacher roles or behaviours. As Anderson (2002, p. 4) points out: "While research says inquiry teaching can produce positive results, it does not, by itself, tell teachers exactly how to do it."

Operational Obstacles

In operational terms, the reform vision is problematic on different levels: the education system, constituent schools and individual teachers. Visions of educational reform are generated at a high level, at a place distant and disparate from schools themselves, however it is schools, and ultimately individual teachers, who have to translate these visions into reality in the complex context of the classroom. Thus, even if policy makers and academics can come to some consensus on what inquiry should look like in the classroom and its educational objectives, these notions still have to be reconciled with those of teachers themselves.

Although there is a preponderance of literature which attests to the lack of definitional clarity inherent in inquiry discourses, in contrast to more traditional pedagogies involving direct instruction aimed at memorising facts, the various notions of inquiry converge on a more pupil-centred, active learning approach with constructivism as its main philosophy, aimed at developing scientific literacy in all children, including critical skills and deep understanding. This objective necessitates transforming classroom practice in many ways.

Traditionally science has been taught as a body of knowledge, with the role of the teacher being that of transmitter and assessor; apparently student acquiescence and rote learning were more highly valued than active participation and critical thinking (Yore, 2001). It is little wonder, perhaps, that engagement and further study of science subjects has declined. Incorporating more student-centred collaborative inquiry is advocated to stimulate interest and encourage students to pursue their own interests and investigate problems relevant to them, but this imposes new roles on both teachers and pupils. From the pupils' point of view it involves active participation, often as part of collaborative learning structures, which can be disconcerting, even uncomfortable, for some students conditioned towards a more passive mode of learning. The inquiry-based science teacher is expected to take on the role of scientist, diagnostician, motivator, guide, mentor, monitor and collaborator (Crawford, 2000), but as Wallace and Kang (2004) assert, "typically teachers are not prepared for these roles during ITE and most teachers do not see these roles exemplified by their peers in school" (p. 940). Incorporating an investigative pedagogy is also relatively time consuming and requires a degree of creativity, flexibility, and relaxing of classroom control mechanisms, which runs the risk of exposing teachers' vulnerabilities. Thus, whilst many teachers agree with the philosophy of inquiry, it is claimed that most have neither the competence nor confidence to incorporate this approach (Jones et al., 1992).

It is often argued that teachers' confidence in their ability to support investigative work is limited by their own lack of research experience and thus limited understanding of the processes of scientific inquiry and the nature of science itself (Gallagher, 1991; Hodson and Bencze, 1998); despite holding degrees in science, they hold common assumptions about what it means to 'do science' which are fundamentally flawed (Gallagher, 1991; Windschitl, 2004). Research suggests that most science teachers hold a 'public view of science' (Gordon, 1984) derived from a combination of their own schooling and how science is portrayed in the media. In his ethnographic study of practising science teachers, Gallagher (1991) found the views of 25/27 to be 'unsettling'. All (25) placed greatest emphasis on science as a 'body of knowledge' as reflected in classwork, homework and tests; labs were much less frequent than expected and issues surrounding the nature of science were rarely discussed. This might suggest that focused learning in this area is warranted, and indeed some researchers have reported modest gains in investigative pedagogy following either a programme of inquiry workshops (Lotter et al., 2007), or a course of instruction on the philosophy and nature of science (Abd-El-Khalick, 2005). However, even with a background in scientific research teachers may be unable to draw on their experience in order to support investigative work in the classroom (McNally, 2006a). It seems that teachers' capacity to support inquiry is mediated by other factors.

Based on a paper prepared for the Centre for Science, Mathematics and Engineering Education at the National Research Council, Anderson (2002) reported that in schools which had successfully initiated new approaches to science and mathematics instruction, barriers and dilemmas were clustered in three dimensions previously identified (Anderson, 1996) - technical, political and cultural. Technical barriers included lack of understanding and low capability, largely due to inadequate training and lack of flexibility. Those in the political dimension included lack of provision (training and resources), parental resistance, and conflicting opinions. Cultural barriers included commitment to a textbook and attitudes towards assessment which lead to "an overriding commitment to coverage because of a perceived need to prepare students for the next level of schooling" (p.8). Anderson suggests that cultural barriers may be the most pervasive as these reflect teachers' deep-seated beliefs and personal values, however, as Haser and Star (2009) point out, "even when teachers have rather untraditional beliefs about teaching, national curriculum context with national exams directs them towards more teacher-centred practices" (p.294).

Renewed reform efforts to place inquiry at the centre of science instruction have been launched against a background of legislation concerned with inclusion and accountability, however, just how compatible these two agendas are is highly questionable. Largely governments' approach to 'science for all' (inclusion) has been to step up summative assessment (accountability) which "encourages teachers to adopt teaching practices that they perceive as the most effective for 'raising test scores' rather than practices that focus on student understanding" (Blanchard et al., 2010, p. 579). Ironically, this is especially true in areas of high deprivation where teachers and principals come under close scrutiny from both government officials and the general public, and there is great pressure to raise attainment and break the poverty cycle (Jones et al., 2003). It is argued that this tendency towards accountability is seriously hampering reform efforts (Anderson, 2012).

CHAPTER 3 - EARLY PROFESSIONAL LEARNING

According to Shulman (1998), all professions are characterized by the following attributes:

- the obligations of service to others, as in a "calling"
- understanding of a scholarly or theoretical kind
- a domain of skilled performance or practice
- the exercise of judgment under conditions of unavoidable uncertainty
- the need for learning from experience as theory and practice interact
- a professional community to monitor quality and aggregate knowledge

This characterisation would certainly resonate with the education community. Most teacher candidates are drawn to the profession, feeling a moral obligation to ‘make a difference’; there exists a variety of governing bodies, as well as recognised standards, by which to control entry to the profession and measure teaching competence; an extensive academic community contribute to a wide body of knowledge pertaining to educational contexts and theories; teaching practice is informed by this broad base of knowledge, but developed and adapted over time and through experience on the job.

New teacher early professional learning can be broken down into three phases, preparation, induction and continuing professional development, all of which are distinct and formative in terms of both of learning and teacher identity. This chapter is concerned with the first two of these phases: preparation and induction. It begins by considering where candidates are when they enter the profession in terms of identity, beliefs and aspirations, and contemplates how these are challenged by the realities of teaching and the contexts they find themselves in. It also considers the nature of knowledge gained during ITE and the extent to which this prepares them for their role. It goes on to discuss the experience of newly qualified teachers; firstly, the dilemmas inherent in taking up the role of classroom teacher, then how their induction into the profession is formalised and learning organised, and how this contrasts with the contended ‘true’ nature of on the job learning (ie. reactive and implicit; Wiliams, 2003). Finally it asks the question: Is becoming established in the profession a process of learning to teach or one of 'becoming' a teacher?

Initial Teacher Education

Teaching Culture and Teacher Identity

Teacher candidates bring with them a personal ideology – a set of beliefs and values concerning the nature and purpose(s) of education, the subject they are to teach, student intelligence and motivation, and the role of the teacher in the learning and development of students, all tempered by notions of authority and morality. These ideas have been shaped over many years by culture, experience and relationships, and constitute the foundations of a preliminary teacher identity which will influence what and how they teach initially (Loughran, 2007).

However, as Florio-Ruane and Lensmire caution (1990, cited in Pajares, 1992), not all beliefs of pre-service teachers are compatible with policy aspirations or the educational hopes of teacher educators. For instance, many view teaching as a process of transmitting knowledge and of dispensing information, and emphasize affective variables over cognitive/academic variables (Porter & Freeman, 1986 and Brookhart & Freeman, 1992 cited in Pajares, 1992). Pajares himself argues that unless their images of teaching are explored and challenged during Initial Teacher Education, pre-service teachers' implicit educational theories will persist and even pervade professional development by influencing how new knowledge is received and interpreted, thereby shaping decisions on, and potentially limiting, classroom practice.

Brousseau and colleagues (1988), however, highlight the influence of the 'teaching culture' – that is, the collective educational beliefs and objectives of a school's community – on beginners' educational beliefs. In their comparative study of beginning versus experienced teachers' educational beliefs (in the areas of students, curriculum, social milieu, teachers and pedagogy), they found that 'years of experience' was the only variable to impact directly on the majority of beliefs measured; the direction of change, however (beneficial or detrimental) varied by area examined. For instance, in terms of beliefs about students, it was suggested that with increasing classroom experience, student autonomy and independence are favoured over strict control and supervision, whereas in terms of teacher efficacy, over time teachers grow more pessimistic about the impact of their efforts on student outcomes. More recently Georgiou's (2008) findings seem to support the claim for the negative effects of enculturation. Using a standardised survey instrument, BASA (Beliefs About School Achievement), Georgiou examined experienced and novice teachers' beliefs about student achievement specifically and reported that, whereas novices' beliefs were optimistic of the positive impact of teacher input and student effort, more experienced teachers tended to attribute achievement more to innate ability, gender and background. Various researchers attest to the influence of school culture (for example, Tobin & McRobbie, 1996; Yerrick et al., 1997; Munby et al., 2000, all cited in Wallace & Kang, 2004) which, Brousseau and colleagues (1988) conclude, is pervasive enough to span school settings and to minimize gender differences.

It should be recognised, however, that a major limitation of research which relies on surveys or questionnaires alone, such as those discussed above, is that teachers' responses may or may not reflect their reality. Participants may say what they believe the researcher wants to hear or espouse practices believed to be valued by the profession (ideals) rather that what is actually done. For instance, using data collected though a combination of surveys and interviews, Cheng et al. (2009) pointed to the lack of a direct relationship between student teachers' espoused epistemological beliefs and their day-to-day teaching practice. As Cheng and colleagues point out, this does not necessarily imply that their underlying beliefs have changed; in the early stages, particularly whilst under the supervision of co-operating teachers, conflicting agendas are common. The complexity of the classroom, expectations of significant others (pupils, parents, peers and superiors), and the demands of the job generally may constrain teachers' ability to "attend to their beliefs" (Fang, 1996) and teach in a way that aligns with them. However, it could also be argued that just such contextual complexity may lead to the actual modification of beliefs themselves. Haser and Star (2009) suggest that when teaching experiences during the first year of teaching contrast with those during teacher training, beliefs become more teacher-centred "in order to survive the real-classroom context" (p. 300).

The Nature of Knowledge Gained

Programmes of Initial Teacher Education (ITE) aim to prepare prospective teachers for professional work in schools. However, schools are idiosyncratic places, and classrooms dynamic and unpredictable. Like other professional work, although dependent on a solid knowledge base, teaching involves “judgement under conditions of unavoidable uncertainty” (Shulman, 1998, p. 516). Managing complexity and meeting challenges requires utilising knowledge strategically in reasoning and decision making. So … How can prospective teachers best be prepared for the uncertain and/or unexpected? What knowledge do teachers require to allow them to make managerial and pedagogical decisions? These are questions which have preoccupied Shulman, and many others, for decades.

Primarily, through university taught courses covering the fundamentals of teaching (educational contexts and principles, cognitive psychology, classroom management, curriculum and pedagogy), ITE aims to provide a broad base of professional knowledge, based on current educational theories and policy aspirations, upon which to build good practice. A challenge for teacher educators is how to connect the "text" of academic learning (theory) to the "context" of contemporary classrooms and schools (practice) (Dalton & Moir, 1996, cited in Feiman-Nemser, 2001). To this end, in addition to taught courses most programmes of ITE provide blocks of teaching practice at strategic points throughout the academic year in order that certain topics can be appreciated in context and to facilitate the interaction of theory and practice. Student teachers are generally expected to ‘learn to teach’ initially through observation and by example, taking on teaching tasks incrementally as their practice and confidence grows. However, research suggests that student-teachers often feel inadequately prepared for the classroom by their teacher education programmes (Kagan, 1992; Korthagen, 2010). ITE theory is seen as remote and of little immediate relevance (McNally et al., 1997). “They expect they will be told how to teach, and instead are presented with a myriad of teaching issues to consider that do not readily translate into how to conduct a lesson” (Loughran et al., 2008, p. 1301). They are often unprepared for the culture and politics within schools and classroom management can be problematic (Saddler, 2006) and paradoxically, although it is ultimately the knowledge of their subject that they hope to pass on to their charges, historically content coverage has been conspicuous by its absence in most programmes of ITE.

Acceptance onto ITE programmes is usually dependent on holding an appropriate level of qualification in their taught subject, so their knowledge in this respect is generally assumed, however, whilst novices may have well developed knowledge and understanding in their particular field they probably lack the ability to translate their own understanding into forms which can be understood by children. Also, many degree courses have a very narrow scope and, as Kind (2009) points out, teachers, even student teachers, often find themselves having to teach topics outwith their specialism. In his address to the American Educational Research Association, Shulman (1986) referred to the lack of focus on the 'what' and 'how' of teaching as 'The Missing Paradigm'. He regarded it a failing of Initial Teacher Education and argued for the inclusion of content knowledge as a critical component of teachers' professional knowledge - not only knowledge of the subject matter being taught and how it fits with the overall curriculum, but crucially how teachers transform their own knowledge into a form which can be more readily understood and learned by others. This latter knowledge category he termed pedagogical content knowledge (PCK), often conceptualised as the intersection of content knowledge, curricular knowledge and knowledge of general pedagogy (Gess-Newsome & Lederman, 2002). Since then PCK has been extensively researched, expounded and elaborated (Barnett & Hodson, 2001; Loughran et al., 2006; van Driel et al., 1998).

Gess-Newsome and Lederman (2002) venture that "the construct of pedagogical content knowledge [PCK]… has served to re-focus educators' attention on the important role of subject matter in educational practice and away from the more generic approach to teacher education that dominated the field prior to 1975." (Abstract) Despite Gess-Newsome and Lederman's claim, the apparent lack of impact on teachers' practice is implied in a recent report, *Success in Science*, published by the Office of Standards in Education (Ofsted) in England:

> *"Given the extensive subject knowledge of most secondary science teachers much teaching paid scant regard to what and how pupils were learning. In many lessons, teachers simply passed on information without any expectation of pupils' direct*

> *engagement in the process. The objective appeared to be to get notes into books, then leave the learning to the pupils."*
>
> ***(OFSTED, 2008, p. 17)***

This gap must be bridged if policy visions are to be realised. In defining PCK as "the most useful forms of representation of [those] ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations" (Shulman, 1986, p. 9), together with the fact that PCK has become an explicit component of, at least some, ITE programmes, suggests that PCK can be developed to an extent through direct teaching, conscious awareness and observation. However, if we extend the definition to include: "knowledge of how to teach specific content in specific contexts" (Appleton, 2003, p. 3), which acknowledges the contribution of pupils, both individually and collectively, then this necessitates personal experience of those contexts. If becoming a teacher is, in essence, about mastering classroom management in order to facilitate pupil learning (Appleton & Kindt, 2002; Clandinin, 1989) then the importance of personal practical knowledge – encompassing "experiential knowledge of students' learning styles, interests, needs, strengths and difficulties and a repertoire of instructional techniques and class management skills" (Elbaz, 1981, p. 5) - cannot be overstated. This type of learning results in an integrated and contextualised collection of knowledge, beliefs, and values and helps teachers develop theories that inform decisions, effectively developing what Shulman would call strategic knowledge. Based on tacit knowledge and personal judgement it provides a rationale for decisions when the situation invokes contradictory theories or when the particulars of a case are incompatible. Shulman illustrates this well:

> *"From Rowe's (1974) research on wait-time, for example, we learn the principle that longer wait-times produce higher levels of cognitive processing. Yet Kounin's (1970) research on classroom management warns the teacher against slowing the pace of the classroom too severely lest the frequency of discipline problems increase. How can the principle of longer wait-times and that of quicker pacing both be correct?"*
>
> ***(Shulman, 1986)***

However, the opportunity to develop such situation-specific knowledge during ITE is limited. Blocks of teaching practice are short and supported, the range of classes limited, and learning is mostly by observation rather than personal experience of teaching. Much more useful in preparing new teachers for the uncertainties of teaching, argues Shulman (1986), would be to adopt the medical profession's 'case' approach to early professional learning. Derived from the experience of other professionals, case knowledge, invokes real situations and provides a precedent for decisions, both managerial and pedagogical, including how best to approach certain topics with certain classes.

The Induction Experience

Assuming the Role

"Few experiences in life have such a tremendous impact on the personal and professional life of a teacher as does the first year of teaching."

(Gold, 1996, p. 548, cited in McCormack, Gore and Thomas, 2006)

Teacher identity is a dominant theme in education literature, central to 'becoming' a teacher. Appleton and Kindt (2002), relate teacher identity to Bandura's (1995) concept of self-efficacy, defined as "teachers' personal beliefs about their ability to teach and their ability to produce positive outcomes for children" (p. 43). Somewhat surprisingly, research suggests that candidates entering the profession already have a strong sense of self-efficacy. As Pajares (1992) claims:

> *"…most pre-service teachers have an unrealistic optimism and a self-serving bias that account for their believing that the attributes most important for successful teaching are the ones they perceive as their own. They believe that problems faced by classroom teachers will not be faced by them, and the vast majority predicts they will be better teachers than their peers." (p. 323)*

However, invariably these sentiments are challenged as they assume the role of classroom teacher and realise that they are not only responsible, but very much accountable for what goes on in their classroom, and for the products of their efforts. Perceived expectations of others, however vaguely articulated, can be quite overwhelming, and the learning curve is a steep one. Beginners must take control and teach whilst still learning to teach, developing their practice through experience, and demonstrating skills which have yet to be developed

- planning, differentiation, assessment, reporting, and crucially, classroom organisation and management. Management problems can leave teachers feeling vulnerable and overwhelmed and can seriously undermine confidence. As such, beginning teachers are preoccupied with discipline and behaviour, and strive to establish rules and routines in order to minimise disruptions (Kagan, 1992; Ewing & Manuel, 2005, cited in McCormack, et al., 2006). According to Kagan, beginning teachers have to resolve such concerns over acceptance, control and adequacy before they can begin to contemplate concerns of a more professional nature, namely teaching and learning. Consequently, at least in the early stages, the beginner's repertoire may be limited to 'activities that work' (Appleton, 2003), which constitute a compromise between useful learning and effective behaviour management.

Dilemmas are not confined to the classroom, however; social, political and even structural dilemmas are rife. Beginners have to integrate effectively with the mix of personalities that make up the department, align with extant systems and agendas, and access support and training appropriate to their developmental needs in order to satisfy the school's success criteria. As discussed in the opening to this chapter, the school context and culture has been identified as having a major influence on early development. Constituted by the collective beliefs, values and practices of the staff therein, the school culture can be stifling in professional terms, discouraging ambitious and innovative pedagogies in favour of more traditional 'safe' approaches, thereby challenging beginners' beliefs and ideals and constraining personal and professional growth (McCormack, et al., 2006). The prevailing culture also determines the organisation and allocation of work and the amount and nature of support available, as well as the expectations of beginners, including how explicitly these expectations are articulated. New teachers are often expected to (over-)commit to additional or extra-curricular activities in the guise of 'proving themselves' or 'initiation to teaching proper' and most lack the confidence to decline or ask for help lest it be seen as weakness or failure (Kind, 2009). Brickhouse (1992) points out that a perceived lack of supportive structures leads to the 'sink or swim' feeling experienced by many beginning teachers, and argues that this is detrimental to professional development as it forces them to "devote time to creating survival strategies rather than designing thoughtful instruction" (p. 14). Further, lack of recognition and positive feedback can lead to feelings of insecurity and isolation. Overall, adapting to their new context can lead to "loss of confidence and self-efficacy by new teachers in the abilities they thought they had and themselves as individuals" (Khamis, 2000, p5, quoted in McCormack et al., 2006).

Scottish Teacher Induction Scheme

Induction represents the transition from "knowing about teaching through formal study to knowing how to teach by confronting the day to day challenges." (Feiman-Nemser, 2001, p. 1027; emphasis added). Recognising the learning involved in this transformation from student of teaching to teacher of students, Williams and Prestage (2002) support the need for a quality induction experience where beginners are immersed in a collaborative environment in the context of a comprehensive, well-thought out and planned induction programme of learning experiences relevant to the learning needs. However, Fieman-Nemser (2001) recognises the inadequacy of conventional induction programmes and argues that the sporadic and disconnected nature of learning opportunities afforded to beginning teachers encourages a limited pedagogical repertoire and does little to foster serious commitment to professional learning and development.

The Scottish Teacher Induction Scheme was introduced in Scotland in 2002 to address such concerns. Aimed at providing a more structured and supportive induction experience, with an emphasis on Continuing Professional Development (CPD), the scheme provides a one-year salaried training post to newly qualified teachers, with a reduced teaching load and an individualised programme of support and monitoring by an experienced in-school mentor with regular meetings, observations, reviews and assessment. As part of the scheme the Standard for Full Registration (SFR) was published. This document is essentially a list of competencies expected of new teachers and, from schools' perspective, constitutes the 'standard' by which to measure progress as well as a framework for early professional learning. With the emphasis in the first year on meeting 'the standard', organised CPD aims to address any deficits in this respect in terms of requisite knowledge, skills and values.

This assumes that useful learning is a "self-conscious, deliberate, goal-driven process" (Eraut et al., 2000, p. 232, cited in Williams, 2003) and that the list of competencies in the SFR is an appropriate way to organise the learning experiences of all new teachers. However, reporting on an intensive study into the early professional learning of 28 new teachers in Scotland, McNally (2006c) demonstrates that the utility of the SFR as a guide for learning is rarely recognised by new teachers. Indeed, most fail to acknowledge the cognitive aspects of their experience at all. Although asked specifically about their learning and how supported they felt in 'becoming' teachers, knowledge, skills and values were rarely mentioned in the first weeks, and no mention was made of the SFR by the new teachers themselves; adapting to their new situation was all about relating to the various new people around them. Only when asked specifically about the SFR in relation to their learning (some months into the study when an interim progress report was due), did it become apparent that it was largely viewed as a checklist of requirements with no real relevance to their actual experience. McNally (2006b) claims the early experience is characterised by emotionality and the formation of a self-as-teacher identity, heavily dependent on the quality of the social environment and professional relationships. Eventually, perhaps as social and support networks are established, emotionality seems to diminish somewhat, however, relationships (both with colleagues and with pupils) remain central to being a teacher.

An extensive review of learning-to-teach studies (Kagan, 1992) highlights the importance of the beginner-mentor relationship specifically for determining the amount and nature of professional growth experienced, particularly when that relationship is based on professional trust and beginners are afforded autonomy and responsibility for instruction (Kilgore et al., 1990; Jacknicke and Samiroden, 1991; both cited in Kagan, 1992). A more recent study conducted in the United States (Marable & Raimondi, 2007) surveyed both mentored and non-mentored teachers (n=165:157) in terms of what was most and least supportive during their first year of teaching[7]. Least supportive factors were somewhat similar between the two groups - dissatisfaction with admin, training, and lack of materials. In terms of most supportive, however, among the mentored teachers, on the whole the mentors themselves were perceived to be the main source of support. Among the non-mentored, peers were identified as the main source of support; often an individual was

[7] Importantly, all mentors had received intensive training and were required to document bi-monthly meetings with their 'interns'. I say 'importantly' because in the context of the current study, although all new teachers are assigned a ‘mentor' (or supporter), the preparation and indeed commitment of these individuals is by no means uniform and beginners' experience of mentoring is highly variable.

identified as 'mentor' even though they had no formal capacity. This illustrates the importance of the 'human factor' in becoming a teacher – of someone beginning teachers can relate to, confide in, take advice and guidance from, and share successes with. This too is consistent with McNally's (2006b) claim that relational and emotional dimensions dominate early professional learning.

The Nature of 'On-the-Job' Learning

Professional learning occurs by a variety of means but essentially these fall into two main categories: formal, derived from planned activities with a structured agenda, and informal, derived from everyday experience and conversation. Additionally, from the point of view of the novice, learning occurs on different levels - deliberative, reactive or implicit - depending on the degree of conscious awareness and intention to learn (Eraut, 2004).

As discussed, most induction programmes take a formalised (deliberative) approach to learning, organising learning experiences around hot topics and perceived deficits in terms of competence based standards. Whilst there are undoubtedly categories of knowledge which can be explicitly taught (and deliberatively learned), such as structural knowledge (systems, policies, etc), knowledge of educational initiatives, and subject/curricular knowledge, due to the unpredictability of the classroom situation, Williams (2003) argues that individual teachers' learning needs are far ranging and difficult to anticipate. She maintains that most useful learning is reactive, in response to events as they unfold, and often implicit in that there is little conscious awareness of the learning taking; the resulting knowledge is tacit and difficult to articulate. For example, teachers acquire much information about the pupils they teach through a variety of sources - school records (deliberative), other teachers (reactive) and from interactions (implicit). At first beginners rely heavily on external sources, especially colleagues, however, over time the tacit knowledge becomes increasingly significant and used to inform classroom decisions over other forms of knowledge. As Stenberg et al. (2000, cited in Eraut, 2004) reason, taught knowledge is second hand at best, based on the experience of other(s) and therefore divorced from its original context. Knowledge acquired through personal experience, on the other hand, is already contextualised and readily accessible, although arguably the time available for reflection will determine the level of information accessed; the less time available, the more intuitive or even reflex behaviours become (Eraut, 2004). Through a series of encounters, tacit knowledge is refined, and given time for reflection, as well as the opportunity for discussion, the tacit can be made more explicit, thereby developing a form of personal case knowledge which allows teachers to recognise and respond to the particulars of a situation and deploy contingencies as appropriate.

This opportunity for communication may be the key to teachers' professional development. Although most induction programmes build in scheduled support meetings with a designated mentor, McNally and others (Eraut, 2004; Williams, 2003) point to the importance of more informal structures which afford opportunities for conversation, consultation and collaboration. Eraut identifies four main processes in workplace learning (listed below in Table 2, together with teaching specific examples), the success of which depend on the quality of workplace relationships and arrangements for supporting learning. Effective support involves a balance between 'on the spot' helpers and designated helpers (ie. mentors), but tips in favour of "informal support from whoever [is] available" (Eraut, 2004, p. 267). Being able to ask questions and get information quickly is important, although this may depend on individuals' disposition and attitude towards seeking help. Research suggests that many beginners are reluctant to seek help with a class or advice on how to teach a certain topic lest it be seen as a weakness and colour others' perception of their professional competence, impacting on their end of year report and ultimately their employability.

Main Processes in Workplace Learning - Eraut (2004)	**Teaching Specific Examples**
participation in group activities	meetings, curricular development, CPD
working alongside others	co-op teaching and observations to 'pick up' knowledge and expertise of more experienced others
tackling challenging tasks	the act of teaching itself? – if supported and successful it leads to motivation and confidence
working with clients	pupils, parents

Table 2 - Eraut's (2004) Main Processes in Workplace Learning, with examples from the Teaching Profession

Learning to Teach … or Becoming a Teacher?

Often described as 'The Roller Coaster Year' (Ryan, 1992), the first year of teaching is a testing time … a time of survival and discovery, adaptation and learning (Feiman-Nemser, 2001). Beginners come to the profession equipped with optimism and a preliminary teacher identity, however, they soon realise that schools too have an identity. It is articulated in its aims and policies (reflective of the community it serves), manifest in practices and protocols, and experienced as culture and climate created collectively by the individuals therein. This 'school identity' places great pressure on beginners. In addition to gaining local and professional knowledge, new teachers must diplomatically navigate school politics, integrate with existing practices and meet fresh challenges daily. Ideologies are challenged as they compromise what is desirable for what is possible, or expected, within their specific context, and teacher identity evolves to accommodate the complexities of school life and the dilemmas it brings.

In the process of becoming a teacher, beginners' self-as-teacher identity is founded on deep-seated knowledge and belief systems but shaped by on the job learning and the realities of teaching. Much of beginning teachers' knowledge of educational practices and contexts is theoretical, gained through university courses during Initial Teacher Education, however, this has been found to be of little immediate relevance to their experience in the classroom (McNally, 2006c; Roth & Tobin, 2001). The knowledge is theoretical, or 'propositional' in Shulman's terms, in that it proposes what is true or likely in a particular situation. This is not to suggest that university learning (theory) is not important, merely that to be useful it must be contextualised in practice. Abstract theoretical knowledge is transformed through the medium of experience (and reflecting on that experience) to practical knowledge (which subsumes case knowledge, pedagogical content knowledge and strategic knowledge) which is much more easily accessible and relevant to practice. Without a doubt early professional learning is complex and multi-dimensional (McNally et al., 2008). However, although the value of informal learning is well established (Williams, 2003), retrospective attempts to reveal the substance of teachers' early professional learning tend to elicit references to 'gaining experience' and 'growing confidence' rather than any explicit knowledge or sources of learning. McNally (2006b) suggests that, instead of 'learning to teach' which implies cognitive growth, the process may be seen as one of 'becoming a teacher' which implies a growing teacher identity, and argues that this is shaped by personal experiences of teaching and a sense of 'fitting in' with that particular community. This is ultimately dependent on positive interactions with significant others and perceptions of self-efficacy, initially in terms of classroom management and ultimately pupil learning, which are dependent on the development of personal practical knowledge and pedagogical content knowledge respectively. Teaching practices reflect their growing identity but are also constrained by teaching context - culture and traditions, expectations, and ideas about what constitutes good teaching - as beginners ultimately seek to achieve acceptance among colleagues, affiliation with the profession and credibility as a teacher.

CHAPTER 4 - INQUIRY: A CHALLENGE FOR NEW TEACHERS

Having explored the literature on inquiry and new teacher professional learning in Chapters 2 and 3 respectively, this chapter now considers the intersection of these literatures – beginning teachers' understanding and experience of science inquiry. This area is a much 'younger' and less well developed area of education research but one which is gaining in momentum, with an explosion of writings on the subject even in the time since the conception of this thesis.

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Hashwey (1996, cited in Wallace & Kang, 2004) conceived of two types of science teacher: empiricists, who see scientific knowledge as a 'collection of facts', invoke 'the scientific method' for generating new knowledge, and believe learning occurs best through a process of reinforcement; and constructivists, who appreciate that scientific knowledge is 'tentative and invented', consider pupils' preconceptions (naïve ideas) and see learning as a construction. It is this latter mindset, together with the requisite process skills of science, which will ultimately guide children towards scientific thinking, argues Harlen (1999). But just how do individuals arrive at such teacher identities?

It is widely held that teachers' core beliefs, shaped largely by personal histories, not only influence their practice, but are a strong predictor of their capacity to implement reform-based strategies (Cronin-Jones, 1991; Wallace & Kang, 2004). In making an argument for the influence of learning history on beginners' practice, in particular their propensity for 'structured' inquiry, Eick and Reed (2002) use two extreme cases from a multiple case study (*n=12*) of secondary science student teachers to demonstrate that stronger inquiry-orientation could be linked to their own learning in science, participation in science courses, and their experience of working in science, all of which seemed to inform their images of science. Lotter, Harwood and Bonner (2007) stress that to successfully promote inquiry, professional development programmes must not focus solely on inquiry instruction, but must also assess and address teachers' core teaching conceptions (conceptions of science, their students, effective teaching practices, and the purpose of education). If these are not addressed as part of a programme of Initial Teacher Education (ITE) or Continuing Professional Development (CPD), then teachers' own notions of inquiry prevail and practices reflect their own personal science epistemology as well as what educational outcomes are valued and how best to serve these (Brickhouse, 1990). Over time these notions are reinforced and practices perpetuated by the 'school science' culture and through the use of textbooks which, by and large, portray an idealised image of science that is structured and authoritative.

Siebert (2001) argues for the inclusion of inquiry instruction in courses of ITE; unless inquiry plays a dominant role in pre-service education there will not be a major impact on seeing inquiry in classrooms - future teachers need to experience inquiry as a learner during science methods courses and observe it happening in their field experience settings. However, Davidson and Bruce (1993) found that placing too much emphasis on classroom inquiry during ITE lead to feelings of anxiety - new teachers felt unable to facilitate inquiry as intended. It was incompatible with their notion of teacher-pupil roles, difficult to co-ordinate, exposed weakness in subject knowledge and threatened authority. Further, university methods courses were often not supported by teachers in schools; generally, pre-service teachers were expected to conform to the practices of supervising teachers, practices which were all too often non-inquiry-oriented. Findings of Fazio et al. (2010) similarly indicated that whilst participation in science methods courses did improve beginners' understanding and capacity for classroom inquiry, experience during practicum (including associate teacher subjugation, available resources and time constraints) often worked against the development of an inquiry-oriented teacher identity. This discord between the expectations of teacher educations and the reality experienced by student teachers is discussed by Saddler (2006). He contended that whilst teacher educators tend to regard placements as a time for trainees to experiment and reflect on innovative teaching approaches in a safe environment, trainees themselves saw the placement as something they must 'survive'. So teacher educators are often disappointed by a perceived lack of progress, and trainees frustrated with the perceived inadequate preparation for the challenges presented by real classrooms.

McNally (2006a) describes an ITE model whereby student teachers teach a series of 20 minute sessions with small groups of S1/S2 pupils prior to their first teaching placement (‘microteaching’) during which time they are required to do a small scale investigation and reflect on the experience. Even after this ‘protected experience’ McNally reveals the emotional dimension and anxieties arising from the early experience of doing investigations with classes during placement. Beginners’ lack confidence and are concerned primarily with ‘fitting in’ and meeting expectations; the risks associated with inquiry teaching may render them even more vulnerable. Nevertheless, students did take the step from ‘controlled exposure’ to the uncertainty of the classroom environment which, McNally suggests, lays the foundations of a pedagogy to be developed as confidence grows.

Luft (2009) points to the importance of teachers’ induction to the profession for establishing beliefs and practice, demonstrating that science-specific induction programmes have the potential to shake teacher-centred beliefs, practices and PCK, and thereby support reform efforts. One study based on an instruction model designed to support teachers’ inquiry implementation was that of Roehrig and Luft (2004). This study followed 14 beginning secondary science teachers over the course of a one year specialised induction program (Alternative Support for Induction Science Teachers; ASIST) in an attempt to understand the constraints that beginning secondary science teachers experienced in the implementation of inquiry-based lessons. The program was developed by university-based teacher educators, with the co-operation of school administrators, to foster inquiry-based environments in secondary science classrooms, and inquiry-based instruction was modelled explicitly according to the notion of ‘science as inquiry’ in the *National Science Education Standards* (NRC, 1996) and *Inquiry and the National Science Education Standards* (NRC, 2000). Despite similar preparation programmes, participants fell into three distinct categories of teacher: inquiry teachers (who advocated student-centred inquiry; *n=4*), process-oriented teachers (who focused on activities designed to support the learning of science process skills; *n=2*), and traditional teachers (who taught via lecture, discussion and verification labs; *n=8*). The most commonly reported constraint was low student ability and motivation and as such inquiry approaches were deemed ineffective. As the authors assert, such beliefs about pupils' abilities and motivation can be highly constraining and difficult to change. Another common constraint on inquiry practice was that of classroom management - inquiry was risky, particularly with low ability classes. On the other hand, it was found that “strong content knowledge combined with student-centred beliefs and a contemporary view of the nature of science increased the likelihood that inquiry would be implemented in the classroom” (Roehrig & Luft, 2004, p. 20).

More recently, Crawford (2007) examined the knowledge, beliefs and efforts of five prospective teachers to enact classroom inquiry in the context of a well-developed university-school partnership – a Science Professional Development School (SPDS). The five participants were hand-selected from a common ITE programme by their prospective mentors (all of whom were well versed in the programme’s goals, inquiry being a major focus), and went on to complete a year-long internship at the SPDS. According the Crawford, “the setting provided about as positive an environment as could be expected for prospective teachers to be supported in articulating and enacting reform-based, inquiry-oriented teaching practices” (inst., p. 619). However, despite a common experience of learning about inquiry during ITE, similar induction contexts (internship school), and mentors cognisant of the focus on inquiry approaches, the trainees’ understanding and views of inquiry differed greatly and they exhibited “an entire spectrum of practice – from traditional, lecture-driven lessons, to innovative, open, full-inquiry projects” (inst., p. 637). It was apparent that field experiences during the year had shaped their ideas – teaching workload, class dynamic, pupils’ attitudes and ability range and, significantly, their mentors’ stance on inquiry were all impediments to them implementing reform-based ideas. Other oft-cited constraints on beginners’ inquiry practice include: lack of administrative and collegial support; inadequate curriculum materials and texts, and limited time to adapt these to accommodate more reform-oriented approaches (Brickhouse & Bodner, 1992); and limited pedagogical content knowledge (either because they lack subject knowledge or the experience to translate it into appropriate activities). This is especially problematic when teaching outwith their specialist area (Crawford, 2000), although as Kind (2009) points out, the relationship between subject matter knowledge, pedagogical content knowledge, and inquiry-orientation is not a straight-forward one (other than in the primary sector where confidence seems to mediate).

That the area of science teaching is especially problematic for primary (elementary) teachers is well acknowledged in the literature. Even with an interest in promoting authentic science in their classroom, research indicates that beginning teachers often struggle to realise their own ideas of inquiry in real teaching contexts and instead rely heavily of existing curriculum materials as representations of accepted and effective science practice (although recent research suggests that, with appropriate instruction and support, elementary teachers are able to adapt curriculum materials to engage pupils in the essential features of inquiry (Forbes, 2011)). The problem is exacerbated by established school cultures which resist reform-minded pedagogies (Grandy & Duschl, 2007) and the de-emphasis of science in the primary curriculum (Marx & Harris, 2006). Informed by a review of the literature on the expectations and challenges faced by beginning science teachers (Davis, Petish, & Smithey, 2006), two of the authors went on to develop and report on a course of ITE intended to better prepare beginning primary (elementary) teachers to implement reform-oriented science instruction (Davis & Smithey, 2009). The goals of the course are threefold: that teachers develop an understanding of scientific inquiry and inquiry-oriented science teaching through experiencing and reflecting on inquiry-oriented science lessons; that teachers learn to adapt science curriculum materials to address the five essential features of inquiry (as per NSES, NRC, 1996); and that teachers learn to elicit and work with students' ideas in the course of instruction. Davis and Smithey contest that foregrounding ITE with these goals does indeed help to move beginners in the direction of reform-oriented science teaching, but identified areas in need of extra support included explanation construction and critiquing instructional representations suggested by curriculum materials (decisions regarding structure and support). Eliciting and working with students' ideas continued to challenge most trainees even on completing the course. Gaps in the literature identified by the review were beginners' conceptualisations of inquiry and their use of curriculum materials.

Thus, a beginning teacher's beliefs are only part of a much bigger picture. Even when beginners' belief systems would seem to support classroom inquiry, their ability to attend to those beliefs, may be challenged as they are faced with the realities of schools and teaching. Bullough and Knowles (1990) reported on the first-year experience of a secondary science teacher. His entry to the profession constituted a career change prompted by a passionate desire to teach his subject. However, a prevailing textbook culture, exacerbated by control problems, threatened his tentative teacher identity and challenged his beliefs about learners and learning, and he abandoned his initial inquiry orientation in favour of 'policing'. A later case study (Brickhouse & Bodner, 1992) revealed contradictory beliefs and practices of a beginning middle-school science teacher. 'McGee' portrayed science as an 'informal', 'creative' and 'often anarchistic' endeavour involving open-ended inquiry, however, his lessons were predominantly structured, teacher-led and goal-oriented. His own reflection on this revealed considerable dissonance between what, to him, was desirable, and what he considered possible in his specific situation. McGinnis et al. (2004) similarly found beginners' individual school context, including perceptions of school culture (specifically whether it was perceived as supportive or non-supportive), to be an important influence on novices' ability to implement inquiry. Complexity may lead to modification of personal beliefs and changes in practice, but as discussed, not necessarily in the direction of reform. Studies from a variety of countries use different methodological approaches and arrive at the same conclusion (eg. Brickhouse & Bodner, 1992, individual case study (n=1), USA; Haser & Star, 2009, questionnaire (n=34), Turkey; Sing Chai, Teo, & Beng Lee, 2009, survey (n=413), Singapore).

Crawford (2007) argues that if reform visions are to be realised then beginning teachers need to see that student-centred inquiry approaches can actually work. It is unlikely that many new teachers will risk 'exposure' unless some rewards are perceived, either in terms of pupil engagement and positive behaviour or in terms of learning outcomes. This argument may be moot in any case as research indicates that inquiry continues to be rare in science classrooms; it is unlikely that many student teachers will observe such practice, other than mandated investigations which, arguably, may be counterproductive.

Where, then, do beginners access examples of inquiry-based practice and how representative are the examples they find? In reality, beginning teachers have few operational models of inquiry teaching to inform their practice, either from their own schooling or from properly instituted professional development programmes (van Driel et al., 2001). It is likely that new teachers refer to a variety of sources when planning a lesson or series of lessons (course notes, textbooks, colleagues, government and local authority resources, internet), however, according to Asay and Orgill (2010), practice is predominantly informed by both personal experience and the experience of others rather than more theoretical knowledge. In the absence of exemplary inquiry-oriented teachers from which to derive operational models, beginners' notions of scientific inquiry are likely to be framed by their memories of learning science, their often limited experience of working science and representations of science in the media (Brickhouse, 1990). This 'experiential' knowledge may serve only to reinforce traditional teacher and pupil roles and limit their pedagogical repertoire to a few 'safe' strategies which, once established, tend to form the meat of their practice until challenged (Appleton, 2003).

Going Forward

Despite its dominance in contemporary curriculum policy, inquiry teaching takes most science teachers out of their comfort zone and challenges some of their personal values and beliefs. It is time-consuming and pedagogically complex, imposing new roles on both teachers and pupils for which, it is argued, teachers are inadequately prepared during ITE (Crawford, 2000). It is pedagogically uncertain and managerially perilous, and taking a step into the unknown runs the risk of exposing teachers' vulnerabilities such as weak subject knowledge and, especially for new teachers, their developing confidence and authority. The ability of new teachers to improvise during student-centred inquiry may be very limited because they lack flexibility in their teaching generally as they have not built up enough relevant experience to deal with all contingencies, nor the pedagogical content knowledge (PCK) which translates internal comprehension in their particular field into forms which can be understood by children. Then, there is the overarching issue of credibility - of 'fitting in', professionally, politically and practically.

Yet, despite the many challenges new teachers face, research suggests that inquiry is beginning to permeate science classrooms (McNally, 2000; Meyer, et al., 2012) and encouragingly a number of recent studies have shown that, with appropriate teacher training and in-school support, there is the potential to capitalise on beginners' vision and initiative to propagate reform efforts (Davis & Smithey, 2009; Forbes, 2011; Luft, 2009).

Clearly, there are many impediments to inquiry in the beginners' classroom. In order to develop courses which better prepare and support new teachers in their efforts to create an inquiry-oriented classroom, it is important to understand these impediments, as well as their conceptualisations of inquiry, from the perspective of beginning teachers' themselves, and to discover what learning and supports are viewed by them as significant and appropriate to their needs in this respect. Attempts to reveal the substance of teachers' early professional learning tend to elicit references to 'gaining experience' and 'growing confidence' rather than any explicit knowledge or sources of learning (J. McNally, 2006b), although the value of informal learning is well established (Williams, 2003). It is now important to dig beneath these allusions in order to begin to understand the nature of knowledge gained from experience which leads to confident and creative pedagogy, and to encourage any efforts in the direction of reform. As Crawford concludes: "*Eliciting the voices of teachers in the context of their practice offers a powerful vehicle for synergy, collaboration, and creation of an environment in which change is possible*" (2007, p. 638).

This study may be seen to extend some of the works cited in this chapter. For example, Roehrig and Luft (2004) discuss the main constraints on beginners' inquiry practice but do not explore or clarify beginners' understanding of classroom inquiry in the first place, nor do they thoroughly examine the school context as experienced by beginners or attempt to elucidate the learning involved in developing an inquiry approach, all of which are major foci of this study. McNally (2000) identified some of the ways in which teachers incorporate inquiry (elaborated in Chapter 11, Concluding Discussion) but noted that the experience of beginners in attempting to implement inquiry was quite distinct from that of seasoned teachers, a situation which warranted further investigation; this study responds to that call. The research design is not dissimilar to that of Crawford (2007) – both are multiple case studies conducted within the qualitative paradigm and with similar foci. However, the current study followed 15 participants rather than 5, arguably adding weight to any conclusions drawn from cross case comparisons. Also, participants were interviewed at four time points spread throughout the year rather than once towards the end of the year; this provided a sense of progression and change and allowed inference as to what learning was coming out of the experiences they described. In so doing it also responds to some of the gaps identified in the literature, such as beginners' conceptions of inquiry (Crawford, 2007; Davis et al., 2006; Windschitl et al., 2008), inquiry practices in secondary schools (Keys & Bryan, 2001), and how teachers use their own initiative in implementing science inquiry outside of specially designed programmes (Gyllenpalm et al., 2009).

CHAPTER 5 - METHODOLOGY

This chapter will begin by restating the research questions and their provenance. It will then discuss my philosophical assumptions before describing the general strategy used to address the research problem and the specific methods used. Finally it will discuss my approach to analysis and measures taken to ensure trustworthiness.

Research Questions

Chapter 2 presents some of the academic arguments within the huge body of literature on inquiry in the classroom – what it is and why it is generally accepted to be an educational imperative, but also why it is seen as problematic. Chapter 3 presents some of the debates in another literature-rich area, that of new teacher early professional learning. Chapter 4 then begins to explore the intersection of these two literatures, illustrating how inquiry is particularly challenging for new teachers of science.

Examination of these literatures reveals an emerging ideology about what inquiry is, or should be, the merits of such an approach, including pupil engagement, and the potential to improve educational outcomes and alter public perception of science. However, it also suggests a lack of clarity on what is actually meant by 'inquiry' in terms of classroom practice, and, given the various practical and political constraints in normal schools, how such a pedagogy is introduced and developed within the teacher's repertoire. Science education reform efforts would benefit greatly from a better understanding of inquiry-based teaching and learning *from the teacher's perspective,* including how prepared they feel to teach in this way. It is likely that many perceive a great rift between what is educationally preferable and what is instructionally practicable, and if this is the case we need to understand what they believe to be the barriers in order that we may address them and allow inquiry to proceed.

This study explores the experience of new teachers of science, particularly in relation to the acquisition of investigative pedagogy, at a time of curricular reform. Specifically it is concerned with (1) beginning teachers' conceptualisations of 'inquiry' in the context of the classroom, the extent to which they are manifest in practice and how stable they are; and (2) developing an understanding of the conditions and early professional learning needed not only to enable new teachers to facilitate inquiry experiences, but also to strengthen their commitment to this innovative, but 'risky' teaching approach. In order to answer these main research questions, several lower level questions were identified.

Questions restated:

1. ***How do beginning teachers conceptualise 'inquiry' in the context of the classroom and how does this change over time and with experience?***

    a. What is the rationale for doing inquiry in the classroom?
    b. What are the important elements of inquiry?
    c. Where do notions of inquiry and ideas for inquiry come from?
    d. To what extent does ITE and life/work experience shape inquiry practice?

2. ***What conditions and early professional learning support new teachers' inquiry practice?***

    a. What are the perceived barriers to inquiry in the classroom?
    b. What is the perceived impact, if any, of inquiry in the classroom?
    c. Is innovation contingent upon confidence and teacher identity and if so what underpins this?
    d. What aspects of the induction experience are seen as supportive overall, and for inquiry specifically?
    e. How is CfE being received and what are its implications for everyday practice?

Ontological and Epistemological Perspective

I am operating from a stance which purports that the social world is complex and constituted by the individuals therein - their relationships and associations, values and priorities - and as such is most meaningfully understood from their perspective. Every person plays a role in the various domains of their life, responding instinctively or creatively to different situations that arise and eliciting a response from others, thereby contributing to the shared understanding and behaviour that constitutes culture. Thus individuals both shape and are shaped by society. However, because of the fundamental differences between human beings in terms of biography, beliefs, personality and aspirations, perceived social reality is likely to differ between individuals. In other words, people behave and interpret experience "on the basis of the meanings that things have for them" (Blumer, 1969, p. 2). Further, in order to understand someone's reality we need to appreciate the various contexts they find themselves in – social, political, economic – and interpret lived experience from their perspective. Quite simply put, "People's behaviour becomes meaningful and understandable when placed in the context of their lives and the lives of those around them. Without context there is little possibility of exploring the meaning of an experience" (Seidman, 2006, pp. 16-17).

With this in mind, and with the aim of exploring and explaining social behaviours and developmental processes rather than merely identifying and quantifying these, a broadly interpretivist stance has been adopted, using qualitative methods which are sensitive to the context and can respond to events as they unfold. This is not to dismiss the utility of a quantitative approach to some social research problems. Indeed, although they do not constitute a mixed methods approach, there are aspects of this study which may be regarded as distinctly quantitative. For example, representing the frequency and weighting of particular responses by numerical values for the purpose of comparing different time points, or the aggregation and coding of data from each time point to identify (pre)dominant themes. Even being alert to such measures as frequency, duration and intensity within interview data (deemed to be reliable, or at least persuasive, indicators of saliency) suggests a tendency towards enumeration. Thus my approach is a pragmatic one; qualitative and quantitative methods are not seen as antithetical but as complementary, in that numbers can be used to explore, support or elucidate patterns in the data, thereby supplementing other forms of analysis.

Although the methods selected promised 'thick description' and contextual detail it was crucial that the data generated was as representative and as whole as possible in order to make the analysis meaningful and provide an authentic insight into the experience of new teachers. However, as Crouch and McKenzie (2006) point out "the social context of the respondents' situation cannot be pieced together solely from accounts of personal experiences which arise out of it … because not all relevant social circumstances come to the fore in those accounts" (p. 490). In other words, participants are unlikely to think of (or mention) everything that is relevant to their situation. This study attempts to understand the development of a pedagogy and teaching approach which, although politically and educationally desirable at a national policy level, is none the less (perceived to be) 'risky' for new teachers both as a practical pedagogy and in terms of meeting expectations and achieving the standard for full registration. It is natural for beginning teachers, and indeed any workplace neophyte, to wish to be perceived in a positive light by others and so they may come across as up-beat and optimistic, failing to share the more negative aspects of their experience lest it reflect badly on them, perhaps affecting working relationships and future prospects. In order to begin to understand their developing practice in terms of motivations, reasoning, attitudes and emotions it was necessary to "penetrate social life beyond appearance and manifest meanings" (Crouch & McKenzie, 2006, p. 483). Questions – often sensitive questions - had to be asked, and observations made. Thus, from the outset an informal and 'naturalistic' setting and a researcher-participant relationship based on trust, experiential empathy and equal status were key aspects of the research strategy.

Whilst the overall approach was inductive and intended to generate initial theory, I found myself oriented towards particular aspects of the induction experience by virtue of my own, fairly recent, experience as a new teacher, and this was probably reflected in my original line of questioning. However, very early on the real diversity of cases in terms of individual experiences and beliefs became apparent, making it necessary to 'listen closely' to the data, and to interrogate, verify and develop themes in subsequent interviews, checking for relevance to the wider group.

General Research Strategy

This study explores the experience of new teachers of science in Scotland, particularly in relation to the acquisition of investigative pedagogy, at a time of curricular change. Recognising the individuality of new teachers and the complexity of the contexts they encounter, it was felt the research questions could best be addressed using a qualitative approach in order to provide insight into "the real operating factors in group life, and the real interaction and relations between factors" (Blumer, 1969, p. 138). Thus, this research takes the form of a multiple case study (n=15) featuring a longitudinal design, with data being collected through focus groups, semi-structured interviews and reflective journals, details of which will be discussed later in this chapter. The relatively small number of cases allowed in-depth inquiry in terms of both generation and analysis of data (Dreher, 1994).

Participants

Participants were new biology (*n=3*), chemistry (*n=3*), physics (*n=4*) and primary (*n=5*) teachers, diverse in terms of age, education and life experience, recruited from the one-year PGDE course at the researcher's own institution and going on to complete a one-year in-school training post in order to achieve full registration with the General Teaching Council for Scotland. Contact was made initially by speaking to the different class groups, providing an overview of the research, and then followed up with an email (with participant information sheet attached) inviting them to participate in the study. This attracted 18 volunteers from across the various sectors and disciplines, however, three withdrew from the study immediately upon embarking on their induction year[8], leaving 15 to complete the study (breakdown shown).

[8] On taking up her induction year post one participant conceded that the demands of the job were so great that she felt unable to commit time to the study; the other two participants could not be contacted.

Participant*	Subject	Gender	Age at Outset
Secondary (n=10)			
Donna	Biology	Female	23
Lisa	Biology	Female	26
Shona	Biology	Female	23
Dee	Chemistry	Female	25
Joanne	Chemistry	Female	28
Douglas	Chemistry	Male	46
Courtney	Physics	Female	25
Charlie	Physics	Male	24
John	Physics	Male	42
Sean	Physics	Male	34
Primary (n=5)			
Carol	Science	Female	26
Jill	Science	Female	42
Rebecca	Science	Female	27
Rose	Science	Female	24
Ruth	Science	Female	33
*Participant names are pseudonyms			

Table 3 - Breakdown of cohort by sector, subject, age and gender.

This is an opportunistic sample; the cohort is not representative of the entire new teacher population in terms of age, gender, sector or subject, nor was there any attempt to make it so. Certainly I was interested in comparing perspectives within and between sectors and subjects, however, as this was a prospective study concerned with identifying grounded themes and elucidating how these interact to influence developmental outcomes, it seemed inappropriate to impose further selection criteria at the design and recruitment stage. More important was securing a sufficient number of detailed and contextualised narratives in the hope of revealing pertinent themes - characteristics of new teachers, aspects of the contexts in which they find themselves, and indeed how these interact – thereby providing authentic insight into the particulars of individual participants' experience as well as the potential for identifying cross-case commonalities. Despite the lack of intentionality, the participants were reasonably diverse in many respects, as can be seen from Table 3, offering the potential to indentify endogenous variables - that is, characteristics of the participants themselves which are salient to the research problem.

Further, perhaps because Strathclyde University is one of the (if not the) main Teacher Education Institutions in Scotland, attracting students from all areas and contributing approximately 27% annually to the new teacher pool[9], the research participants' induction placements showed a wide geographic spread as illustrated in Figure 1. This allowed for the possibility of identifying exogenous variables, that is, specific to the context rather than the individual, for instance, Local Authority policy, style of leadership, induction programme and CPD provision, and cultural, political and economic pressures.

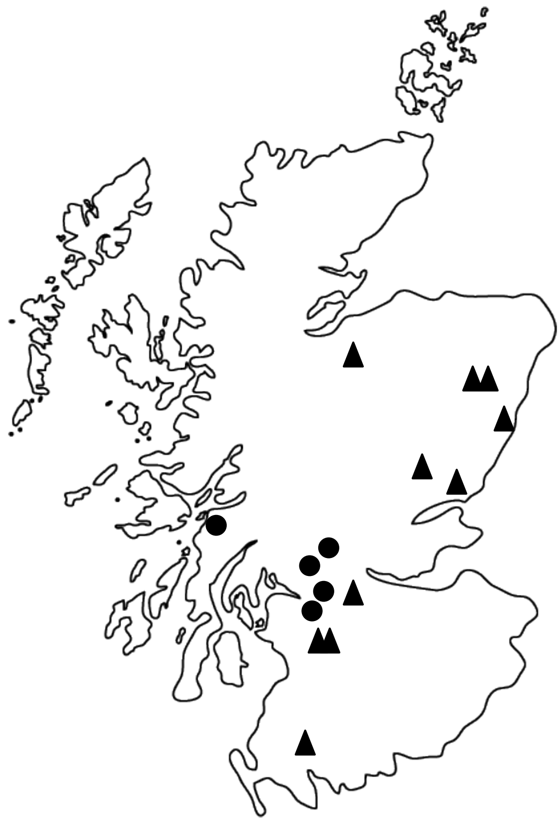

Figure 1 - Geographical Distribution of Participants
▲Secondary ●Primary

The individuals who volunteered for the study were motivated to do so for a variety of reasons, both altruistic and personal gain (determined during the final interview) but importantly, following focus group discussions, all participants declared themselves advocates of an 'inquiry approach' and began their induction year with the intention of making a conscious effort to incorporate inquiry, or at the very least, reflect on their practice with a view to making it more inquiry oriented.

Multiple Case Study

The aims of this research were, firstly, to explore the development of investigative pedagogy in new teachers of science – their ideas and how they manifest in practice; and secondly, to tentatively explain this process through the generation of theory grounded in the research data, by reference to significant aspects of context, relationships and learning, for instance.

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[9] Percentage is average of five year period (2006/7-2010/11) based on figures provided on request by the Higher Education Statistics Agency (HESA).

With respect to the first aim, that of exploring, the multiple case study (using qualitative methods) allowed close and repeated contact with a range of participants, offering the potential to capture their respective realities through data which was richly descriptive and highly contextualised. Researchers working within a more positivist paradigm would argue that this kind of data is impressionistic and lacks objectivity, and that the case approach to knowledge acquisition is unscientific, however, as Christensen (1987, cited in Flyvbjerg, 2006) asserts, case knowledge is central to human learning. From a very young age our understanding of the world, both social and physical, develops through our interaction with that world. Through cumulative experience we develop an understanding of concepts such as 'cause and effect' and can begin to predict outcomes based on specific circumstances and conditions, and so we develop internal schemas which form the basis of our world view and thus guide the decisions we make and our manifest behaviour. As Levy (1981) points out, "consciousness… is reactive in the sense that it reacts creatively to the possibilities of the context" (p. 19).

Thus context is key. We must appreciate that teacher behaviour (practice) is contingent on social and political context; in other words, their developing pedagogy is at least in part dependent on cultural and political pressure within the school. The data generated by individual cases provided accounts of how particular individuals experienced and responded to particular situations within their given context. Hans Eysenck was originally disparaging of case knowledge as anecdotal and idiosyncratic, although he later conceded that "sometimes we have to keep our eyes open and look carefully at individual cases – not in the hope of proving anything, but rather in the hope of learning something!" (Eysenck, 1976, p. 9, cited in Flyvbjerg, 2006). For its utility in contributing to readers' knowledge and understanding, Merriam offers:

> *"The case study offers a means of investigating complex social units consisting of multiple variables of potential importance in understanding the phenomenon. Anchored in real-life situations, the case study results in a rich and holistic account of a phenomenon. It offers insights and illuminates meanings that expand its readers' experiences."*
>
> ***(Merriam, 1998, p. 32)***

Whilst it is recognised that individual cases can generate new insights, they are not in and of themselves generalisable. However, as Giddens (1984, p. 328, cited in Flyvbjerg, 2006) points out, "they can easily become so if carried on in some numbers, so that judgements of their typicality can justifiably be made." Thus, with respect to the second aim, that of building a general explanation for the developmental of investigative pedagogy, the multiple case study offered the potential for aggregation of data and cross-case comparison "aimed at identifying attitudes and/or behaviours of particular groups of individuals with a view to establishing relationships among variables uncovered in the research" (Crouch & McKenzie, 2006). Participants' narratives recounted a range of experiences in a range of settings; theory development was contingent upon finding some commonalities among a significant number of these narratives, and where there was variation, seeking to elucidate the possible reasons in terms of context and biographies of individual cases, thereby creating wider resonance. This objective is somewhat "analogous to creating an overall explanation, in science, for the findings from multiple experiments" (Yin, 2009, p. 142 box).

The multiple case study offers the balance of depth and breadth; the depth of exploring and describing the particular, the breadth of pointing to some possible level of generalisation, although as Crouch and McKenzie (2006) recognise, case studies, even multiple case studies, don't have the persuasive weight of large samples. This study proposes explanations and understandings then, rather than making any attempt at verification.

Longitudinal Design

First and foremost, the design stems from the need to understand a developmental process which would depend, at least in part, on individual participants' contexts and how they were interacting with that context over time. For this reason it seemed sensible to monitor that process in 'real-time,' with introspective access to participants' experience and learning as opposed to relying on retrospective accounts, which is often problematic. With the passing of time people forget the specifics of situations - what they did, the rationale for decisions, the impact of their (and others') behaviours, and importantly, how they felt – but there is also risk of 'judging the past through the lens of the present' (a saying coined by American fantasy novelist, Jim C. Hines). Also, repeated visits over the course of the year would allow me to build on prominent themes and test emerging views thereby permitting the generation of tentative theory which was grounded in the research data, ultimately the aim of the study.

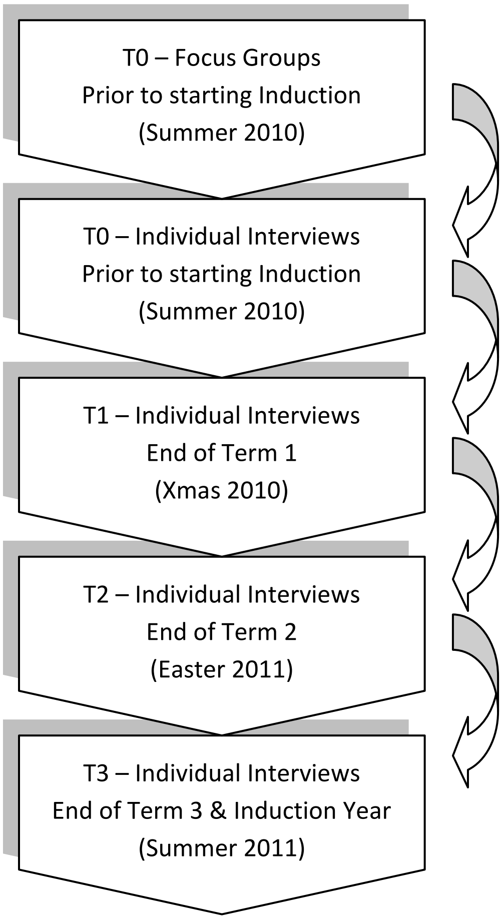

Figure 2 - Data Collection Schedule

Following initial same-subject focus groups, which were conducted towards the end of Initial Teacher Education, participants were interviewed individually at four time points: initially on campus before starting their induction year (T0) to explore attitudes, aspirations and expectations based on placement experience; then again towards the end of each of the three teaching terms (T1, T2, T3) in their respective schools. These interviews sought to interrogate data from previous time points, to monitor learning and aspects of context relevant to their developing classroom practice, and to discover the temporal relevance of issues identified.

The time points were selected not only to give an even spread of visits throughout the year, but also to allow participants to reflect on a culmination of events and experiences before they went on holiday and forgot everything! Also, based on my own induction experience, I saw each of the three school terms as quite discrete and distinctive, not only in terms of their learning and CPD focus, but also in terms of confidence and teacher identity.

Research Methods

Participants' initial involvement in the study was an informal focus group meeting with their peers intended to generate relaxed and open discussion and minimise any perceived status differential between myself and the participants. Thereafter flexibility in arranging interviews, experiential empathy with their situation, and genial manner during interviews helped me to build rapport and trust allowing potentially sensitive questions to be asked without participants feeling vulnerable and exposed. Online blogs offered an alternative way of reflecting on experience which had the advantage of being both impersonal, allowing participants to express themselves in writing rather than in person, and 'immediate' in that it allows them to capture events and insights as they occurred. As intimated earlier, respondents are unlikely to remember or mention everything that is significant to their situation so the 'barriers to inquiry task' was included to offer alternatives which may not have come to the fore naturally.

'Face-to-face' methods were preferred over more 'distant' methods of data collection because they are more sensitive to context, responsive to the 'here and now', and offer supplementary forms of data such as field observations of relational and structural minutiae, body language, tone of voice and emotionality, creating an overall impression which may either support what is being said or give grounds for querying it. They also offer the potential to clarify statements, elucidate behaviours in situ, which other methods, such as surveys and questionnaires, don't permit - with the latter you get answers only to those questions you thought to ask in the first place with no opportunity to cross-examine should anything interesting come to light. The various methods will now be discussed in detail.

Focus Groups

At the end of Initial Teacher Education (T0) discrete subject focus groups provided a forum for informal discussion centred on participants' views on inquiry, issues surrounding its implementation, priorities for learning and attitudes towards the new Scottish curriculum based on placement experience. My role was that of host and moderator, introducing the different areas and encouraging open discussion, asking occasional questions for clarification or to solicit wider views, and moving on only when topic seemed exhausted.

Focus groups were an important precursor to individual interviews in various respects:

1. *Establish the tone of the researcher-participant relationship*

   It was important that participants' initiation to the research process was comfortable, even enjoyable – a conversation rather than an interrogation. Within-subject peer groupings were used to tip any perceived balance of power in participants' favour and refreshments were offered on arrival to help create a relaxed and informal atmosphere.

My research base is located in the STEM[10] building so participants were accustomed to seeing me around, interacting with the science tutors. Not wanting to be erroneously perceived as an experienced teacher or teacher educator I made it clear from the outset that I myself had just completed my induction year before embarking on the current study, thereby acknowledging some level of identification with the participants and reassurance that I had no involvement in assessment or appraisal.

2. *Generate insights worth exploring in later stages of the study*

   With participants being familiar and having had experience of working together to some extent, it was hoped that they would feel empowered and supported, able to openly discuss experiences, beliefs and aspirations and perhaps even remind each other of aspects that may otherwise have been overlooked.

3. *Joint construction of basic concepts prior to participants taking up their teaching post*

   It was hoped that the sharing of ideas and opinions would lead to some initial understanding of inquiry which was unlikely to be way off the mark. Although it was expected that this definition would evolve, particularly in the operational sense, once participants got into the classroom, it was important for these new teachers to have an initial conceptualisation of inquiry practice for beginning teaching that they had at least some confidence in, in the sense that it was perceived to be jointly constructed.

4. *Strengthen affiliation and commitment*

   It was also hoped that the use of pre-existing groups would help strengthen their social identity and reduce attrition rates by creating a sense of collegiality and shared commitment.

Semi-Structured Interviews

Initial individual interviews took place at the end of ITE, before participants took up their teaching posts. These interviews sought to develop themes identified in the focus group meetings but from a more personal perspective, providing insight into individual participants' experience on teaching practice and exploring their expectations, priorities and aspirations for beginning teaching based on that experience. Once induction year placements were allocated, arrangements were made to visit participants in their respective schools at the end of each teaching term (T1, T2 and T3), although due to

[10] STEM – Science, Technology, Engineering & Mathematics

inclement weather, some T1 interviews were postponed until the first week of the new term. The rationale for this was to capture the substance of experience within that term prior to participants going on leave and forgetting significant episodes, or seeing them in a different light! Certain central themes - such as inquiry, learning, confidence and CfE - were retained over the course of the year for the purpose of comparing responses at different time points, thereby providing a sense of change and growth in practice and teacher identity. The overall interview structure was cumulative in that insights gleaned from the data at one time point provided a framework for subsequent interviews; data from each time point were aggregated and examined for common themes and points of interest prior to subsequent data collection so that these could be explored further.

Interviews were informal and followed a semi-structured format, addressing the main topics but with scope for interaction and elaboration of emerging themes … "a conversation with a purpose" (Burgess, 1984, p. 102). Based on the assumption that "individual respondents define the world in unique ways" (Merriam, 1998, p. 73) this loose format allowed me to "enter into the other person's perspective" (Patton, 2002, p. 341), and to understand intrapersonal aspects such as perceptions and motivations that cannot be directly observed. Another advantage of 'face-to-face' interviews over less personal forms of questioning such as questionnaires and surveys was access to the context of participants' experience. Interviews held in their respective schools, indeed often in their own classrooms (naturalistic setting) provided valuable field data: a 'feel' for the school itself, a glimpse of participants' interaction with pupils and colleagues, how their classroom is set up and practice discussed therein. For example, body language and gesturing towards particular resources and pupils (not actually present), allowed me to conceptualise them in their teacher role and gain a sense of their developing teacher identity. The 'naturalistic' setting also helped them to remember and reflect on particular episodes and make meaning of them. "It is this process of selecting constitutive details of experience, reflecting on them, giving them order, and thereby making sense of them that makes telling stories a meaning-making experience" (Seidman, 2006, p. 7).

Although the choice of face-to-face interviews was "to understand the world from the subjects' point of view, to unfold the meaning of peoples' experiences, to uncover their lived world prior to scientific explanations" (Kvale, 2007, p. xvii), it is important to appreciate and acknowledge that participants' views and understandings were on occasion shaped, even modified, by the interview itself as they reflected on experience and considered alternative scenarios.

> *"In the course of an interview, subjects can change their descriptions of, and meanings about, a theme. The subjects may themselves discover new aspects of the themes they are describing, and suddenly see relations that they have not been aware of earlier. The questioning can thus instigate processes of reflection where the meanings of themes described by the subjects are no longer the same after the interview. An interview may be a learning process for the interviewee, as well as for the interviewer."* ***(Kvale, 2007, p. 13)***

My own part in this transformation must also be acknowledged. My general demeanour and identification with the participants' may have influenced the nature of data obtained and my line of questioning may have oriented participants towards particular themes during the interview as well as influence their behaviour thereafter. Indeed, in the final interview at the end of the induction year several participants alluded to how being involved in the research process had encouraged them to be more reflective and influenced their practice. However, I hold that the success of the interviews depended on participants' perception of the interview situation and how comfortable they felt discussing themselves with someone who was, to all intents and purposes, a stranger, as well as how reflexive I was in the process. With this in mind I attempted to maintain a rapport with the participants by being upbeat and interested in what they were saying but at the same time neutral so as not to influence the direction of responses, although in order to circumvent problems of interpretation and analysis at a later stage, occasional paraphrasing or requests for clarification or elaboration were necessary to summarise and verify my understanding.

All transcribing was done personally to allow an initial analysis of content as well as to stimulate recall of contextual and emotional minutiae. Interviews were transcribed verbatim as far as possible, with pauses and false starts included (indicated by ellipsis '…') as it was felt that these were suggestive of meaning making in progress. Unclear words or phrases were indicated [.] or […] respectively. Other non-verbal aspects such as tone of voice, facial expression and gestures were included in transcripts in italics to provide a more authentic rendering of the interview. All transcripts were passed back to participants for verification prior to analysis.

Barriers to Inquiry 'Task'

This 'task' was included in an attempt to understand the most salient issues surrounding the implementation of inquiry in the classroom, including the temporal relevance of the barriers identified, and as such was seen as an integral part of the interview. Individually – and even collectively - people are unlikely to think of (or mention!) everything that is significant to their situation so this element was an attempt to unearth valuable insight by presenting alternatives that may not have surfaced otherwise. Beginning teachers may be reluctant to 'admit' to issues or insecurities lest they been seen as weaknesses, however, knowing that the issues had been identified by other(s) during focus groups may have made them more inclined to open up, with the potential to gain more authentic knowledge.

The 'barriers' were not based on existing literature or my own teaching experience, but arose from focus group discussions when participants were asked to consider barriers to inquiry, or 'issues that would affect their ability or willingness to incorporate an inquiry approach'. Collective responses were reduced to 14 themes which were subsequently presented at individual interviews as flash cards to allow physical manipulation and to support cognitive processing. Participants were asked to select and rank their top 5 based on their school experience so far, providing commentary as appropriate. Upon selection of the top 5 the barriers were scored in accordance with their rank in the list (top=5; bottom=1); this value is referred to as 'Weight of Response'. The number of participants selecting any one barrier at a particular time point is referred to as 'Frequency of Response'. The following table, which presents T0 data, illustrates the utility of these measures, with the potential to reveal how persistent the perceived barriers are over time and with growing experience.

Implementation Issues – T0	Frequency	Weight of Response												Average
Classroom Management (organisation, behaviour, safety)	12	4	2	4	5	4	3	3	4	4	3	5	3	3.7
Time Considerations	11	3	3	5	5	4	4	5	3	5	2	1		3.6
Availability of Resources / Personal Cost	11	2	3	5	4	4	4	1	1	2	2	5		3.0
Curriculum Structure & Course Content	10	4	1	3	5	1	3	2	2	4	4			2.9
School / Department Politics (culture & expectations)	10	3	3	1	1	2	2	2	5	1	1			2.1
Knowledge of Pupils (ability, interests, independence)	7	5	5	4	5	2	5	1						3.9
Subject Knowledge	6	4	3	2	5	5	3							3.7
Confidence	6	1	1	2	4	3	3							2.3
Practical Support Available	6	1	2	2	1	1	4							1.8
Learning Intentions	5	5	3	2	3	2								3.0
Understanding & Belief in Inquiry-Based Approach	2	5	4											4.5
Assessment / Achievement Implications	2	1	2											1.5
Personal Commitment	1	1												1.0
School Location (in relation to external resources)	1	1												1.0

Table 4 - Barriers at T0 showing Frequency & Weight of Responses

This methodological element adds a distinct quantitative hue to the research, however it was not intended to constitute a mixed methods approach. Indeed, although interested in the barriers to inquiry in a qualitative sense, that is, the relative import of the different issues over time, I was also interested in how they were discussed. It was hoped that participants' reasoning behind their selections would provide glimpses of their experience and insights into their learning. For instance, if time is an issue, is it because inquiry is more time consuming and so it takes longer to cover course content, or because one period is not long enough, or because it takes longer to organise? In other words, how time interacts with other identified issues such as curriculum/courses, assessment/achievement, or planning and organisation. Is the issue of resourcing to do with funds, quality of equipment or the nature of technical support?

Bearing in mind these were predictions or projections based on students' placement experience I was open to the possibility of these changing once participants overtook the role of classroom teacher rather than observer and co-operating teacher. And they did! After T1, the first time point after starting induction, several categories were modified according to how the issues were being discussed. For example, although 'Knowledge of Pupils' and 'Classroom Management' were initially conceptualised as two separate issues, it became apparent that the two of these were so entwined that is seemed prudent to combine them into 'Pupils and Behaviour'. Also, the original issue 'Personal Commitment' derived from discussions surrounding willingness to put in the extra effort involved in thinking up inquiry activities or adapting practicals to make them more inquiry based. However, following T1 interviews, it became apparent that this was more to do with 'Planning & Organisation' in the practical sense than 'Personal Commitment' which implies ethic or attitude. A list of changes, and justification for these, is shown in Figure 3.

Selective data is provided to ground discussion in the relevant sections; for example, by participant in Chapter 6 ('The Cases') and by barrier in Chapter 8 ('Barriers to Inquiry'), however, a more detailed and holistic analysis of the data derived from this task is provided in the appendices.

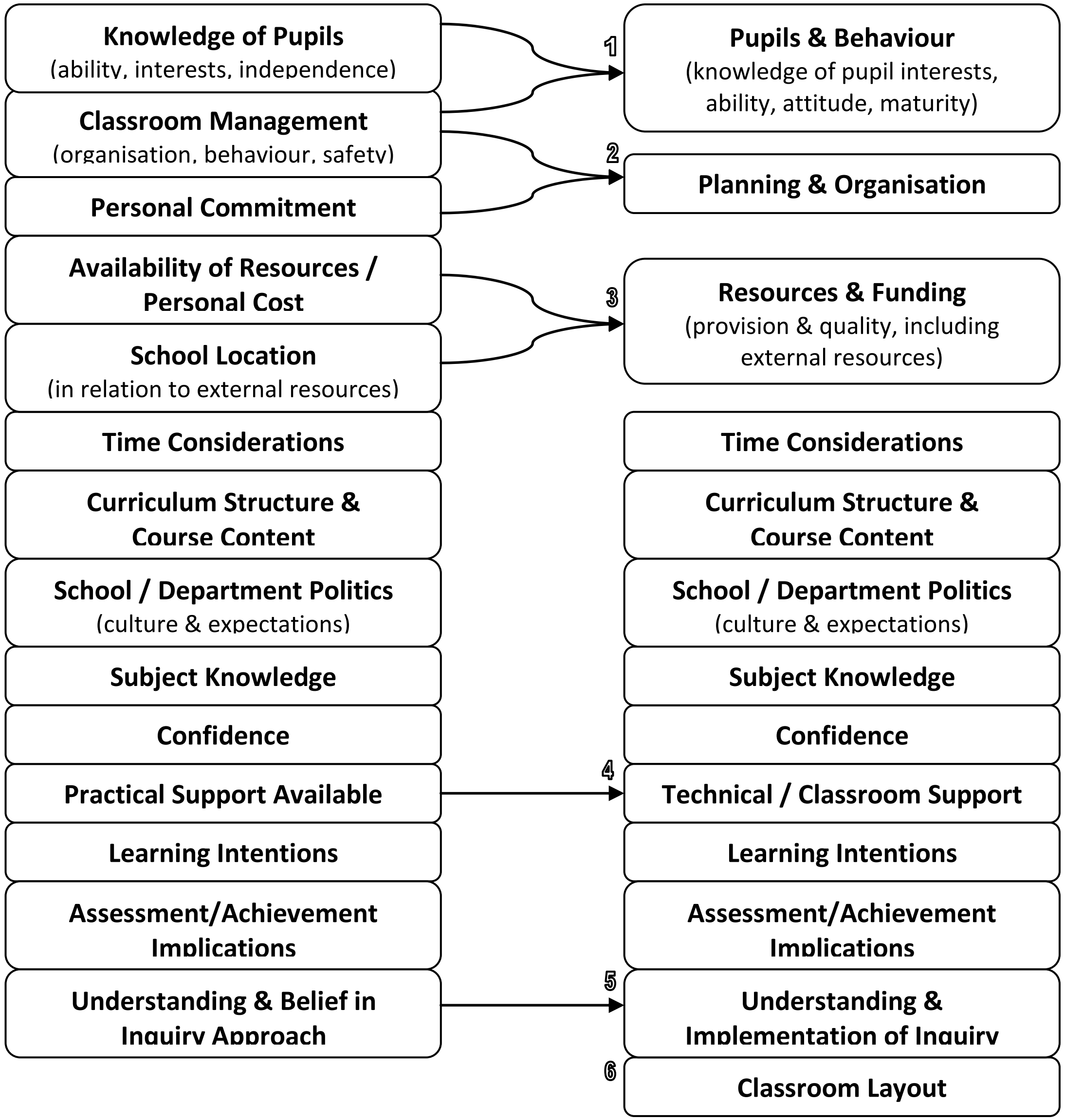

Figure 3 - Barriers to Inquiry; changes to categories in response to early data collection

Justification for Changes

1. When Classroom Management was discussed it was normally in terms of safety and managing behaviour and often in conjunction with familiarity with classes and pupils therein, so these were combined into one category, Pupils & Behaviour.
2. Any discussion of Personal Commitment was in relation to the time and effort involved in setting up and managing an inquiry based lesson therefore this was combined with the 'organisation' component of Classroom Management to give Planning & Organisation.
3. Concerns about Resources were generally in connection with funding and being 'allowed' to use/order consumables and equipment or organise field trips.
4. Practical Support Available was specifically discussed in terms of technicians and classroom assistants (including learning support).
5. 'Belief' turned out to be largely redundant, the issue being 'how to make inquiry happen'.
6. Classroom Layout was mentioned early on by two participants so it was introduced as a new category to ascertain wider resonance.

Online Blogs

In an attempt to capture experience and learning as it was happening, participants were invited to maintain individual 'private' blogs throughout their induction year. It was hoped this would encourage them to reflect on daily practice, including their own attempts at investigative pedagogy, and record significant learning events, including the nature of knowledge attained and an evaluation of its impact on both general and pedagogical confidence. Decisions about frequency, format and length of blogs were left entirely up to the participants; they could record whatever they were moved to write about and in whatever style they saw fit.

However, very few blogs were written. Some participants blogged fairly regularly at the start of the year but soon fell away. Most did not blog at all. As suspected throughout the year, and confirmed in the final interviews, most participants felt overwhelmed by their workload and the expectations of others and simply could not fit blogging into their already busy schedule … "It just wasn't a priority". Especially in the early stages, when every experience is a new one and every day brings fresh challenges, beginning teachers have so much to learn and perceive a great pressure to meet deadlines whilst achieving an acceptable standard of teaching. This methodological element was intended to augment the research design by its 'immediacy' and lack of reliance on long-term memory, facilitating discussion of significant episodes in subsequent meetings, however this objective failed to take account of the demanding nature of the first year of teaching.

Other underlying issues which emerged during the final interview were the lack of familiarity with the technology due to the relative 'newness' of blogging, and the degree of comfort people feel in having their personal reflections aired in such a 'public' way.

Analysis & Generation of Theory

Concerned with the development of investigative pedagogy in new teachers of science from the perspective of teachers themselves, this study aimed to develop empirically grounded theory through a series of situated interviews with newly qualified teachers.

In taking a 'grounded theory' approach to data collection and analysis, the intention was not to emulate the *Grounded Theory* framework originally described by Glaser and Strauss (1967) – in its entirety it was felt this imposed too many constraints on the research design and did not acknowledge the interpretive nature of the analysis process. (Indeed, the respective authors, and other academics, have developed *Grounded Theory* down divergent pathways since its original conceptualisation). The approach used in this study was closer to that of Glaser's (1978) interpretation of grounded theory, with its emphasis on theoretical sensitivity, its main tenets being: discovery as opposed to verification; theoretical sampling, concerned with the development and refinement of ideas, as opposed to population sampling; emergent direction rather than hypothesis testing; constant comparison and keeping data 'whole' (contextualised) as opposed to 'fracturing' the data. The main differences to Glaser's (1978) approach were that theoretical saturation was not a feature (this study used a finite number of participants so there was no opportunity to test emerging ideas on 'new recruits'), and coding was done in phases rather than continuously, with data from one time point being collected and coded before moving on to the next.

Interviews were transcribed personally and in full to provide an initial analysis of the data (although, arguably, the initial analysis was ongoing during the interviews themselves through a process of interpretation and substantiation). Transcripts were then read throughout and their content systematically coded into descriptive categories and sub-categories in order to determine the frequency of themes and their inter-relatedness. NVivo software was used to store and manage the data, however none of the analysis tools were employed and coding was effectively a manual process. NVivo's main utility was that it allowed reduction of the substantial data set to an organised hierarchy of themes and categories, allowing easy retrieval of coded references.

The data was organised in main two ways: by time point and by case. Data from each time point were analysed using the constant comparative method (Glaser & Strauss, 1967) to ensure all diversity within the transcripts was accounted for before progressing to the next stage of data collection in order that emerging themes could be further explored. Data from all participants were aggregated and the quantitative representation of coded references was useful in highlighting the dominant themes. At the end of the year-long data collection period, each 'case' was considered on its own and in relation to other 'cases' with the aim of establishing “points of contact (adhesion or friction, as the case may be) between individual experience/action and the social context” (Crouch & McKenzie, 2006, p. 491).

In this sense it is inductive, interpretive and iterative; inductive in that it seeks discovery as opposed to verification; interpretive in that participants’ accounts are “further reconstructed through the researcher’s frames of reference” (Grbich, 2007, p. 71); and iterative in that insight and direction were emergent through the continual alternating between collection and analysis of data. The generation of theory was contingent upon seeking the underlying patterns amid the many perspectives which participants present (Glaser, 1978).

Trustworthiness

In demonstrating the rigour and quality of this research I have elected to use Lincoln and Guba’s construct of ‘trustworthiness’, with its components credibility, transferability, dependability and confirmability (1985). These components are more appropriate to qualitative research, however, they do have parallels in the more conventional measures of internal validity, external validity, reliability and objectivity respectively.

Credibility

Congruence between data, findings and reality. All interviews were audio recorded, transcribed in full and subsequently passed back to participants for verification prior to analysis. Despite this ‘member checking’ (Lincoln & Guba, 1985), the findings arising from the data are inevitably my interpretation of participants’ constructions of reality. In order to make this interpretation more robust, data were generated using a variety of methods and compared for points of contact. For example, the quantitative element (barriers task) suggested that 'behaviour' became less of an issue over the course of the year, but 'time' was a more persistent barrier; this observation was borne out by a variety of quotes. In certain extreme cases (eg. insecurity or strained relationships) interview data were corroborated by field notes and/or blogs, as in the case of Rose and Douglas. Also, the longitudinal design meant my own impressions and interpretations could be checked on subsequent visits. My findings are substantiated with participants' quotes, which are occasionally quite lengthy in order to give the reader a fuller understanding of their context and meaning.

Transferability

Degree to which findings can be generalised. The relatively low number of cases overall (n=15) makes generalisation to the wider population dubious; the sample was not representative in any case. That said, where something is true of the majority of participants (for instance, that the SFR and associated Professional Profile were seen as a time-consuming formality which added little to their professional development) then, arguably, there is justification for believing this to be true of many beginning teachers, or at least probing further by conducting more research. As Yin offers, "The evidence from multiple cases is often considered more compelling and the overall study is therefore regarded as being more robust" (2009, p. 53).

The low number of cases did, however, offer the potential to enhance transferability by allowing repeated contacts with participants in their individual school settings over the course of their induction year (Dreher, 1994), as well as more in-depth, contextual analysis of the data collected. The contextual description and commentary is provided throughout "so that anyone else interested in transferability has a base of information appropriate to the judgement" (Lincoln & Guba, 1985, pp. 124-125).

Dependability

Can findings be replicated? Replication of a study such as this would be difficult, not only because human behaviour is unpredictable and heavily context-dependent, but also because the study was conducted at quite a unique time in Scottish Education history. The introduction of CfE coincided with participants' induction year (and data collection) and this would have had wide ranging implications for professional learning, teaching practice, time demands and workload, even school culture and relationships, thus, in all probability, impacting on the research findings.

With this in mind I endeavoured to make explicit my rationale, methodology and reasoning throughout the research process. Interview schedules are provided in the appendices, showing reasoning where appropriate. Interviews were recorded, and recordings safeguarded. Case files were maintained for all participants; these contained all transcripts, field notes, blogs, emails, and quantitative ('barriers') data. Following each round of data collection and analysis, coding lists were printed out to provide an overview of the prominent themes in the data, and filed for future checking. The above measures constitute an 'audit trail' whereby anyone interested may study the precise circumstance giving rise to my arguments.

Confirmability

Researcher Objectivity. It is important to acknowledge identification with their situation by virtue of my own recent experience as a student teacher/probationer. However, I tried to avoid making assumptions, looking for particular data or outcomes, or asking leading questions in order to satisfy my own curiosity and validate my own memories of being a beginner! In the hope of getting the whole picture, good and bad, I endeavoured to minimise any perceived status differential (I was, after all, a qualified teacher, with teaching duties within the university, and completing a doctorate) by making it clear that I was very recently qualified and had little more teaching experience than they had, thereby asserting empathy for their situation. It has to be acknowledged, however, that a genial approach and co-identification with the participants may have impacted on the research process. Whilst it was hoped that it would lead to openness and honesty in responding to questions, there was also the possibility that they would be more inclined to tell me what they thought I wanted to hear. However, it was stressed that my interest lay in understanding the particulars of their experience, and to avoid over-romanticising participants were encouraged to reflect on real events rather than hypothetical situations, thereby situating the discussion of their teaching in a real context (Gyllenpalm et al., 2009).

CHAPTER 6 - THE CASES

The following chapter presents a series of participant profiles, intended to portray individual participants' specific situation and how they coped with the context they found themselves in. The profiles were compiled using all data sources (mainly interviews and field notes), and each comprises a discussion of their individual experience and a table showing that participant's perceived main barriers to inquiry over the course of their induction year.

An example of such a table is given below with labels and values explained to avoid duplication thereafter.

Inquiry Implementation Issues – Example Participant

Time Points

	T0	**T1**	**T2**	**T3**	**#**	**Ave**
Subject Knowledge	5	4	2	5	4	4.00
Resources	2	2	5	1	4	2.50
Confidence	3	5		4	3	4.00
Understanding		3	4	3	3	3.33
Classroom Management	4		1	2	3	2.33
Time		1	3		2	2.00
Practical Support	1				1	1.00
Planning & Organisation			1	2	2	1.50

Weighting given to selected barriers; 5 most pervasive, 1 least pervasive.

 # - No. of time points particular barrier selected into Top 5

Average weighting

Table 5 - Individual participant top 5 barriers over the four time points (T0, T1, T2, and T3) – Example

Carol

Carol completed a degree in Marketing with Film and Media, which involved a small research project, then worked as a Marketing Manager for one year, and as a restaurant manager for five years, before making the move to primary education at the age of 26.

Carol's student placements contrasted greatly in terms of demographics. This was reflected in the school ethos, manifesting in the classroom as different expectations of pupils and typical teacher styles and practice. She was anxious about taking up her induction post, more at the enormity of the role rather than any specific fears. Within weeks of beginning induction, HMIe conducted a 'follow up' inspection in the school, and despite not being there for the original visit, Carol's class was one of those observed. It was not a good experience and Carol's confidence took a severe knock from which it took a while to bounce back.

Carol experienced support in the form of a comprehensive and structured induction programme, with access to policies and other important information, but found the profile process (SFR) to be a complete waste of time, and felt her mentor (pleasant but rarely available) had no bearing on her learning and development other than approving her at the end of the year. Further, she had little contact with the other probationers and experienced the staffroom as 'cliquish' and uncomfortable, with established but unspoken protocols which newcomers had to work out for themselves. Thus her relationships were largely limited to stage partners. Carol's stage was composed of an NQT from the previous year, two job-sharers, and herself, none of whom had taught that stage before, so, with the introduction of CfE, both the curriculum and the planning were completely new to all concerned. Stage meetings were generally unproductive and frustrating, and communication was sketchy. The ex-NQT was regarded as a valuable source of professional support, happy to share advice and ideas, but even then Carol was careful not to take up too much of her time. About half way through the year the department was appointed a new principal teacher who became Carol's main source of moral and emotional support.

Carol felt compelled to get involved in everything she could, partly because she believed it was expected of probationers, but also because she was acutely aware of the job situation and the need to show herself in the best possible light – full of energy and enthusiasm – to potential employers. In retrospect, it probably did help her situation as she was the only one of a handful of probationers to be kept on at the school. She had a 'good class' with few discipline issues and was happy in her teacher role. Her main challenge was the amount of paperwork – detailed planning, tracking, reports, etc – but on reflection she conceded that she probably did too much. At the time she was very unclear as to what others' expectations of her actually were and tended to err on the side of caution, doing too much rather than too little in terms of paperwork, planning and extra-curricular activities, which often left her feeling physically exhausted and emotionally drained.

Carol liked the idea of CfE in principle – the *'whole-child approach'* with *'more importance being put on them talking and listening and group work and collaborative working and all these kinds of things'* - but felt the planning was much more complicated and, especially in science where her own knowledge is poor, more specific guidelines were needed. Her experience of ITE led her to believe that Science was not something that was valued or prioritised in the primary sector. She didn't get the opportunity to teach science and observed only one science lesson during her placements which involved using electrical circuits to identify conductors and non-conductors. In that lesson, she appreciated the teacher's approach, building on prior learning, encouraging curiosity, developing investigative skills and using evidence to arrive at a logical conclusion, and seemed to use this as a model for going forward into her induction year. However, she had little opportunity to teach science throughout the year as there was a science specialist who was shared around the school. The one topic that had to be covered by class teachers ('Forces') they had managed to avoid doing by prioritising other areas of the curriculum, which Carol attributes largely to lack of confidence in their science knowledge and process skills. For Carol, confidence (in relation to subject knowledge and understanding of inquiry) was a major impediment to inquiry but the issue of access to resources, as well as managing these in the context of classroom inquiry, was also acknowledged.

During the final interview Carol advised me that she'd got the job at her probation school, which she was delighted about. I was surprised given that her experience up to that point had not been very positive, but she proceeded to talk about the school and the staff and the relations in a much more positive light than previously – a case of "interpretation of the past through the lens of the present" perhaps? (Mason, 2002, p. 31).

Inquiry Implementation Issues - Carol

	T0	T1	T2	T3	#	Ave
Subject Knowledge	5	4	2	5	4	4.00
Resources	2	2	5	1	4	2.50
Confidence	3	5		4	3	4.00
Understanding		3	4	3	3	3.33
Classroom Management	4		1	2	3	2.33
Time		1	3		2	2.00
Practical Support	1				1	1.00
Planning & Organisation			1	2	2	1.50

Charlie

Charlie completed a 5-year Masters Degree in Mechanical Engineering, which involved a small practical research project, then went straight into the PGDE Physics with Science at the age of 24. Charlie was unable to attend the initial Physics focus group so our first meeting was on campus at the end of ITE. My impression of Charlie at that time (from field notes) was that he was very affable and 'private school' – articulate but quite measured and specific in his use of language. His two placement schools contrasted greatly in terms of demographics and his biggest concerns going into induction year were subject/curricular knowledge and maintaining discipline.

Charlie felt welcome and supported in his induction school, which exceeded his expectations based on student placement experience. He enjoyed positive relationships with colleagues and with classes generally, although he conceded that classes were challenging at first. A lot of effort went into maintaining discipline whilst experimenting with interesting ways to teach topics in an attempt to forge positive relationships. Over the year he got most classes on side but relationships remained difficult with two classes in particular (Intermediate 2 and Higher) which he shared with a colleague. He saw the classes only one period out of five and consequently, in his opinion, pupils did not regard him as their teacher and viewed that period as a *'wee holiday'*. Behaviour was difficult to manage and Charlie was reluctant to relinquish any control to them. Other than managing behaviour, his main focus for learning was becoming familiar with the taught curriculum and improving his own subject knowledge.

Charlie's main source of support was his mentor, who was very generous with his time and provided valuable advice and guidance. He also valued the structured induction programme, although he was somewhat disappointed that, because of the large number of probationers in the school, he was not permitted to attend all external CPD events. However, the probationers seemed to have formed a small alliance, regularly sharing information and providing an important source of moral and emotional support.

Charlie's school was originally a private school, and despite being under control of the Local Authority for many years, it has retained that status, along with some very traditional values - corporate identity, conformity, traditional instruction for the purpose of knowledge acquisition, and ultimately qualifications. CfE was *'interpreted as something that needs to be done ... possibly not the most desirable thing.'* So, although the school had 'adopted' CfE, they were still compelled to respond to the clientele. Families commonly move to the catchment area and every year there is a long list of placing requests with the expectation of high academic achievement. How this translated into practice was that many of the experiences and outcomes intended for the three years 'broad general education' phase were crammed into the first year in order to give pupils a good sense of each of the three disciplines and allow them to make their choices for further study in S2 onward. This pressure was acutely felt by Charlie and hindered his propensity for flexibility and innovation.

For Charlie, science education was for developing scientific thought and critical understanding of world issues. He purported to advocate inquiry – *'when pupils have more control over what they pursue... more responsibility'* - but believed it was not *'built into the curriculum'*. Indeed, he was unable to relinquish any control to the pupils in his classes and there were many instances which revealed a preoccupation with examinable content and a need to be regarded by pupils as an expert or authority in the subject. Generally speaking, his capacity to respond to pupil questions depended on time available and his knowledge of that subject.

> *I would say the subject knowledge, if it's outwith my area of specialism... again that might be a confidence thing. I do learn stuff before I teach it, but then you get questions thrown up and you think ... (gestures discomfort) (T0)*
>
> *If they've asked a question kind of on a tangent? Well, to be honest, just now there's a kind of pressure to get through the course almost before they pick subjects, and there is a need to get the test done before it.*
> *I'm often teaching out of my speciality, such as the biology one. They were looking into parts of the human body and asking questions like "What does the pancreas do?"... (gestures uncomfortable uncertainty) (T1)*
>
> *Teaching style? I would say probably quite traditional. Not just chalk and talk, I do give them certain little activities, but then I will give them quite nice notes to put down.*
> *I'd say probably a challenge for me is to be more confident with group working... I'm not completely convinced that... it's so hard to, like, keep a track of everyone. (T2)*
>
> *There have been occasions, again with time, like, oh that's a good question but we kind of have to... there is a pressure to get your units all taught before they're choosing, just so they've had a fair go at each. (T3)*

Interestingly Charlie began his year with a strong concept of inquiry and how this might proceed in the classroom: *'activities that involve research, that are undertaken by pupils who have control over how it is done, and the outcome is unknown'*. He also believed that *'inquiry tasks would lead to the individual and independent learners that CfE aims to bring about'.* As the year progressed, however, he became increasingly insecure about it in terms of both method and value in his specific context.

When I asked about job prospects, Charlie advised me he had decided to travel for a year before settling into teaching (if indeed that's what he decides to do because I suspect he may be slightly disillusioned?!), despite the fact there's a job at this school and he has a VERY good chance of getting it.

In summary, Charlie enjoyed an extensive support network and, in keeping with the general school ethos, settled into his role as a physics teacher primarily focused on pupil attainment. Although he retained a strong concept of inquiry – which for him meant student-driven research or investigations for which the outcome was unknown (to them) – due to time constraints, concerns about behaviour and lack of familiarity with subject matter, he did not develop the flexibility to implement such an approach. In focusing on knowledge transmission Charlie has neglected skills development - pedagogies which are more in the spirit of CfE such as collaborative working, active learning, self- and peer-assessment, open inquiry, problem solving and independent research.

Inquiry Implementation Issues – Charlie

	T0	T1	T2	T3	#	Ave
Time	5	4	3	5	4	4.25
Behaviour Management	3	2	2	3	4	2.50
Curriculum / Courses		5	1	4	3	3.33
Subject Knowledge	2	1	4		3	2.33
School/Dept Politics	1			1	2	1.00
Understanding			5		1	5.00
Confidence	4				1	4.00
Resources		3			1	3.00
Assessment/Achievement				2	1	2.00

Courtney & Donna

These research participants not only went to the same school for induction but shared accommodation in a nearby town and enjoyed each other's company socially. They also perceived an extensive social and professional support network within the school.

On two occasions I accompanied one or both to the staffroom at interval. The staffroom was large and seemed to accommodate all school staff (served by auxiliary staff for the sake of time-efficiency) and, although there did seem to be established social groupings, all staff were pleasant and welcoming. On a separate occasion I joined them for lunch in the science base where conversation amongst colleagues was relaxed and friendly.

They were posted in a large modern school (8 years old) with modern equipment and good resources, and both felt fortunate that they were not under the same budget restrictions as previously experienced on student placements. Further, resources were centralised ('staff sharing area') and there were colleagues in the department who were known for their active learning and formative assessment strategies, and their classrooms showcased this well – *'you see examples of good practice all over the place'* (Courtney).

The school ran an excellent in-house CPD programme for probationers and new staff generally, (although Local Authority CPD was 'poor'), important information was organised electronically and readily accessible, and expectations were reasonable and explicit.

Courtney

Courtney completed a BSc Physics, specialising in experimental physics. She is a firm advocate of practical science, and indeed was involved in an outreach programme, SciFun, run by Edinburgh University, which was charged with the task of getting science into schools. Courtney began her induction year at 25.

Courtney felt comfortable seeking advice from a number of colleagues. However, because one of her main challenges was managing behaviour (with one class in particular), she considered her main source of professional support to be her PT, who offered ideas, discussed strategies, and followed up on disciplinary issues. Courtney found the behaviour policy quite difficult to grasp, but conceded that many other members of staff did too. Her mentor was a Social Sciences teacher and offered support of a more general nature (moral /emotional) as well as support with her profile.

There were courses in place for each stage but Courtney perceived that she had total autonomy in how these were delivered, both in terms of approach and specific content, especially with the lower school. This was important in allowing her to adapt and respond to the needs and interests of different classes, a huge part of Courtney's early professional development. In terms of planning and managing learning activities, Courtney believed that knowing the pupils (both individually and collectively) was key; their interests, capabilities, learning styles, and so forth. For most of the year behaviour management was considered one of the main barriers to inquiry, however, by Term 2 Courtney came to realise that providing opportunities for pupil-led work, structured around their own interests and abilities, actually improved motivation and behaviour. Time and resources, however, were more persistent issues; she would be encouraged to do more inquiry activities if it was *'built into the curriculum a little bit more'* with *'basic kit'* there to support it.

Courtney's teaching style seemed to naturally introduce elements of inquiry (encouraging pupil questions, class discussion eliciting logical reasoning and setting out to answer questions) without her explicit intention; in fact, she expressed some doubt about whether she was actually managing to incorporate inquiry at all. Mostly, inquiry episodes tended to be of a discursive nature rather than practical, however, she conceded that familiarity with topics will help her to anticipate pupils' questions and develop appropriate resources.

Inquiry Implementation Issues – Courtney

	T0	T1	T2	T3	#	Ave
Resources	4	2	5	5	4	4.00
Time	5	4	2	2	4	3.25
Behaviour Management	3	5	3		3	3.67
School/Dept Politics	2			4	2	3.00
Understanding			1	3	2	2.00
Curriculum & Courses	1	1			2	1.00
Assessment/Achievement			4		1	4.00
Knowledge of Pupils		3			1	3.00
Planning & Organisation				1	1	1.00

Donna

Donna completed a BSc in Anatomy and Physiology which involved a small practical research project, then worked for a year as a learning assistant at a secondary school in Edinburgh before completing the PDGE. She began her induction year at age 23.

Donna benefited from an extensive social and professional support network; colleagues, PT, technicians, mentor, SMT and other probationers, especially Courtney. Donna really appreciated the relationship (they play sport together) and support of her mentor, a Social Sciences teacher who had a *'wealth of knowledge'* and experience of mentoring. Although Donna felt the SFR was a formality – *'a ticky-box exercise'* – she valued the observations, mentor meetings, and support in completing her profile.

To begin with Donna's teacher identity very much hinged on her being in control of the class and an 'expert' in what she was teaching; in terms of confidence both 'good' and 'bad' lessons were attributed in some way to subject knowledge and managing behaviour. She had a couple of challenging classes (for which she received support) and felt insecure in her knowledge of some topics, thus Donna's early professional learning focused on was behaviour management and *'brushing up on'* the curriculum. In terms of classroom management she learned that, as well as setting expectations and being consistent with rules, it was important to really 'know' all of the pupils in her classes when selecting teaching approaches (eg. backgrounds, abilities, interests, personalities, learning preferences) as this helps build rapport which has a knock-on effect on motivation and behaviour.

Her idea of 'inquiry' seemed to accommodate two types: 1) use pupils' questions to initiate personal research/projects, or 2) get pupils to conduct an experiment through from start to finish in order to answer a question, usually one that's come from her. She dabbled in the latter early on but soon realised that she had failed to take into account their lack of experience with this type of approach and therefore their limited confidence in their ability to carry out practical investigations. This, she reflected, boiled down to unfamiliarity with classes, and she was able to use that experience to inform future planning.

Donna did not have her own classroom which was a complication from the point of view of inquiry because she was unable to get things set up in advance. Also, she felt really under pressure time-wise to get through some of the courses. She believed that CfE supported inquiry because it was more flexible in terms of time and specific content (also there is no exam at the end!), thus she was able to incorporate inquiry more with S1 (the only year following CfE courses) than any other year group.

Inquiry Implementation Issues – Donna

	T0	T1	T2	T3	#	Ave
Time	5	5	5	5	4	5
Curriculum & Courses	4	4	4	3	4	3.75
Behaviour Management	3	3	3	1	4	2.5
Assessment/Achievement			1	4	2	2.5
Knowledge of Pupils	1	2			2	1.5
Planning & Organisation		1	2		2	1.5
Resources	2				1	2
Classroom Layout				2	1	2

Dee & Lisa

These research participants felt fortunate to be placed in the same school for induction (and to have their own classroom). They attended courses together, sat on the same committees and jointly ran the science club, so they provided an important source of both moral and professional support for each other. Both had mentors within the Science Department but there was also a Regent who looked after all probationers. Following Term 1 interviews, Dee and Lisa took me to meet the Regent who had shown an interest in the research project and was keen to support them in their endeavours. They also perceived an extensive social and professional support network within the school generally. They had access to policies and other important information and felt that expectations were reasonable and explicit. Both participants commended the council's new teacher CPD programme.

The school itself seemed to be embracing Curriculum for Excellence, which was manifested mainly in interdisciplinary projects, however, the science department was having difficulty with the transition to CfE. The existing science courses were dated and prescriptive with teacher guides for all topics with supporting PowerPoints and numbered lesson plans stating the learning objectives and the resources needed. The two PTs (Biology and Chemistry) were older and, in Dee and Lisa's opinion, not really on board with CfE; there was only one Physics teacher and he did not contribute much. Two more forward thinking and proactive subordinate staff would normally have driven any initiatives and developments, but they were both on maternity leave, which was why the probationers were brought in. Departmental meetings were unproductive and there was frustration at the lack of coherence and collegiate working within the department, including inequity of workload. Further, the school was subject to serious budget restrictions, with little money for consumables for practical work, and even the science technician was shared between schools, which was another source of frustration.

Dee

Dee completed a four year degree in Chemistry with Analytical Chemistry, which included a practical research project (spectroscopic analysis), then worked for two years before enrolling on the PGDE at the age of 24. Her placements contrasted greatly – one in a private school, the other in a deprived area – and Dee noted differences in their approach to teaching, reporting and discipline, but also in the attitudes of, and support from, other staff members. Her main concern on taking up her induction post was discipline.

Dee was stunned at how quickly she was expected to overtake the *'whole'* teaching role and welcomed the space to become established and learn from her mistakes in her own classroom without someone constantly watching her. In the beginning planning was very time consuming, but as she became more organised and confident, her *'command'* of the classroom improved, she was better able to understand the needs therein and gauge the timing of activities, and planning became easier. The amount of support offered exceeded her expectations (presumably based on student experience), however, she was shocked at the lack of money available for resources and technical support. Particularly frustrating was the amount of money spent on photocopying course notes. Courses were very prescriptive (even S1/S2, although these were in the process of being redeveloped), with write-on workbooks, associated lesson plans and set experiments, which left little scope for inquiry. Dee felt compelled to deliver courses as intended (*'...it's his department ... so I have to do what he wants me to do ...'*) but was happy to be involved in the development of S1/S2 courses in line with CfE. She believed that CfE should, in theory, give teachers the freedom to engage in inquiry but, in practical terms, one still had to conform to the expectations of others and meet the demands of future assessments, the format and content of which were still uncertain.

> *It's ... from an inquiry point of view it seems to lend itself well. There's so much scope to do different types of learning, for pupils to lead learning, for them to come to you with questions and, so long as it's reasonably relevant, you can investigate it. From a kind of practical point of view, I don't know how practical it's going to be because we don't know ... like the National 4 / National 5 ... phew ... you don't know what's going to be tested, what's going to be in the exam. (T0)*

Dee's early idea of inquiry was *'pupils asking questions and figuring things out for themselves'* and this did not change throughout the year. From the outset Dee was a real advocate of inquiry from a learning perspective, but she also came to acknowledge the potential for responsive, pupil-led learning to improve engagement and behaviour in the class. Although *'pupils answering their own questions'* was probably Dee's ideal form of inquiry, this was not something that was realised during her induction year. Investigations were done regularly, but in the interests of maintaining authority (in terms of both control and knowledge) questions were posed and lessons mapped out; practicals were generally 'set' experiments modified to use a more open-ended approach. If a question arose she preferred to defer that question to allow her time to plan a lesson around it. She conceded that she often struggled to recognise and operationalise opportunities for inquiry (probably linked to unfamiliarity with courses) and still get through the work because, particularly early on, she felt she was constantly running out of time.

> *Em ... a lot of the questions I had were more real life examples, so ... Why is the fuel in formula one cars really, really cold? ... Obviously something like that you can't do in the class [practically] – I couldn't think of a way you could investigate it. But ... if there was something you could just turn around and say: Well, why don't we try and*

find out... That would be good to do if you had the time; that's always a problem... the time. (FG)

In summary, Dee felt well supported but was frustrated at 1) the weakness of her mentor as a manager and leader, 2) the rigid structure of the courses she was expected to deliver, and 3) the lack of technical support and resources for experiments. She was an advocate of inquiry approaches to learning and believed that CfE would, in time, support this form of pedagogy as teachers become more familiar with the experiences and outcomes and more flexible in their classroom practice, and as more ideas and exemplars become available.

Inquiry Implementation Issues – Dee

	T0	**T1**	**T2**	**T3**	#	**Ave**
Resources	5	5	1	2	4	3.25
Curriculum & Courses	4	2	3	4	4	3.25
Time	1	4			2	2.5
Planning & Organisation			4	1	2	2.5
Understanding			5		1	5
Confidence				5	1	5
Classroom Management	3				1	3
Knowledge of Pupils		3			1	3
Subject Knowledge				3	1	3
Learning Intentions	2				1	2
Assessment/Achievement			2		1	2
Practical Support		1			1	1

Lisa

Lisa completed a 5-year Bio-Physics degree, which included an Optics-based practical research project, then worked for three years before enrolling on the PGDE course. She was 26 when she started teaching. Lisa didn't observe any inspiring inquiry lessons during student placements but was involved in CASE[11] lessons which she felt provided a good basis

[11] CASE: Cognitive Acceleration through Science Education - Materials developed by researchers at King's College London from around 1981.

for getting pupils to explore and inquire and problem solve. A behaviour incident in her final block of teaching practice left her anxious about managing behaviour when she began teaching independently, especially as a school within her allocated Local Authority had recently been portrayed in a TV documentary, and not in a positive light!

Lisa found the first few weeks of probation overwhelming; she had a busy schedule, lots to learn, and was not getting home until very late because of the commute time. However, staff were friendly and supportive and she appreciated the structured courses with set lessons as this helped to cut down on preparation time. Unlike Dee, Lisa felt she had a degree of freedom to alter or add things as she saw fit. Nonetheless, she felt the lack of resources and technical support was holding her back because it affected her planning of practical work and she spent a lot of time (often unnecessarily) trialling new practicals before doing them in class for fear of them going wrong.

For Lisa inquiry was about pupils *'being independent and actually trying to discover things for themselves'*. Lisa felt this was not a feasible approach with certificated classes but that there was definitely scope with the lower school and she attempted to incorporate it when she felt it was appropriate; for example, exploring streamlining, investigating wind turbines, designing rockets, and establishing order (reactivity/density). Her experience, however, taught her that *'they can't really do anything on their own'.*

It would seem that Lisa had much experience of pupils being apathetic or even obstructive as she spoke in rather negative way about pupils' skills, motivation and agendas. She talked about pupils slacking and being annoying, she felt that behaviour often impeded the learning, and even suggested more malicious intent...

> *'I'm sure they just want to blow things up' (T1)*
>
> *'they managed to somehow cheat' (T1)*
>
> *'let's ask her this so that we don't have to do anything, and we can make a mess, ruin all the equipment and annoy the technician.' (T2)*

Lisa's attempts to rationalise pupil attitudes were apparent in three ways: 1) She believed school science was contrived ('set up') and uninteresting and, indeed, that an inquiry approach would make it more like 'real science' than following set practicals or conducting 'proving' experiments; 2) She conceded that certain pedagogies and topics are used to excess and pupils *'get sick of it after a while'*; and 3) She turned her attention inward and considered the possibility that she herself could do more to stimulate their interest and motivation.

> *I think I've got classes that give up quite easily... I probably don't motivate them enough. I tend to be quite relaxed with them, however, that's probably part of the problem why some of them aren't quite motivated because I maybe don't get on at them as much as I should. (T2)*

In terms of responding to pupils' interested, Lisa intimated that she was happy to deviate *'as long as it's sensible and it's worthwhile in terms of their learning'*, which suggests that often it wasn't. An occasion when this approach worked particularly well was investigating wind turbines with S1 in the context of a Renewable Energy topic when pupils had an element of choice in what they investigated (eg. number of blades, 'wind strength'). Working in groups pupils were engaged and actively learning, and able to formulate questions which led to useful extension work. However, in general, she found group work difficult to manage because *'they struggle, some of them, to work with other people'*. With one class in particular she felt she spent whole periods *'trying to manage and control them rather than actually getting through any work'*.

In summary, although overwhelmed at first, with support and encouragement Lisa settled into the teaching role but continued to face significant challenges with her classes, mainly in terms of motivation and behaviour. Although Lisa advocated inquiry, implementation was challenging, partly due to unfamiliarity with courses (and understanding where it could be used to support learning so that she was confident she wasn't *'wasting everybody's time'*), but also due in part to attitudes of pupils themselves. She would be more inclined to do inquiry if she felt the pupils were more enthusiastic and tenacious and wouldn't give up too readily, although she conceded that knowing the pupils' interests and motivators would help.

Inquiry Implementation Issues – Lisa

	T0	T1	T2	T3	#	Ave
Curriculum & Courses	2		5	5	3	4
Behaviour Management	4	5	1		3	3.33
Time	3	2		4	3	3
Knowledge of Pupils	5	4			2	4.5
Understanding		3	2		2	2.5
School/Dept Politics	1			3	2	2
Resources			3	1	2	2
Planning & Organisation			4		1	4
Learning Intentions				2	1	2
Confidence		1			1	1

Douglas

Douglas holds a BSc in Agricultural Chemistry, a Masters Degree in Information Management and is a member of the Royal Society of Chemists. He worked for two years as a Research Chemist, then spent some months analysing data pertaining to the British Antarctic Survey. He also has 25 years experience in commerce: Managing Director of two companies, one involved in plant breeding and the other in product development; Sales & Marketing Director of a third company; and five years consultancy experience in a global context. Douglas completed the PGDE and began his induction year at the age of 46. He is very disposed to straight talking and had absolutely no compunction about voicing his opinion - and was rather amusing with it! Douglas described vastly different experiences in his two student placement schools which he put down to politics and personalities. On arrival at his induction school staff and management were very welcoming and supportive and Douglas immediately felt *'part of the team'*. He developed strong friendships and he had good classes with few behaviour issues. There was an excellent induction programme, although for economic reasons probationers were permitted to attend only 'core' external CPD sessions (eg. Child Protection, Health & Safety), which was disappointing. Important information was centralised and accessible and there was a formalised set of meetings (too many in Douglas' opinion), including regular mentor meetings.

Douglas' mentor was a Depute Head, close to retiral. He placed great importance in the probationer/mentor relationship which he characterised as friendly but not always professional. Indeed he felt the school was failing to follow GTC protocols in respect of observations: unannounced observations were common (due to mismanagement of diary rather than any deliberate sabotage or maliciousness) and feedback was often based on areas other than the agreed focus.

Douglas' main challenge was his relationship with his Head of Department (HoD), who he described as having Obsessive Compulsive Disorder (OCD). She was dogmatic and controlling, and was inclined to 'rant' in front of pupils. Some colleagues did not communicate with her, others were completely compliant. On my first visit to the department he showed me the store/technicians' room where all lessons were arranged in boxes, colour coded and appropriately labelled, in order to back up his claims. He then introduced me to his (like-minded) Physics colleague who re-affirmed the already clear picture of a very rigidly managed department. During the interview he was able to demonstrate further examples of *'micro-management'*; for example, course materials which were essentially *'scripted'*, leaving no room for deviation or improvisation. Feedback from observations was often perceived as 'nit-picking' and pedantic, for example, the use of subject-specific terminology: 'configuration' rather than 'arrangement'; 'cancel out' rather than 'balance out'; 'outer electrons' rather than 'valence electrons'. Towards the end of the first terms Douglas was formally reprimanded and told to absolutely stick verbatim with the prescribed courses. This difference in professional opinions resulted in Douglas handing in his notice. Thankfully the situation was resolved and his resignation rescinded, however, it involved a complete re-write of his interim report because he was able to produce evidence contrary to what the HoD had written. Nevertheless, his main strategy for the remainder of the year was to keep his head down and 'try' to do precisely what he was told. Indeed, at the end of Term 2, although he was happy to be interviewed, he requested the interview be conducted off-tape because he felt extremely vulnerable, and when asked to select five barriers to inquiry, he was adamant that, for the purpose of my research, there was only one barrier ... politics!

At the final interview Douglas' demeanour was much improved. It transpired that this was due to staff changes in the department, including a new line manager and a supply teacher who reported directly to Douglas. He was enjoying his new found autonomy and was increasing his pedagogical repertoire in line with his own educational philosophies, including more inquiry-based approaches. On reflection, Douglas decided his conceptualisation of inquiry hadn't changed much over the year. It involved pupils formulating questions and designing controlled experiments to answer those questions, essentially *'giving pupils the opportunity to build their own conceptual framework'*. Although he felt he had not implemented much inquiry (because the focus of learning was not pupils' questions) he definitely had been able to facilitate 'discovery learning' through planned activities and strategic questioning.

Although some older colleagues complained about the lack of specificity of CfE, Douglas saw it as a huge opportunity and believed it was easier to do inquiry with the lower school due to CfE courses (further up the school there's an increasing focus on content and more structure and specificity to the learning outcomes). However, he commented that it would help if it was interpreted properly rather than simply *'pretending'* existing courses fit with CfE, as was the case in his department.

Douglas described the transition from teacher training to probation: in the early stages he was getting to grips with teaching his subject (egocentric), then progressed to teaching the class (in terms of managing an *'organic whole'*), then to teaching individuals, which ultimately is his idea of developing professionalism. He feels confident about his teaching role, which he puts down to competence, evidenced by pupil learning, feedback from colleagues and parents, pupil enjoyment and behaviour.

In summary, Douglas, who considers himself to be well versed in the development of both personnel and self, passed his probation year but it was not a good experience; in his own words, *'awful ... the most unprofessional professional development experience of my life'*. Although he appreciated working within an organised environment, Douglas perceived no professional autonomy whatsoever and felt that his professional development was being compromised because he was being forced to teach in a fashion which was contradictory to his own educational philosophy, not to mention contrary to current government policy. Despite being a strong advocate of inquiry (and 'discovery') based pedagogies, he felt unable to incorporate such an approach due to the restrictive, indeed prescriptive, nature of the courses and departmental micro-management. Staff changes late in the year brought about positive changes and Douglas looked forward to greater autonomy and *'much more dynamic engagement with CfE'* in his next school.

Inquiry Implementation Issues – Douglas

	T0	T1	T2	T3	#	Ave
School/Dept Politics	1	5	5	5	4	4.00
Curriculum & Courses	5	4		4	3	4.33
Assessment/Achievement	2	3		3	3	2.67
Time	3	2		2	3	2.33
Resources	4				1	4.00
Learning Intentions		1			1	1.00
Practical Support				1	1	1.00

Jill

Jill has an HND in Printing, Administration and Production and an open degree from the Open University, comprising Childhood Studies and Psychology. She was 42 when she began teaching. Jill was placed in two demographically very different schools as a student but, although she noted quite different educational agendas, she was pleasantly surprised at the high expectations for behaviour and learning in both schools. Jill's confidence was low starting induction year, mainly linked to her limited subject knowledge in the various curricular areas.

> *Well it's just ... the whole thing about primary teaching is it's like a jack of all trades and a master of none really, there's so many different subjects. I don't know what primary stage I'm going to have yet so, yeah, I'm kind of worried about that. Hopefully I'll know before the summer so I can read up on everything that I might ever want to know. (T0)*

On arrival at her induction school staff were friendly and welcoming but Jill felt completely overwhelmed by the reality of teaching. Managing the various behaviour issues and catering for the diverse learning needs of the class were a real challenge ... a *'baptism of fire'*. Jill spent the first few days getting to know the class before quickly getting down to establishing structure and discipline. With the introduction of CfE, planning was challenging and time consuming, and because it was new to everyone there was little support with it. Forward plans were described as a *'blank canvas'* intended to allow teachers the freedom to respond to a class's needs and interests and encourage them to develop their own ideas and resources, but, at the time, Jill would definitely have appreciated a bit more structure and guidance in her first year of teaching. It was a huge learning curve, however, on reflection, she conceded that this autonomy had contributed enormously to her professional development.

In terms of support Jill was allocated a mentor but this person went off sick after the first week and didn't return until mid October at which point Jill had several observations in quick succession in order to 'catch up'; this was quite stressful especially as her mentor was inclined to intervene. Regular meetings were resumed but their relationship was a professional one and meetings were stiff and formal. Although Jill appreciated her mentor's support with her profile and professional development, she relied mainly on her stage partner and the only other probationer in the school for important emotional and practical support.

Jill was keen to engage children in science to encourage and satisfy curiosity, but was deeply concerned about her own subject knowledge (although this was not confined to science). Further, she advocated an inquiry approach to teaching/learning science because '*...it's good for them to investigate it and try and find it out themselves, and to ask questions, just to try and, you know, have some ownership of how it could go.' (T0)* However, she perceived inquiry as risky in terms of both managing the activity and the learning achieved, and, especially initially, was terrified at the prospect of not being able to answer a question. Dismayed at how little science was scheduled into the teaching course at university, she had taken the science elective but even that fell short of her expectations. During placements her experience of science was as part of Environmental Studies, but it was rare, basic and uninspiring. She enrolled in the current study in the hope that it would increase her understanding of, and confidence to support, inquiry (and science) in the classroom.

Jill did not teach much science during her induction year as this was remit of the other P4 teacher (although she took the opportunity to help in Science Club in the last term), however, topic work provided opportunities to involve pupils in inquiry, generally in the form of research and fact finding. Jill conceded that such activities were quite structured, often with criteria, direction to information (books, websites, etc) and writing frames provided; she justified this support on the basis of their age and level of independence. However, she actively encouraged questioning and, on occasion – again, usually during topic work – pursued these questions in the course of lessons, but only for a short time as she was always mindful of its impact on behaviour in the class. With the topic *Minibeasts* in Term 3, Jill took a very open, practical and child-led approach. Pupils had the opportunity to conduct personal research of choice, and questions which arose were often answered collectively through discussion, research or practical investigations (eg. What materials attract minibeasts?) A butterfly farm (growing caterpillars) involved pupils in observing, recording, predicting, investigating and applying knowledge. Jill thoroughly enjoyed the topic (as did the children) and the experience had a positive impact on her professional development and confidence to take risks.

> *I think science is a great thing to be involved in at school and I was just a bit apprehensive about it ... [BUT] ... I think it has maybe, aye, I think I do feel... just through this last topic I feel as if ... I have managed to achieve something. (laughs) (T3)*

In summary, Jill felt fortunate about her school allocation because, although she faced significant challenges, staff were, on the whole, friendly and supportive, and she learned a lot from the experience, better preparing her for her next teaching post. Throughout the year she struggled with confidence, particularly in relation to subject knowledge and managing behaviour, and for this reason was wary of implementing inquiry. However, a major breakthrough occurred in the final term when, during a science-oriented topic, she realised that these issues became much less significant when children were interested and engaged and 'leading the learning'.

Inquiry Implementation Issues – Jill

	T0	T1	T2	T3	#	Ave
Subject Knowledge	5	5	4	3	4	4.25
Understanding	4	4	5	2	4	3.75
Resources	1		2	4	3	2.33
Curriculum & Courses	2			5	2	3.50
Confidence	3	2			2	2.50
Pupils & Behaviour			1	1	2	1.00
Learning Intentions		3			1	3.00
Planning & Organisation			3		1	3.00
Time		1			1	1.00

Joanne

After completing a 5 years Masters degree in Chemistry with Medicinal Chemistry, Joanne spent the next 5 years working as a Medicinal Research Chemist and travelling before making the decision to become a Chemistry Teacher at the age of 28.

Joanne's two student placements contrasted greatly in terms of support. In one school the co-operating teachers were very supportive and encouraged her to try different things, remaining with her in class at all times and providing constructive feedback following teaching episodes. In the other school she was left very much to her own devices, and often taught with no supervision. In the latter school, however, the courses were very structured and resources organised so that everything needed for a particular lesson could be taken 'off the shelf', which, in retrospect, turned out to be a form of support in itself. Joanne struggled with discipline at times during student placements but was hopeful that, with experience and the right support, she could overcome this.

Unfortunately Joanne's induction placement failed miserably to meet her expectations for support on so many levels, and by the end of the first term Joanne was deflated and exhausted. Firstly, there were no course notes, resources or suggested activities for any of the certificated courses. There was merely a 'timeline' which specified when each topic should be completed, but the content of each lesson had to be devised in its entirety. Then in the lower school, with the introduction of CfE, all old resources had been thrown out; so, although there were courses (in the process of) being written for S1 and S2, there were very little resources to support them. On top of that, the technician was less than accommodating and insisted on requisitions being in a week before they were needed. Secondly, Joanne was given very challenging S1 and S2 classes (S1 in terms of the diversity of learning needs; S2, behaviour) and very little support in coping with these. Although both classes had been 'earmarked' for support, this was not put into place for several months, and even then it was inconsistent. Further, all science classes were double periods (1hr 50min) which made her time with these classes even more stressful. She was aware of a *'referral system'* in the school but it had never been discussed with her. Thirdly, there was no in-house induction programme to speak of. Early on, Joanne and her fellow probationers had approached the Head Teacher about the possibility of regular meetings and a regent to oversee their training and they were *'interrogated'* as to what that might involve. Joanne's mentor was the only other Chemistry teacher in the department and they had no timetabled meetings, indeed no corresponding non-contact time. Consequently, any talks usually took place during breaks or after school hours; Joanne was reluctant to take up too much of her time because it was apparent that she was extremely busy. Fourthly, the Science Department itself was *'very divided'*. Relations were strained and communication difficult, there was no sharing of resources and departmental meetings were unconstructive and frustrating. The 'PT Science' was actually a Social Studies teacher who was difficult to access and not much use for support with curriculum and pedagogy anyway. Further, because the Science Department was not housed within the main school building, Joanne had little contact with other staff members outwith the department.

Towards the end of her induction year there was a marked change in Joanne's demeanour; she had gained in confidence - which manifested in the classroom in increased flexibility and willingness to try new things - and was *'enjoying it more'*, which she put down to improved classroom control and pupils' responding to her *'teacher voice'*. Although not much had changed support-wise, she seemed to have resigned herself to the situation and was determined to make the best of it, learning from experience (from her mistakes!) and engaging in professional discussion with fellow probationers. She reported positive changes within the department (for which herself and the Biology probationer were given credit), and indeed she had applied – successfully - for the new Chemistry post the following term.

In summary, Joanne felt seriously disadvantaged compared to other probationers who were learning from others as she felt she was learning everything on her own and doing what she needed to do to get through – which amounted to *'fire fighting'* most of the time. Joanne's only real source of support (emotional and professional) throughout the year was the Biology probationer. Joanne was very unsure about inquiry and how to incorporate it despite having worked as a scientist in industry prior to teaching, and having observed the positive effects of using an inquiry approach during one of her student placements. Feeling abandoned and struggling with behaviour, time management and confidence, inquiry was just too risky.

Inquiry Implementation Issues – Joanne

	T0	T1	T2	T3	#	Ave
Resources	2	1	2	4	4	2.25
Classroom Management	4	4		2	3	3.33
Confidence		5	1	3	3	3.00
Practical Support	1	2	3		3	2.00
Knowledge of Pupils	5				1	5.00
Understanding			5		1	5.00
Planning & Organisation				5	1	5.00
Curriculum & Courses			4		1	4.00
School/Dept Politics	3				1	3.00
Subject Knowledge		3			1	3.00
Time				1	1	1.00

John

John completed a 'distance' degree (Open University) in Physical Science over a period of about 4½ years, which incorporated a small literature-based research element, immediately prior to embarking on the PGDE. He was 42 when he took up his induction post as a Physics Teacher. John was interviewed immediately prior to starting induction, then again at the end of Term 1 (Christmas) and Term 2 (Easter), however, I was unable to arrange a final interview at the end of the induction year.

John felt welcome in his induction school and was quickly accepted as a member of staff, although retrospectively he conceded that this had not been instant and automatic, but had taken a while to *'warm up'*, perhaps as they got a measure of his worth. The general feeling of *'camaraderie'* within the school exceeded his expectations (presumably based on student placements). He felt supported but by no means held by the hand. Virtually anyone could be approached for help and advice but other than that he was very much left to his own devices. This suited him and he was careful to develop good relationships with everyone and fit in with operational aspects of the department. He acknowledged the inadequacy of certain aspects of observed practice but was not critical. Rather, he had empathy for his colleagues and their agendas, acknowledging that they had to meet deadlines and hit targets – they are, after all, accountable for the progress and attainment of their classes and their competence would be measured against that.

He was quick to justify their actions even when it was to his detriment. For example, whilst teaching on student placement he was quite happy responding to pupils' questions in the course of a lesson, but was reprimanded afterwards for *'allowing himself to be distracted'*. On that occasion he felt in control and that he was supporting the learning through class discussion, however, because he was also able to see the co-operating teacher's perspective and understand his motivations, he was willing to conform. Also, it was apparent that the induction school were reluctant to let all probationers out of school for CPD. Given the complexity of timetabling and the pressure to cover courses, this too was justified in John's opinion: *'...you've got to come and go... take what's minimum inconvenience and disruption for the pupils'. (T1)*

For John the purpose of science education is to foster curiosity, encourage logical thought and develop problem solving skills... and inquiry fits this bill, but they have to have a starting point, a question, perhaps based on prior learning, and an endpoint which fits into the scheme of intended learning. For this reason structure and guidance are important. For John, relevance and application of knowledge are key. His main, and consistent, issue in implementing an inquiry approach was time, however, the impact of politics (educational agendas rather than relational aspects) was acutely perceived at two separate time points: prior to starting probation (T0) when contemplating the responsibility of the teacher role, and at the end of Term 2 (T2) when pupils were preparing for final exams (implications of assessment and achievement), suggesting that accountability was often at the forefront of John's mind. Curriculum and Resources were also considerations for John in incorporating inquiry experiences. There were courses (with supporting resources) in place for all classes, and, although he perceived the autonomy to deliver these as he saw fit, modifying where necessary, he conceded that he tended to *'stick to the plan'* (especially early on) for the sake of hitting learning objectives and meeting deadlines.

In terms of flexibility he was unlikely to commit time to pursuing pupils' questions but was more relaxed about slowing things down *'so you might not get through absolutely everything, but that would be for the purpose of making sure you get as many people coming with you as possible really'*. However, as his confidence in managing pupil-centred group-oriented work developed he began to *'plan in'* investigative experiences, for example, by modifying existing lessons. He fully expected that the ability to identify opportunities for inquiry would improve through familiarity with courses, although he conceded that the *'other pressures'* would continue to compete; he has to learn how to implement inquiry approaches without compromising exam results!

Inquiry Implementation Issues – John

	T0	**T1**	**T2**	**T3**	#	**Ave**
Time	4	5	4		3	4.33
School/Dept Politics	5		5		2	5.00
Curriculum & Courses		4	2		2	3.00
Resources		2	3		2	2.50
Assessment/Achievement		3	1		2	2.00
Knowledge of Pupils	2	1			2	1.50
Learning Intentions	3				1	3.00
Personal Commitment	1				1	1.00

Rebecca

Rebecca has two science degrees; the first in Forensic Psycho-Biology and the second in Forensic Science; the latter involved a practical research project (investigating drug impurities). After completing these courses she worked in sales for two years before deciding to become a primary school teacher at the age of 26.

During her PGDE, dissatisfied with level of science included in the core course (one lecture), Rebecca signed up for the CPD course, *Science in the Primary School*. She had hugely contrasting placement experiences, which she put down to the different dispositions of her co-operating teachers, and was extremely disappointed at how little science was done in primary school. In her second placement she ran a series of CfE-oriented lessons (deliberately open and responding to children's questions and interests) based on the Social Studies topic, *The Celts*, but on reflection she was happy to classify this as inquiry. Although it was not a science topic, science concepts did creep in, usually in the form of engineering challenges. The experience was highly significant for her in terms of learning, engagement and pupil responsibility. Her main concern going into induction year was behaviour management.

Rebecca's induction school was in a deprived area and her class (a composite 4/3 class) had a broad range of additional support needs. Initial learning was centred on *'admin'*, procedures, policies and getting to know her class, after which the priority was additional support for learning, including differentiating for maths and language. She was lucky to have a pupil support assistant at maths times to support individual pupils but a real challenge for Rebecca was meeting the needs of the whole class.

As with most participants, Rebecca was a bit apprehensive about CfE moving into her induction year, mainly in terms of lack of guidance and time constraints, but Rebecca's school had embraced CfE, and much work was being done to deconstruct the Experiences and Outcomes and translate these into coherent courses and learning activities. During her induction year CfE manifested itself in termly themes which aimed to make learning more cross-curricular and child-led. Rebecca perceived complete autonomy for pedagogical decisions, particularly in the context of topics and themes, and felt able to take any *'justifiable'* approach... and if activities improved learning by being more relevant and meaningful then they were justifiable! To Rebecca, CfE now felt more *'natural'* than it did on placements, where one school ignored it and for the other it involved a mere matching exercise.

Throughout the year Rebecca regularly exploited opportunities to incorporate science. Sometimes opportunities were obvious, for example, in the themes *Heath & Wellbeing* and *Our Natural World,* but even when they were less obvious Rebecca usually managed to lever in some science; for example, experiments with sound and colour as part of the theme, *The Arts.* She relied heavily on lesson plans to begin with because that's what she believed was expected, but often they did not go to plan and she soon realised that rigid planning assumed unrealistic expectations and was not conducive to inquiry.

> *There's not a lot of time to get everything you plan in, or everything that you're supposed to plan in, and then let them kind of explore it a wee bit. (T1)*

Although she could relate more to pre-planned inquiry, on reflection she was able to recognise inquiry moments also, when children took lessons down an unintended path. In her opinion, responding to their interests made the lesson relevant to them and therefore the learning more meaningful, however, it was also risky in terms of behaviour and subject knowledge. For most of the year she relied on her own subject knowledge to support science teaching but in final term the topic was *Our Natural World* which was centred on growing plants, an area Rebecca knew little about. However, it was probably the most inquiry-oriented learning of the year as they were learning together through observation and investigation. She really enjoyed it, as did the children, and realised, *'Just because I don't know it doesn't mean I can't teach it.'* For such an approach to be successful, however, she reasoned that you need a good working knowledge of your class.

Rebecca's main source of support was her supporter (mentor) but there was also a structured induction programme which included initial orientation and ongoing in-house and external (LA) CPD. Moreover she felt the expectations of her were clear and she had no issues accessing important information. She felt welcome and part of the team, and contributed to staff development by delivering science-based CPD (*Teaching Science through CfE*), which was well received by colleagues, impacting positively on Rebecca's confidence. Rebecca was the only probationer in the school but she had regular contact with other probationers at the LA training days, and her close friend had completed probation the previous year, so these were good sources of emotional and practical support. She found the profile (SFR) a real chore throughout the year, but on reflection conceded its usefulness.

In summary, Rebecca had a busy but enjoyable induction year. Her school was in an area of high deprivation and she commended the school's ethos and commitment to the local community. Rebecca was very fond of her class but a major challenge was meeting the wide range of additional support needs therein. Nevertheless, she felt well supported and included and grew in confidence and planning became more flexible and responsive. She was passionate about promoting science in the primary curriculum and actively sought opportunities to incorporate science learning as part of the ongoing theme, and with increasing orientation towards inquiry. She also encouraged colleagues to incorporate science by providing science-based CPD (*Teaching Science through CfE*).

Inquiry Implementation Issues – Rebecca

	T0	**T1**	**T2**	**T3**	#	**Ave**
Time	2	5	5	4	4	4.00
Behaviour Management	5		4	5	3	4.67
Subject Knowledge	3	4	2		3	3.00
Practical Support	4		1	2	3	2.33
Resources	1	2	3		3	2.00
School /Dept Politics		1		3	2	2.00
Confidence		3			1	3.00
Planning & Organisation				1	1	1.00

Rose

Rose, aged 24, originates from the USA but moved to the UK in order to learn Gaelic and become a primary teacher in a Gaelic-medium school. She has a BA in Theatre and worked briefly as a Research Assistant for a Professor in English Literature before coming to Scotland.

During Initial Teacher Education Rose completed three placements (2 primary; 1 nursery), however, as an overseas student she was not automatically placed in a school under the New Teacher Induction Scheme. She did manage to find her own induction placement by applying for the job effectively - which she attributes largely to her Gaelic language qualification and her research involvement – although this took her to a rather remote part of Scotland.

Rose is a strong advocate of inquiry, particularly *'critical inquiry'* as she calls it, and also supports radical education movements such as Summerhill[12] and democratic classrooms. She liked the idea of Curriculum for Excellence because she believed it would give her *'creative control'* and *'flexibility'* in her classroom although she expressed concern from the outset that her ideas for education may be too radical for her colleagues and that she may *'piss people off'*. Despite the lack of a scientific background, and having seen very little science on placements, she was keen to teach science through inquiry to demonstrate that '*reason and... human curiosity are really important in science ... and using our brains we can figure things out'*. (T0) What she herself struggled to figure out was just how to DO inquiry as this was not something that was covered during initial teacher education, nor was it something that was practised, or even valued, by her colleagues in school. She experimented with her own ideas and came to an understanding of what constituted inquiry and what didn't, the main criteria being that the children were formulating and/or answering scientific questions; and what worked and what didn't, which largely depended on their level of maturity and reasoning ability. This was compounded by the fact that she had a composite P3/4/5 class and that they were required to communicate predominantly in Gaelic. Also frustrating from the point of view of implementing inquiry was the perceived rigidity of the curriculum; the school's (indeed the sector's) preoccupation with maths and language to the detriment of all else, and insistence on fine detailed planning, which made it very difficult to incorporate science at all let alone pursue a line of inquiry and follow pupils' interests in the moment. She perceived limited autonomy over what she did in class and was forced to change her priorities to coincide with those of management

[12] Founded in the 1920s, Summerhill is a progressive 'democratic' independent school in England which offers a radical alternative to conventional schooling; lessons are optional and rules negotiated.

in order to pass her probation year. The school's apparent alignment with CfE was nothing more than lip service as far as Rose could see.

Rose quickly developed positive relationships with her pupils and felt very comfortable in her own classroom, however, she was much less confident in her interactions with staff, management especially. On two separate occasions Rose's insecurity was apparent when she requested that we speak quietly lest others overhear our conversation! Part of the reason for this insecurity was that she was very unclear on some of the operational aspects of the school and what others' expectations of her actually were. There was no structured induction programme in place for the probationers, and no policies available to refer to as these were in the process of being reviewed and re-written. Rose went through the year seeking information and advice as it was needed, often learning from her mistakes and stepping on toes in the process. The school office was often her first port of call for procedural issues or for particular resources, but she found the admin staff less than accommodating and indeed quite intolerant of her needs as a beginner.

Rose's relationship with her mentor was a very important one, but only in so far as the mentor was the person with the ultimate power to determine the outcome of Rose's probation year – pass or fail. That relationship seemed quite strained at the beginning of the year. Rose perceived a huge power differential and, based on her experience on placement, was surprised at how little her mentor was interested in her ideas and opinions, and at how closely she was being watched. The mentor seemed quite critical of Rose, undermining her authority by interfering during observed lessons, and chastising her lack of observance to protocol. In fact, she held the other two probationers up as examples of what Rose should be like and should be doing, making Rose feel inefficient and inadequate. However, Rose worked hard to improve the relationship, and the more she was able to conform to her mentor's expectations and willing to adopt her priorities, the easier it became. There was time set aside for regular meetings but these often failed to meet Rose's needs as they tended to focus on administrative issues rather than any meaningful pedagogical discussion. Rose's main source of support, both emotional and developmental, was other probationers and she valued the opportunity to meet outwith the school context to let off steam and engage in professional discussion.

In summary, induction to the teaching profession was a difficult year for Rose. Her own goals and ideals were incompatible with the harsh realities of the school system and had to be compromised in order to successfully complete probation, including her aspirations for science education, which was frustrating and demoralising. Due to a general lack of information and support Rose went through the year learning from her mistakes and constantly *'watching her back'*, which impacted on her confidence. The main impediments to inquiry were her understanding of inquiry-based practice, school/department politics and the rigidity of the curriculum.

Inquiry Implementation Issues – Rose

	T0	T1	T2	T3	#	Ave
Understanding	5	3	5	5	4	4.50
School/Dept Politics	2	4	1	4	4	2.75
Curriculum & Courses	3	5	2		3	3.33
Time	4			3	2	3.50
Planning & Organisation			4	2	2	3.00
Confidence		1		1	2	1.00
Pupils & Behaviour			3		1	3.00
Subject Knowledge		2			1	2.00
Resources	1				1	1.00

Ruth

Ruth completed a joint honours degree in Business Studies and Environmental Studies then worked for two years in marketing and achieved a Direct Marketing Diploma before taking a break from working to have a family. She was 33 when she made the move to teaching.

As a student Ruth was placed in two demographically very different schools - one in a deprived area, the other in an affluent suburb – and she noted marked differences between the two, especially in terms of expectations for pupils. Another observation was that there were very few science resources; she had to buy everything she wanted to use (eg. seeds, soil, yoghurt pots). Also, after learning about CfE in University, she was surprised and disappointed at both schools' lack of engagement with it. There was little evidence of cross curricular working and she found the timetable very rigid and with a narrow focus - predominantly maths and language - which suited most teachers. She rarely observed science on placement other than science club. Science in class was generally subsumed within topic work, and indeed often had a maths or language focus. She observed one good science lesson on friction from which she took ideas on how to approach such a lesson in order to promote engagement and learning.

The first few weeks of probation were a blur for Ruth - *'getting to know the children and settling them in'*, establishing routines, rules and discipline – but she really enjoyed it. Everyone in the school was very supportive, especially her mentor who gave her space and encouragement to try out her own ideas, but was on hand to provide help and guidance when needed. Like all Primary participants Ruth found CfE-based planning very difficult and had little support because it was new to everyone. Although at the start she would have liked more structure and guidelines (and more explicit expectations), in retrospect she conceded that the freedom to experiment had been very important for her professional development. There were no other probationers in the school so getting together with probationers from other schools at the weekly LA probationers meeting provided good emotional support. There were also three *'young'* teachers at Ruth's school who'd completed probation within the last two or three years. These were a good source of moral support and were happy to have Ruth observing their classes, which Ruth found particularly helpful.

Ruth had set very high expectations for herself and was often frustrated or disappointed when lessons didn't go to plan. A major learning point was that prior learning had to be put into the current context: *'You've got all the theory but it just means nothing until you're actually there'. (T1)* After the first term she began to relax a bit more and realise that *'you can't do everything'*, and was intend on striking a better balance between her work and personal life, and by the end of Term 2 she felt confident and flexible in her teaching, able to adapt to needs and interests of pupils. For Ruth inquiry equates to critical thinking; taking a question or problem, relating it to what you know or understand, examining evidence or different perspectives and holding these up against existing framework thereby arriving at new or deeper understanding. She described several planned inquiry episodes, including exploring wind turbines in the context of the renewable energy topic, kite making and evaluation in response to pupils' interests after reading a book, and - a major success in Ruth's induction year - a week long forensic based investigation (CSI theme) at the end of Term 1. This was sanctioned by the Head Teacher and involved gathering and analysing evidence, questioning, explaining and justifying, problem solving, experiments and other practical activities. It was very successful with the children engaging well and the whole school being involved to an extent. As well as planned activities she described various episodes where lessons changed direction in response to children's questions and interests but she saw this as tantamount to good teaching and in line with the philosophies of CfE.

In summary, Ruth enjoyed her induction year. She had a good class and felt welcomed, supported and part of the team. She grew in both confidence and flexibility, gradually building in more discussion, interaction and inquiry in most areas of the curriculum, maths and language being the notable exception when lessons were, on the whole, much more routine and structured. She was a strong advocate of inquiry but her main challenges in this respect were time and planning, created by an overcrowded curriculum and timetable.

> *I think you can manage inquiry really, really well. I think having inquiry as a central focus, that's your target, you know, why is this happening, what's the purpose of this, I think that is more of a catch for the children to want to learn... I think the time element it takes to do inquiry lessons and to do it justice is the restrainer I think. I wish I could have done it more, I wish I'd planned more ... but now in hindsight I'd definitely do it more. Definitely. (T3)*

Inquiry Implementation Issues – Ruth

	T0	T1	T2	T3	#	Ave
Time	3	5	3	4	4	3.75
Behaviour Management	5		5	3	3	4.33
Understanding		3	1	2	3	2.00
Planning & Organisation			4	5	2	4.50
Knowledge of Pupils	4	2			2	3.00
Learning Intentions	2		2		2	2.00
Confidence	1			1	2	1.00
Resources		4			1	4.00
School/Dept Politics		1			1	1.00

Sean

Brought up in Australia, Sean worked as a chef before and while completing his first degree in Aeronautical Engineering at Cambridge University, where he conducted a small scale research project in the area of Kit Aircraft and Stealth Technologies. He went on to do a PhD in Space Tourism and Intergalactic Space Travel then worked as an airline pilot and subsequently an aircraft designer.

Sean was 34 when he started his induction year and, despite concerns about discipline and fitting in (*'being teacherish enough'*) based on student placement experience, he seemed very comfortable in his induction school and, over the course of the year, developed a strong self-as-teacher identity. Indeed, unlike on placement when his biggest challenge was convincing co-operating teachers that his ideas were sound and the pupils capable, during induction he perceived an enormous amount of autonomy, which he welcomed. However, as with student placements, Sean was acutely aware of in-house politics: tensions and disputes, *'tit for tat'* behaviour of staff, unwritten rules, access to resources, protocols and procedures, and inequitable distribution of work and class allocation. Indeed, in the first few weeks Sean was *'more sort of gob smacked at the teachers' behaviour than anything to do with the kids'* and as such could appreciate the importance of maintaining friendly relations with everyone.

In addition to negotiating school politics, a major challenge throughout the year was a particularly difficult 3rd year science class. There were only nine pupils in the class but all were *'high tariff'* despite a policy mandate of no more than two such pupils in any one class. Luckily the class was *'well known'* and colleagues were sympathetic and supportive, but more significantly, Sean was given free reign to do with them as he saw fit, which resulted in what may be regarded as an 'alternative curriculum' - alternative to the curriculum they were signed up for but none-the-less beneficial for that particular group of young people. Despite several major incidents, colleagues and management remained supportive and he was able to make some headway with the class, for instance, despite being *'written off as no hopers'*, one pupil achieved a credit pass in one of the class tests.

Sean's supporter was young and inexperienced in terms of the New Teacher Induction Scheme and Sean found himself completing most of the paperwork himself. His main sources of support were other probationers (Biology in particular) for professional discussion, ex-NQTs for moral support and *'inside information'*, and the backing of the Headmaster.

Sean could be accurately described as 'an investor in people'. He puts a lot of effort into building and maintaining relationships (volunteering assistance, being a sympathetic listener, massaging egos), possibly in the expectation of a payoff of some sort further down the line, for example, co-operation from pupils, support from colleagues, or help with resources. The networker in him enjoys engaging with colleagues and experts in the field, and he would happily enlist their help to bring a topic to life. He accepts that some people can be won over, but not others... *'once you've figured out which staff are amenable to that sort of stuff that makes a huge difference.' (FG)*

Sean is a very innovative and resourceful individual with lots of ideas to enrich the learning experience, and the technical ability to produce quality resources to support the learning. The philosophies of CfE are very much aligned with his own educational ideology, however, he acknowledged an incompatibility with the current culture of accountability with associated deadlines, goals and exams. From his narratives, inquiry was very much in evidence in his day-to-day practice. He described it as an *'organic process'* in that it took its own path depending on pupils' interest. Sean was very comfortable with this approach (especially as he had been able to demonstrate pupil learning and progression whilst regularly using this approach) and would readily pursue an emerging line of inquiry if it was likely to add to the learning and/or improve motivation. In this way learning was relevant to them and contextualised within their own cognitive framework, improving retention and application of knowledge.

In summary, despite certain challenges concerning politics and managing difficult behaviour (which were perceived to be the main impediments to inquiry also), Sean's induction year was a constructive experience in terms of teacher identity. He enjoyed positive relationships with colleagues and appreciated the balance of professional autonomy and support which allowed him to experience a high degree of success in the classroom and demonstrate progression in his pupils.

Inquiry Implementation Issues – Sean

	T0	T1	T2	T3	#	Ave
School/Dept Politics	1	5	3	5	4	3.5
Behaviour Management	4	4	2	1	4	2.75
Assessment/Achievement		3	5	4	3	4
Curriculum & Courses	3	2	1		3	2
Resources		1		3	2	2
Knowledge of Pupils	5				1	5
Understanding			4		1	4
Confidence	2				1	2
Time				2	1	2

Shona

Shona completed a four year degree in Anatomy and Physiology, with a small research project in her final year, then spent a year working as a classroom assistant before completing the PGDE at age 23.

She experienced a good level of support during student placements, however, a behaviour-related incident whilst in charge of a class left her a bit anxious about behaviour management going into her induction year - a concern that was not unfounded as behaviour turned out to be possibly her biggest challenge that year, with time management a close second.

Shona felt fortunate in terms of the school building itself (which was big and modern and well resourced), support from colleagues, and especially having her own classroom. She had attended an induction day even before the school broke up for summer when she was introduced to colleagues, given a tour of the school, and spent some time with her PT, who provided upfront information on timetables and starting topics, which allowed her to prepare, both mentally and in a practical sense.

On starting her induction year she found staff very welcoming and supportive (which exceeded her expectations), and was delighted that there were three other probationers. Initially there was a strong induction programme in place which included both in-house and Local Authority run sessions, however, the in-house element fell away after the first term due to staff attrition. Despite this Shona still felt supported in that she was able to approach others for help and advice. Her main source of support in this respect was her mentor with whom she had a weekly meeting and who was instrumental in monitoring her professional development, ensuring she achieved the standard for full registration.

Shona invested time and effort at the start getting to know the various people, what went on in the school in terms of development work and extra curricular activities, and becoming familiar with procedures and policies, especially the behaviour policy (which she found lacking and unenforceable). In class her efforts went into getting to know pupils, establishing rules and boundaries and setting expectations for work and behaviour. By Term 2 her focus had shifted to aspects of teaching, including differentiation and incorporating more active and collaborative learning.

During that year the school were still using 5-14 topics but attempting to deliver these in a more CfE-oriented fashion, and work was being done to develop new courses. Staff were generally pro-CfE, if a bit insecure. Consequently, Shona perceived a higher level of autonomy with S1 and S2 than with certificated classes, with flexibility in terms of how courses were taught (and believed CfE was helping in this respect). However, she found the more pupil-centred approaches to be much more time consuming and even impractical in terms of meeting deadlines (eg. test dates) because, although the school were on the whole embracing CfE, they had retained (at least for the time being) their *'test every topic'* agenda. This incompatibility was acknowledged.

Shona discussed two pre-planned inquiry episodes, both with S1. The first was discussion based on a concept cartoon and the other an end of topic practical investigation which had been modified to promote more active learning (thinking). She conceded limited success with each of these, which she attributed to student ability and reliance on structure, and on both occasions was compelled to revert to a more transmissive style of teaching in order to meet learning objectives and scheduled deadlines. In terms of more spontaneous inquiry, the behaviour of certain individuals in the S1 class (as well as time pressures) made it difficult to accommodate. With her limited experience and flexibility - *'obviously like every new teacher'* - she found it difficult to *'let them go with it'*. Also, although she had an understanding of inquiry on one level, gained largely through participation in the study and engagement with CfE, she was unsure how to make it happen in her own class and suggested that inquiry based CPD and observing others doing it may be helpful.

In summary, Shona had a generally positive induction experience but struggled with pupil behaviour and time management. She advocated inquiry and other pupil-centred approaches but, although she gained in confidence over the year, she did not develop sufficient flexibility in her teaching to allow this to happen. This was probably largely due to the schools rigid teaching and testing timetable and Shona's perception of accountability for achievement.

Inquiry Implementation Issues – Shona

	T0	T1	T2	T3	#	Ave
Resources	5	2	5	5	4	4.25
Classroom Management		5	4	4	3	4.33
Subject Knowledge	4			3	2	3.50
Time		4		1	2	2.50
Confidence		3	2		2	2.50
Practical Support	2			2	2	2.00
Understanding		1	3		2	2.00
Assessment/Achievement	1		1		2	1.00
Learning Intentions	3				1	3.00

CHAPTER 7 – IMAGES OF INQUIRY

Preliminary Notions of Inquiry

The terms 'Investigative Pedagogy' and 'Inquiry Approach' are used interchangeably in the project documentation. When the understanding of these terms was explored in focus groups, however, it was apparent that many participants had no clear concept of what was entailed; indeed they were not necessarily thought to be the same thing. A handful of participants suggested that 'Investigative Pedagogy' meant investigating your own teaching rather than pupils investigating to learn. This should not be surprising as this definition also featured at the S-TEAM[13] inaugural meeting (7th May, 2009) which was attended by seasoned teachers and teacher educators from 26 institutions in 15 countries. For other participants, 'Investigative Pedagogy' suggested investigating to learn but within a controlled environment where the teacher directed the learning by providing a question or problem and then structured the environment to allow pupils to address the problem. An 'Inquiry Approach', on the other hand, evoked the notion of pupil questions, of pupils pursuing their interests in an open and more '*free-flowing*' manner, a vision more aligned with current reform efforts

> *Do you not think 'inquiry' is much more sort of free-flowing, it's going to go off on its own route? Whereas 'investigative,' in my opinion, is you're still keeping on track to that thing, but you're letting them be much more involved in the process. I would have thought 'inquiry' could abandon the topic, quite often ... because with natural inquiry you go with what you're interested in, you know.*
>
> ***(Sean, Physics, FG)***

> *That makes me think of sort of pupil-directed kind of work where, rather than the teacher being like "ok, this is the thing we've got to learn", it's like the teacher and*

[13] S-TEAM (Science Teacher Education Advanced Methods) is a European wide initiative aimed at promoting inquiry and other innovative teaching methods through teacher training and support.

the student are setting off where both are intending to learn something maybe and that you're starting with a question, like instead of starting with a fact. I would say it's like starting with a question and then investigating that question.

(Rose, Primary, FG)

I would say it was getting them to ... to want to find out, getting them to find out basically like them asking questions, them doing research, anything like that to find out or, even if they ask a question, well you go and find out the answer for me, I'm not going to give you the answer.

(Dee, Chemistry, FG)

Although pupils' questions were seen as a natural catalyst and starting point for inquiry, participants' experience of pupil questions during student placements was variable. Generally speaking, questions attended to were those posed by the teacher or presented in course notes rather than coming from the pupils themselves.

Although it was apparent that many participants had previously formed only a tentative conceptualisation of inquiry, throughout the focus groups a collective definition of inquiry emerged which very much focused on questions or problems where the outcome was unknown (to the pupil); ideally inquiry was about setting out to answer pupils' questions. When asked individually before beginning their induction year, all agreed in principle with an inquiry approach and, further, were able to justify their advocacy in terms of authenticity, scientific literacy or its impact on learning. This pedagogy would seem to satisfy the purpose and aims of science education which, for 17/18 participants, was the development of practical knowledge and transferable skills. Notably for the participants in this study, as for many proponents of this approach, inquiry was practical, collaborative and problem-based (Bell et al., 2005; Rowe, 1973; Schwab, 1962). It stems from a question and involves devising ways of answering that question, or 'discovering'.

I think to actually inquire and ask and sort of discover things, I think that's what it's all about... You would have to have a question... I mean, fair enough, you could throw somebody a bunch of stuff and they'll come up with this, that or the next thing, and it'll not be bad or good or whatever. It might be brilliant, who's to say. But it's not necessarily going to be the learning intention, the learning outcome that *you want, so I think you need to start off somewhere... or you need to have something... look, see if you can get here... I think that's the sort of essence of maybe what it should be about. Where they're having to think something through, solve a problem, apply knowledge.*

(John, Physics, T0)

However this is not, it would seem, in the sense of pure 'Discovery Learning' as advocated by, for example, Piaget and (early) Bruner. Although there have been many proponents of this approach over the years, it is often argued that, whilst it may foster curiosity and engagement, pure discovery fails to ensure that intended learning takes place, risks the spawning of misconceptions which are not easily accessible to the teacher, and can lead to cognitive overload and frustration on the part of the pupil (Kirschner, et al., 2006; Mayer, 2004). This tension is evident in the research data as participants struggle to strike a balance between allowing the freedom and scope to foster creativity and responsibility for learning and providing sufficient structure to ensure learning intentions are met. At this early stage most participants are intuitively edging toward more structure rather than less, perhaps revealing their developing teacher identity, perceived as self-efficacy.

I mean they obviously need guiding, like they need resources given to them and, you know, you need ... this is an experiment, it's what we're going to do, but then let them go away and maybe find out for themselves which things work and which things don't. I don't think you could just say, right off you go and try and work something out, they definitely need some sort of structure, but ... they definitely need to have a go themselves and see what works and what doesn't work.

(Ruth, Primary, T0)

I think you need a bit of guidance. I suppose it's maybe time constraints possibly or, it's just the system we're working under just now where you do have pretty specific sort of learning outcomes, you know what I mean, things that you have to know or learn or whatever, so I suppose you're forcing it a bit. But I don't know how avoidable that is, to be fair. But I think certainly you would need to have ... you need a certain amount of structure from the point of view that you need to know where you are and where, ideally, you want to be or what you want to find out about or what you want to create or discover.

(John, Physics, T0)

Like John (above), although advocated 'on paper', Douglas also questioned whether current agendas actually accommodated inquiry.

> *Well, inquiry suggests to me ... as opposed to discovery ... inquiry suggests to me that the questions have to come from the children. That's the difference, for me. And I don't think there's any space in the curriculum for that whatsoever.*
>
> ***(Douglas, Chemistry, T0)***

Early Grapplings with Inquiry – Term 1

During Term 1 (August - December), questions or problems remained the starting point for inquiry but only a few participants held strongly to the idea of inquiry being necessarily about pupils' questions, although, as the following excerpts illustrate, this created serious dilemmas for them in the context of real schools and real classrooms.

> *In terms of science, the next step I guess is to form a question. Again, though, it's really going to be me steering questions. I'm struggling with how to plan for an inquiry-based series of lessons. Is it still inquiry if I know already that I want them to learn about native plants and animals? Isn't it really my question, then, and not at all their question? ...How can they learn anything about native plants and animals if I don't teach them? How could they find out for themselves? Is it still inquiry if I steer their questions and then provide resources with information? ... I'm going to try to get resources out of the local library where I am now, field guides and stuff like that so that I could potentially give them to the kids in class or we could try and identify plants, I could bring in cuttings. I just don't know if they can do that, or if that could remotely count as inquiry. How do I plan an inquiry-based investigation if it has to all be planned out ahead of time?*
>
> ***(Rose, Primary, T1 Blog)***

> *I do try and use discovery-type teaching where I can - where it's possible, it's not always possible - leading them through a set of experiments to draw their own conclusions. I do try and teach like that, and even within a highly prescriptive course you can still do that but, I mean, it comes back to the conversation we had*

before I left [uni], what's your definition of inquiry-based teaching, doesn't it really? And, I mean, for me inquiry based teaching means ... it's more than discovery based teaching. It means identifying your own avenues of discovery, in other words it means putting the pupil in charge of their own learning and it means providing the structure for them to answer their own questions. That's what it means for me and that may not be a correct academic definition. If that is the case, then none. On the other hand, discovery-based teaching, I do try and use it quite a lot actually.

(Douglas, Chemistry, T1)

Like Douglas (but not as consciously aware), John also used a discovery-type approach, using a combination of structured materials and strategic questioning to guide pupils to their own conclusions, or perhaps more accurately, the right conclusion! Apparently defining inquiry in such terms is not as problematic for John, although, he does question the merit of him always asking the questions.

I'd shown them refraction... so they knew it changed direction but it wasn't very clear and I wanted them to measure it and I wanted them to keep going beyond and see what happened... You'll eventually get to a point where, instead of refracting, you get total internal reflection. Well, when I set the instructions I used a sheet... I had a couple of angles marked so they come in at 30 and 40 [degrees], and there was a third angle at 50 and you know what's going to happen between that. So I was wanting them to do that and... see what happens... What's happening here? Do you not find that a wee bit unusual? ...Maybe I shouldn't be posing the question possibly, I don't know, but I wanted them to think ... Then you can go into all different things, why is this and ... You can ask them different questions, so you're building towards the outcomes that you need to sit their test or whatever.

(John, Physics, T1)

Participants' experience of pupil questions at this stage was variable. Many secondary participants reported that few pupils asked relevant or investigable questions, a sub-set of whom, on reflection, conceded that they were perhaps too focused on their own agenda and not yet tuned in to pupils' awareness and, therefore, may be missing opportunities for inquiry. Others acknowledged that pupils did ask questions, and often 'good' questions, but struggled to accommodate those questions within their planned lesson, with its predetermined path and outcome.

> *...we do get a lot of questions, and it's great when they ask them as long as I can answer them.*
>
> ***(Dee, Chemistry, T1)***

> *In first year and third year at the moment we've been doing about reproduction, so quite a lot of the questions aren't relevant (laughs) but they're just very inquisitive and they want to know about things, which is good, but I just try and divert it back to the point. (laughs)*
>
> ***(Shona, Biology, T1)***

Only two secondary participants actively seized pupils' questions and used these to generate discussion and develop understanding of concepts under study, including how they link to other areas, although this was mainly in a discursive rather than practical way, and tended to be short episodes within the lesson.

> *I still don't really understand investigative pedagogy. (laughs) If I'm being honest, no, I don't think I do. I mean there are elements of inquiry, I think ... what you understand as inquiry in lessons but not like where it's a stand alone lesson, do you know what I mean. I think the kids do ask questions and you kind of ... you go with the flow, you let them lead the discussion. Like this morning we started doing gravity with the class and they were kind of coming up with all the questions and the discussions... So although they're not really getting to explore that themselves, they're kind of questioning it and then they're talking about 'what if you went up in a really high aeroplane?' and we got to discuss how it would be the same as just letting it off here because an aeroplane will still be travelling through the atmosphere, it doesn't leave the atmosphere. In discussion it's quite easy but in practical things it's not.*
>
> ***(Courtney, Physics, T1)***

> *But just simple things like we were talking about, What do you think is the main source of pollution? and one of them says cows farting. And I went fantastic, yes, that makes up (gestures approximately) 20%. I had nervous giggling for about 5*

minutes... and then they sort of seemed to chill off a bit, then they started asking me more silly stuff so we could actually get into it, you know. Does global warming cause colder conditions? 'Course it doesn't', 'yes it does'. So they're starting to do that a bit, you know... and those sort of approaches to it but it's all been fairly small instances of it and then back to some of the course curriculum and then back to that so ...It's arising organically to some extent because... it's just the nature of the class, they can ask any question at all.

(Sean, Physics, T1)

Most secondary participants, on reflecting on their own inquiry-oriented practices, were happy to include lessons which centred on course questions under the umbrella of inquiry so long as they were actively investigating to answer those questions.

If they're making decisions I would say about how they're setting up their experiment or if they're making decisions about what they want to investigate. Or even if they're doing something that's prescribed like that but they maybe say, 'what if we did something ... what if we added this to the acid' or something, I don't know. (laughs) But that's usually just like 'no, don't do that!'

(Lisa, Biology, T1)

The aim was to find out what yeast - dry yeast or fresh yeast - would make the dough rise the most. Some of them have done it quite well; some of them haven't, so we'll see if that works. That was a question that came up [in course notes] ... they're on bread-making at the moment.

(Shona, Biology, T1)

I asked my 4th year Int 2 class to devise experiments into the effects of temperature and pH on enzymes. I gave them the questions: What are the effects of temperature on enzymes? and What are the effects of pH on enzymes?

(Donna, Biology, T1)

Recognising the inadequacy of some prescribed experiments for meeting desired learning outcomes, some participants described their efforts to modify these practicals to make them more inquiry-oriented (with variable success).

I'd say with the 1st years, ... in most workbooks [they have] a practical investigation but it's still quite structured with the boxes and stuff with 'this is what you need to think about', but I'm trying to turn it so that they have to, more so in their group, think about it rather than me just saying it to them. But I haven't had the greatest success with that at the moment, it's so easy to revert back to the ... Because once again you have to get through it, and because they struggle.

(Shona, Biology, T1)

I just got them to get out the kits and play with them and then they started coming up with the questions, 'What if I only have one blade in, can I do that?' and I was like that, well, you try, do what you want to do. 'What happens when I put it on this setting on the fan?' and stuff like that, and that's what I hoped would happen and it did happen. It was them coming up with the kind of variables we were looking at and... once they'd played about with the equipment we came back as a class and I spoke to them about... that was really good. It's not quite inquiry but it's a little bit like it. It's prescriptive as in... well, it's going to be covered anyway, but giving them the opportunity just to play with the equipment, not telling them ...

(Dee, Chemistry, T1)

A connecting theme in early primary discourses was one of ‘(structured) discovery’; where the teacher structures the learning environment to enable pupils to discover ‘new knowledge’, perhaps through a problem-solving, engineering or research type task. Oftentimes these were musings rather than reflections as most felt they had not yet managed to facilitate scientific inquiry, or indeed science in any form, although some described inquiry episodes in the context of topic work.

I think inquiry would just be, you know, giving the children the ... I don't know, like problem solving almost, would be my idea of what an inquiry lesson would be. Yeah, that's what I would think, giving them whatever they might need to do it and then letting them work it out by themselves.

(Carol, Primary, T1)

I don't think we're going to be able to do sort of an ongoing investigation, just because of the time limits, but we might do just one or two small experiments to *find something out about sound, so if I give them materials and I say, here's a question, can you guys work with these materials for half an hour, what can you find out, or can you make something like this, can you make an instrument with these things ... I'm giving them the materials and we're starting with a question, and they're trying to answer the question using the materials.*

(Rose, Primary, T1)

If you've sort of given them a problem and they've got to try and investigate it to find a solution. And I'm just trying to think if I've ever kind of done that. I don't know. Not really through science. Well, what else ... finding out facts, for instance, like maybe to do with our topic. Again directing them probably to a website to use... We're doing Australia just now ... and something I'm about to do is Animals, Australian Animals, they've to research those. What I may give them is a structure, a kind of writing frame really... It'll maybe say, I want you to tell me where it lives, what it eats, for instance, and then I might say now give me some interesting facts about it, and they've got to then read it to find out more information about it.

(Jill, Primary, T1)

All primary participants acknowledged that pupils were curious by nature and were happy to respond to pupils' questions in the course of lessons, using these to develop class discussions, indeed it was seen as tantamount to good teaching, but mostly this was not acknowledged as inquiry. Only two primary participants (interestingly those with a science component to their degree!) felt able to respond to pupils' science-oriented interests in a practical way or placed any emphasis on science skills or validity of findings.

The one with the flowers. (laughs) Because we'd been doing colour and they did a colour wheel with the primary colours and the secondary colours, I'd bought primary colour food die, so we had yellow, red and blue, and one of the kids said, 'But Miss, what would happen if you put the red and the blue together, would it make a purple flower … can we try that?'. So we tried that ... No it didn't, it made a brown flower! And they were like 'Why is that?!'... 'I don't know...why do you think it is?' And they were saying 'Oh, but we just put them in, we didn't measure them, there might have been like more red in or there might have been...'

(Rebecca, Primary, T1)

I'm not quite sure exactly what I will do yet, but it will involve being child led and basically letting the kids get a chance to get hands on, ask questions and experiment. The week will finish up with a trip to the Science centre. The focus of the week is not so much the science itself but the methodology and procedure involved in undertaking science experiments, with emphasis (I think at the moment) on a fair test, safety, and documenting results.

(Ruth, Primary, T1 Blog)

Developing Inquiry – Term 2

After approximately 7 months of teaching experience, amongst the five primary participants, conceptually inquiry was essentially a pupil-centred approach, the general objective being to get pupils thinking creatively. It placed teachers in a facilitative or supportive role rather than direct instruction to allow pupils to ask questions (based on current understanding) and find things out for themselves rather than being told. However, although 'inquiry' invoked visions of pupils asking questions and 'solving problems', from their narratives one gets the sense that, at this point, these visions remained mere conceptualisations which had not (or rarely) been played out in practice... perhaps due to inherent uncertainty over what it should involve.

I guess you would be trying to get the kids to ask questions, instead of you always asking them questions. And, certainly from what I understand and am planning to do, you sort of give them materials and have them see what they can make of it, you know, have them try to figure things out and then go back and look at what they've figured out.

(Rose, Primary, T2)

The children kind of leading the learning I guess. The children taking the lead and it being, I don't know, maybe something that they ... a problem that they come across or something that they come across that they're maybe unsure of or a question that they have that they don't know the answer to. And then maybe me kind of *facilitating them to inquire about it in whatever way would be useful, so either research or...*

(Carol, Primary T2)

Well, they come up with the questions themselves, you know, they've asked the questions and they can try and think of how they would answer them maybe and what they can use to find the answers out. Em ... What else? And then really just helping them to do that, to try and see if we can answer them, either as a class or individually... I suppose presenting it as well...

(Jill, Primary, T2)

Effective questioning. Kind of freedom to, like, research things or maybe take it down a slightly different route or thinking outside the box, and that kind of thing. Using the things that are around you, whether it's resources or people or... Drawing on previous knowledge.

(Rebecca, Primary, T2)

I think again I would go back to this getting a discussion out of things and using a stimulus to try and get the children thinking about something new... is it problem solving, is it inquiry? I'm not quite sure. I suppose it's a strategy, isn't it. It's trying to get them thinking... I quite like to start lessons with a conversation and a discussion and let ideas kind of grow from there, which I find quite often then change my lesson because they've gone off in a completely different tangent than I thought and actually their ideas are better than what I'd kind of planned for. So my lessons tend to have a flexibility in them that, if that does happen, I can change it.

(Ruth, Primary, T2)

Indeed the most common manifestation of 'inquiry' in primary participants' classrooms was conducting research and presenting this to peers; this usually involved gathering general information on a topic or fact finding rather than trying to answer a specific question. Transient inquiry, in the sense of responding to pupils' interests in the moment, was apparent, but there was little evidence of experimenting or explaining phenomena, perhaps not surprisingly as there was still very little science itself and any inquiry tended to be in the context of topic work.

> *I think they have more practice inquiring in other things. We've done research in class, sort of like, you have this topic, can you go and find things out about it and can you present this to the class. Unfortunately I feel like a lot of the questions that they ... I'm saying this and I haven't done very much science with them, but I feel like a lot of the questions that they tend to ask would be very difficult for us to investigate, like to prove in class by doing experiments. They would tend to be things that they would need to go read a book about, you know.*
>
> ***(Rose, Primary, T2)***

Interestingly, in the context of an upcoming topic, *Living Things*, one participant discussed her plans for investigating *'plants growing in different conditions... seeing how high they grow and what difference it makes what kind of environment they're in'*. Remarkably she had not acknowledged this as inquiry, even though her planned strategy involved eliciting pupils' questions and hypotheses.

> *No. Definitely not. No, I wouldn't have thought of that ... Or ... Well, I suppose then you do it a lot more than you think then if that's inquiry. (laughs)*
>
> ***(Carol, Primary, T2)***

Whilst primary participants acknowledged the benefits of using an open, pupil-centred approach in terms of either learning or engagement, it was not without risk! Risks included exposing weak subject knowledge, loss of classroom control and errant learning.

> *I think it's quite difficult because you think, oh ... (feigns panic) ... where's this going to go? But, yeah, it kind of means that they're more focused and engaged so I don't see why not.*
>
> ***(Carol, Primary, T2)***

> *To be honest I was quite scared of the idea of inquiry because how do you structure something like that? You can't really structure critical thinking, I think, it very much comes from the ... So I was always a wee bit scared of it because I wouldn't know how the lesson would run... I think because at the beginning I'd have to make sure I knew exactly what I was saying in my introduction, what activities we were going to do, what the children were going to be doing and what we'd be talking about in the*

plenary, whereas by now I know that actually lessons can kind of evolve a wee bit more and I'm not so worried about it. And I think more inquiry has come out because I'm more flexible to their kind of ideas.

(Ruth, Primary, T2)

Do you know what I mean though about being nervous about ...Like if you tell them, ok, we're going to do this experiment, and if we get this result it'll show us this and if we get this result it'll show us this ... And then you get either something in the middle or something that you know to be blatantly not true. If the kids are designing the experiment and they design something you know won't work, or you know that they've left out an important variable and that could really affect the results or something like that... do you know what I mean?

(Rose, Primary, T2)

At the end of Term 2 secondary participants similarly invoked a very pupil-centred approach aimed at generating rather than receiving knowledge, but generally placed much more emphasis on experiments and practical investigations, although for many generating knowledge through collaborative research and class discussion was also a valid form of inquiry.

I probably would say them being independent and actually trying to discover things for themselves rather than maybe me standing at the front saying, if you add this to this and take the pH it will be 3... or something!

(Lisa, Biology, T2)

I think the core of it is giving the child the opportunity to build their own conceptual framework rather than just telling them. That means either through experimentation, practical hands-on activities, activity-based learning ... It doesn't have to involve a test tube, but the pupils must be given an opportunity to formulate their own questions and I think through designing and experimenting activity to answer that question.

(Douglas, Chemistry, T2)

Not just me giving them answers all the time. Getting them to go away and think about the answers, getting them to come up with the answers... doesn't necessarily need to be going away and finding it on the internet or finding it in a book or whatever, it could be actually physically doing something to find the answer.

(Donna, Biology, T2)

So, trying to get the students to inquire about something? So ideally ... Kids not knowing the outcome... Then investigating it... And then a certain amount of presenting at the end. I don't know if that's right. (laughs) It could be a kind of structured question from the teacher leading them down a certain direction so it kind of links into the course and what they're doing. Or it could be a question posed by the class about a certain topic; they could choose what to investigate themselves I suppose. Maybe even something in the news that kind of links in.

(Charlie, Physics, T2)

Although from their reflective narratives it is apparent that, for most, their understanding of what inquiry means in practice is still tentative and developing, there is evidence of experimentation with this approach and learning from the experience. However, despite the centrality of pupils' questions in their conceptualisations of inquiry (pupils' questions would seem to provide a natural catalyst for inquiry), in practice investigations were generally centred on in-course questions rather than their own.

They have to choose a planet to move to because Earth is doomed, so the inquiry is that they're learning about factors that affect human life and then they're given profiles of these planets that have been discovered and they have to choose which one they're going to move to and present a reasoned argument... So I suppose that is a little bit of inquiry, but it is very structured. It's not them asking a question and then going off ...

(Charlie, Physics, T2)

Charlie's comment *'I suppose that is a little bit of inquiry, but it is very structured'* suggests that he was critically appraising this practice against some 'ideal' notion of inquiry that he holds; the same was true for John who, in the following excerpt, concedes '*I know it wasn't quite inquiry based learning but...'.*

You need something to start if off. So it might be a question, it might be just something you want to find out, whatever. I think you need to give them a bit of free rein and I know it wasn't quite inquiry based learning but, talking about the electrical circuits and letting them go, you know... crack on and see what you come up with... Because I think intuitively they would probably ... in their mind they would have some sort of prior learning to an extent where they would probably know that a battery creates electricity for instance... I was talking about the starting point maybe, or a sort of catalyst or a prompt of some sort, but prior learning's got to be in there somehow... And once they start to join the stuff together I mean, they were quite excited... They weren't getting told it. As far as they were concerned they worked that out by themselves...

(John, Physics, T2)

This idea of contextualising learning was another emergent theme in the secondary participants' data. As their primary counterparts similarly acknowledged, pupils' current understanding was important for making sense of what was to come - as Sean reasons '*...there's no point in inquiring about something when you don't have any base material'.* However many secondary participants also espoused the importance of connecting learning to wider concepts or tying it in to the wider scheme of learning.

I suppose it's all about asking questions and then... not asking a question and getting the answer, but asking a question and finding out the answer which I think is different. If they've asked a question and you go, bla-bla-bla, that's the answer, they'd be like, that doesn't mean anything to me. So it's finding it out for themselves is more what inquiry is. So then thinking about things and thinking, oh, what would happen if...? It's them actually engaging the brain to relate it to something ... either relate it to something that they know or that they've seen before and they think, what would happen if we did this or... That really.

(Dee, Chemistry, T2)

I think you certainly need to tie it back in. So they might discover something, they might say, ok, I've got this, I did this and this is my result, fine I'm away up the road. Good fun but what was that all about? So I think you really need to go back on it and say, right ok, what have we learned and why? What do you think this relates *to? Relate, I suppose that's it, relating it back to whatever you're wanting to relate it back to obviously. Hopefully it's the right thing. (laughs)*

(John, Physics, T2)

At this time, going into the third and final term of induction year, there was more evidence of responding to pupils' interests. Sometimes this was dealt with in the moment in the form of a class discussion; at other times the inquiry warranted more time and was subsequently developed into a lesson.

It's what interests you about this. Someone was quite keen as well to ... because we spoke a little bit about the Northern Lights ... just a little bit about ... so that was something she was keen to [know about]. We haven't actually had time to go back to it again but she was interested in it.

(Shona, Biology, T2)

The pupils come up with the questions ... and the answers I'd say. Because I think with science we don't know everything, like dinosaurs for example, I've no idea about anything about dinosaurs so they asked the question and they're going to find it out rather than me just giving them the information... Plus just making time in your lesson plan to do that, being flexible to allow that to happen.

(Courtney, Physics, T2)

As Courtney acknowledged, incorporating inquiry requires a certain level of flexibility in one's teaching; the ability to seize opportunities and improvise... and it is not without risk! As with primary participants' data, again the allusion of risk was perceptible, but this time, as well as the risk of 'things going wrong', taking an inquiry was risky in terms of accountability; not meeting intended learning outcomes and targets for achievement.

...with inquiry it takes a wee bit of courage as well because with proper inquiry based learning you don't necessarily know what the learning outcome might be and it's about having the courage to let the children take it where they want to take it ... and they might end up learning something that you didn't expect them to learn, and even with the best planning in the world, something you didn't plan for them to learn.

(Douglas, Chemistry, T2)

> *Once you're doing certain things a wee bit more automatically you can devote your mind to doing things that are slightly more challenging and, I suppose, investigative approaches, you're really ... It is scary, you're letting the reins out a wee bit, and we all know how badly these things can go wrong...*
>
> *I think maybe it's a bit of fear as... you maybe do tend to do the accepted thing rather than thinking, I'd really like to do it this way, do I want to take the risk ... and have it bomb?! (laughs) Oh, you're going to get a real skelp for that, let's face it. (laughs) I mean, you've got a big responsibility. But... as long as I get the same result I don't think anybody's going to bother.*
>
> ***(John, Physics, T2)***

Although a couple of secondary participants' conceptualisations of inquiry had developed through their own classroom experience, including critical engagement with existing practicals, overwhelmingly most had developed their understanding of inquiry practice through the materials and discourses surrounding Curriculum for Excellence. A smaller number felt their understanding had developed as a result of being involved in this study; through discussions and reflecting on practice.

Reflecting on Inquiry – Term 3

Aggregating the participant data on inquiry T0-T2, the following definition was constructed and presented to participants in the final interview:

Inquiry in the classroom is, in essence, trying to find something out rather than just being told. It involves a more active form of learning, that is, pupils engaging with a question or a problem and using their existing knowledge base and thinking skills, including creativity often, to create rather than receive knowledge, thereby forging understanding as opposed to just mere memorising.

On reflection, all participants were happy with the definition offered, although some seemed surprised that inquiry wasn't something more complicated, and further, acknowledged that 'if that's all it was' then they were doing it more than they realised.

> *Well, maybe I am doing it already, I just wouldn't have called it that necessarily... It's the same with a lot of new things that are coming in, like active assessment and AifL and stuff, you actually do do it, you just didn't have a label.*
>
> ***(Dee, Chemistry, T3)***

> *I don't know what it was before that I thought it was just something difficult to do, when it's not. Like, I think it becomes just part of your everyday lessons...*
>
> ***(Joanne, Chemistry, T3)***

> *I think I was doing it all along maybe to some degree as well without realising I was, because I think I do ask a lot of questions that get them to think. I naturally ask a lot of deeper questions that get them to think, and now I'm maybe doing it in different ways more, is what I would maybe say.*
>
> ***(Courtney, Physics, T3)***

> *If that's what ... Well, I guess so. I mean, if that's what it is we've done a lot more of that than I guess I thought. We do a lot of ... I don't like telling them a lot of things.*
>
> ***(Rose, Primary, T3)***

> *I think in the beginning I ... because I think I was thinking of it in direct relation to science, in my head I thought like ... resources. I think now I maybe see it more as something that could be done - not that it would have to be done - but it could just be done orally. I think to begin with I had a totally different understanding of what it was and how you would use it but I think now ... I think it's just about engaging the kids really, like, having them actively involved in their learning and trying to push them to answer their own questions instead of always coming from me.*
>
> ***(Carol, Primary, T3)***

Analysis of data revealed two main ways in which these beginning teachers implemented an inquiry approach. The first is what I have described as the pre-planned and teacher structured investigative or research activity, where the teacher decides what is to be investigated and provides a structure to facilitate that. The other form is more organic, or spontaneous, arising in the course of lessons often from pupils' questions; I've called these 'inquiry moments'.

> *The pre-planned happens more often. I still don't know how comfortable I am with saying, ok, well why don't we spend a couple of lessons finding out the answer to that, because I find it hard to recognise these inquiry moments and differentiate them from just a plain old question that is ... that has just got an answer to it as opposed to something that ... Being able to think on the spot... Could I make that into a couple of lessons or just even 10 minutes ... Do I have the things at hand where we could maybe look at it? Do I know the answer what the answer might be? What do I want to find out and what could I use to find out? And doing all that in the space of about a couple of seconds before I either blurt out the answer or say I don't know. (laughs) … As long as I've thought about it it's easy enough to say, why don't we hold on to that, put it up on the wall or the board or something like that, and then we'll come back to that at a later date… [Sometimes] it's kind of ... It has come from one of the inquiry moments but I've been able to pre-plan it, which I would be much more comfortable with. I think what I need to work on is focusing on being able to identify these questions that can be used later on... Or if there's any way of planning that would maybe get them to ask that question. (laughs)*
>
> ***(Dee, Chemistry T3)***

> *I mean, the first one is something that I identify with because I would plan an inquiry lesson. I would say, right, this is what we're going to do and the children would find out themselves. The second one I just see as part of teaching. I just see that's... as a teacher that's what you do naturally. If the children have got a question you try and show them how to find the answers, and that's how I feel about the second part. It's still inquiry but I would never put that in my planning that that happens, it's not something that you would plan for or comment on really, it's just something that happens.*
>
> *I tend to try... I've got my lesson in my head but I'm quite happy for them to deviate, and if the questions come from them then we'll answer them but I won't... I would*

obviously facilitate it if the children have questions, they want to find answers to these things, of course we will, but I won't actively go in and say, you know, throw in a question in the middle of a lesson to get them to try and answer it. I think that I would leave that to an inquiry based lesson.

(Ruth, Primary, T3)

Following up on the idea of inquiry being a risky approach alluded to in previous interview data, participants confirmed that it was indeed risky, and for a variety of reasons; health and safety, classroom and behaviour management, shaky subject knowledge, political (competing agendas), meeting learning objectives, wasting valuable time, meeting expectations ... also it was uncharted territory with no model or template to follow.

Would you describe inquiry as risky ... in the classroom?

Em ... Not so much now. I think at the beginning quite definitely because a lot of them didn't want to do it in their own curriculum, but now that there's a bit more freedom and it's up to the teachers' choice ...

So when you said they didn't want to do it in their own curriculum, so that was ... in terms of it being accepted as a valid practice in the classroom?

Yeah. Although it was really encouraged in a lot of the courses being written, with a lot of inquiry approach in it, quite a few teachers didn't want to do it themselves, you know. And there was a certain tension, if I'm doing it, you know, there was sort of pressure for them to do it, whereas I should boycott it too.

(Sean, Physics, T3)

So with that in mind, would you describe inquiry as risky?

You see, that's the problem, isn't it? I wouldn't, I think it's how we should teach... but in the context of ... I think if you suffer from OCD and you think it's appropriate to tell an NQT that every single kid in your class, and worse than that, even the kids between different classes, should have exactly the same notes in their jotters, I think you've got a powerful battle on your hands, you know. And ... No, I personally don't think it's risky, I think it's the normal way to teach. I think it's an intelligent way to teach. It's constructive.

(Douglas, Chemistry, T3)

CHAPTER 8 – BARRIERS TO INQUIRY

During focus groups participants were asked to suggest issues which could potentially affect their ability or willingness to implement an inquiry approach - in effect, barriers to inquiry. Collective responses were reduced to fourteen themes which were presented to individuals as flash cards during subsequent individual interviews, first, before beginning their induction year, then at the end of each teaching term (T0, T1, T2, T3). Based on their school experience, participants were asked to select and rank their top five barriers at each time point, providing commentary as appropriate. This commentary helped to elucidate the specific nature of their dilemmas, which at times bridged more than one category. Consequently, following analysis of Term 1 data, some categories were modified to reflect more clearly defined parameters (see Methodology, Chapter 5, for further details). Even after this revision, there was still a degree of crossover between some categories; for example, *Confidence* was discussed in relation to managing behaviour, subject knowledge and school/departmental politics. However, where *Confidence* was selected, it seemed to be the perception of their own capacity to rise to the challenge and negotiate risk which was of issue rather than any of the other 'barriers' as such. Similarly, *Assessment and Achievement Implications* crossed over into *Time* and *Politics*, but its selection in particular seemed to reflect the individuals' commitment to the examination agenda linked to their awareness of their accountability and credibility as a teacher.

These flash cards generated data which provided a general picture of the main barriers to inquiry over the course of the participants' induction year as well as the magnitude of difficulty they presented. These data are presented and discussed in this chapter. Table 5 is a summary of the frequency with which each barrier was selected into participants' 'top 5' at each time point; the rank, or weighting, is not shown but is discussed in the following sections where noteworthy.

Whilst the table has been compiled from the data set as a whole (primary and secondary combined), where significant differences between sectors was noted this is discussed in the relevant section. More detailed tabular data by participant and time point is provided in Chapter 6 - The Cases.

Implementation Issues	**Term 0**	**Term 1**	**Term 2**	**Term 3**
Classroom Management	10	7	-	-
Knowledge of Pupils	6	6	-	-
Pupils & Behaviour*	-	-	10	8
Time	10	12	7	11
Resources (including external)	10	10	9	8
Politics	8	5	4	7
Curriculum / Courses	8	8	8	6
Subject Knowledge	5	6	4	4
Confidence	5	7	2	5
Practical Support	4	2	2	3
Learning Intentions	4	2	1	1
Understanding & Belief in Approach	2	6	-	-
Understanding (Implementing) Approach*	-	-	11	5
Assessment / Achievement Implications	2	3	6	4
Personal Commitment	1	1	-	-
Planning & Organisation*	-	-	7	7
Classroom Layout*	-	-	0	1
Totals	75	75	71	70
	(n=18)	(n=15)	(n=15)	(n=14)

Table 6 - Implementation Issues by Term; Frequency of Selection into Top 5 (Primary & Secondary Combined)

Notes

1. Items are listed primarily according to frequency of selection at Term 0, however, groupings exist where original category was modified; (*) denotes new categories developed in response to data collected at earlier time points.
2. In Term 2 one participant selected only one barrier, Politics, the others being irrelevant at that time.
3. In Term 3 one of the participants could not be interviewed so there is no corresponding data.

Classroom Management (Pupils & Behaviour)

Implementation Issues	Term 0	Term 1	Term 2	Term 3
Classroom Management	10	7	-	-
Knowledge of Pupils	6	6	-	-
Pupils & Behaviour*	-	-	10	8

Before taking up their induction post, classroom management was the biggest concern with respect to implementing an inquiry approach, ranking especially high with three of the five primary participants. By the end of Term 1, classroom management was still a major issue for many secondary participants, and with moderate to high ranking, but interestingly, no primary participants identified classroom management as an issue at this time. Apparently an aspect of classroom management which had proved problematic during student placements ceased to be an issue upon overtaking the teacher role. In order to elucidate this aspect, it was felt that this category had to be broken down, with more clearly defined parameters.

The category, *Classroom Management,* originally encapsulated organisation, behaviour and safety, however, on closer scrutiny it was found that when secondary participants discussed classroom management it was normally in terms of managing behaviour, and often in conjunction with familiarity with classes and pupils. In other words, classroom management can be problematic but it really depends on the class – the ability of pupils, their attitudes and how they interact, what they're interested in, how they behave, and so on. Indeed in most cases, those individuals who had picked *Knowledge of Pupils* had also picked *Classroom Management*.

> *These two are really on a par (indicates Classroom Management and Knowledge of Pupils) because it depends on the type of class. For classes who have the ability, it's their confidence that's lacking. For some of my classes it's just purely behaviour.*
>
> ***(Donna, Biology, T1)***

Amongst primary participants, however, classroom management was not synonymous with behaviour management; other aspects such as resourcing, differentiation and groupings, were major components of classroom management. For subsequent interviews, the categories *Classroom Management* (behaviour aspect) and *Knowledge of Pupils* were combined into one category - *Pupils & Behaviour* - which would accommodate difficulties such as ability, engagement, motivation, mood/attitude and class dynamic.

At Term 2, the new category, *Pupils & Behaviour,* was selected by ten participants, including four of the five primary participants; and at Term 3 by eight participants including three primary participants. This suggests that it was, indeed, the behaviour aspect of classroom management which had been problematic.

> *I think Pupils & Behaviour is very much ... I'd put that as the first one ... because I feel that there's some times where, if you did an inquiry lesson it would just go completely to pot because sometimes ... they just need to sit down and just write or just focus and be quiet for an hour because, you know, all lessons can't all be inquiry and thinking and, you know, this more active way of learning.*
>
> ***(Ruth, Primary, T2)***

Pupil behaviour (challenging classes) was a major consideration in terms of inquiry based pedagogy for four secondary participants for the entire duration of their induction year, three of whom had anticipated this prior to starting. However, there was also the suggestion from some individuals that engaging classes in more authentic, pupil-centred learning had a positive impact on student motivation and behaviour.

> *I would certainly say there was a marked response from some of the less engaged pupils who, to be fair, maybe they shouldn't have been put in Physics to begin with, when there's lots of issues which I'll not go into, when pupils start to choose their courses. But certainly they were a wee bit more engaged, without a doubt.*
>
> ***(John, Physics, T2)***

> *I think I probably said Pupils & Behaviour before but now I see that when they're enjoying themselves the behaviour is much better, things you read about as a student actually ... it's true.*
>
> ***(Joanne, Chemistry, T3)***

Time Constraints

Implementation Issues	Term 0	Term 1	Term 2	Term 3
Time	10	12	7	11

For both primary and secondary sectors, *Time* was the most pervasive and persistent of all barriers identified. Particular issues discussed included:

1. A generally heavy workload with little time for innovation and creativity (which included devising and organising inquiry oriented lessons).
   The time-pressured nature of the job was acknowledged even before they started and keenly felt as they took up teaching proper and began to appreciate the many time-consuming aspects of the teaching role. Many participants felt ‘overwhelmed’, especially at the start of the year, as they assumed responsibility for meeting deadlines and accountability for the management and outcomes of their teaching.

2. Length of teaching periods.
   In general teaching periods were considered too short to conduct worthwhile inquiry. For one participant, however, double Science periods proved problematic in terms of waning pupil focus and consequent behavioural issues, which impacted on her confidence to try more innovative, pupil-centred approaches.

3. Pressure to cover courses in time for exams.
   This was amplified by the amount of teaching time lost due to school closures as a result of bad weather, although this would probably be the case for any additional or unforeseen pressures, such as strikes, HMIe inspections, illness, etc.

4. Timetabling emphasises ‘core’ subjects.
   Primary participants in particular seem to have accepted time pressures as part of the job, however, they still identify *Time* as an issue for implementing inquiry - there are so many things to cram into the week that science is 'squeezed' anyway, never mind trying

more innovative, eclectic, and open-ended approaches which take more time and may involve more risk.

5. Wasting valuable time.
   Inquiry invariably takes longer than traditional teaching to arrive at the intended learning outcome, and if this is somehow countermanded (errant results or wrong conclusions drawn), it may necessitate re-teaching the lesson.

Resources

Implementation Issues	**Term 0**	**Term 1**	**Term 2**	**Term 3**
Resources (including external)	10	10	9	8

Resources were seen to be problematic in both the primary and secondary sectors and for a variety of specific reasons:

1. Availability of resources.
   Even in schools which are 'well-resourced' resourcing may be an issue because of the 'open' nature of inquiry; children may want to investigate certain phenomena for which there are no resources. This is especially problematic in the primary sector where the range of resources to support the teaching of science is perceived to be very limited.

2. Funding
   Constraints on school budgets place limits on what can reasonably be ordered for the purpose of exploring and experimenting, especially when the subject of the inquiry is outwith the planned course.

3. Quantity and quality of equipment.
   A common observation was that there was insufficient equipment (eg. scientific instruments and computers) for the whole class to participate, and what equipment was there may be old (even obsolete), faulty or not accurate enough and, therefore, not fit for purpose.

4. School location in relation to external resources.

   The school may not be well placed to access things like parks, science centres, observatories, or other places of scientific interest.

5. Difficult to anticipate what's needed.

   This is especially true for organic inquiry arising in the course of lessons. Obviously it is not feasible to leave the class unattended whilst the requisite resources are sourced.

6. Knowing what resources are available or what may be useful for different purposes.

   This is due to a lack of knowledge of, and experience of teaching, particular topics.

   > *There's also an element of not knowing yourself what's out there. I mean there might be some sort of fantastic experiment that you could do which is dead, dead easy, really easy to do in class but, I don't know, I haven't come across it yet.*
   >
   > ***(Ruth, Primary, FG)***

The frequency of selection into participants' Top 5 dropped gradually over the course of the year. This may be seen to reflect a diminishing dependence on physical resources to support classroom inquiry, or it may be that other barriers posed more of an impediment to inquiry for different individuals at different times.

For instance, although there was a core of five individuals for whom resourcing was a persistent barrier (selected at all four time points and often with a high ranking), there were another three participants who selected *Resources* on more than one occasion, but not consecutively. Jill anticipated that *Resources* would be an issue in relation to inquiry teaching before starting her induction year, however, at the end of Term 1 other issues, which were not anticipated, came to the fore (*Time* and *Learning Intentions)*. This effectively squeezed *Resources* from her Top 5, but only temporarily, as it was selected again at the end of both Term 2 and Term 3.

Culture and Politics

Implementation Issues	Term 0	Term 1	Term 2	Term 3
School/Dept Politics	8	5	4	7

It was perhaps not surprising that many participants selected *Politics* in their top five before starting the induction year given their student experience of the culture and relations within schools (discussed in detail in the next chapter, *School Context*). Issues discussed included how much autonomy they were likely to have, agendas and priorities in play, and what pedagogies would be valued and expected in their respective teaching contexts to achieve these agendas.

> *That's what I mean about... you can have very important, influential people, or people that can be potentially influential on me or my future... I see that as being potentially one of the biggest barriers to doing these things... possibly. Not just this but things in general... If you want to try something new, if they're not doing it already, I think it would be difficult... that's just the nature of what I've saw already and it's not any different from any other job or any other industry. That's just the way it is and you've just got to watch yourself.*
>
> ***(John, Physics, T0)***

Over Terms 2-3, as they took up their posts and settled into their schools, the number of participants who identified this as a major issue dropped considerably. However, for three participants in particular (2 secondary, Douglas and Sean; 1 primary, Rose), the nature of school (or department) culture, relationships and agendas presented a real and persistent challenge for their classroom practice in general; and in relation to hindering inquiry, *Politics* was assigned a high ranking throughout the year. Indeed at Time 2 one of these individuals (Douglas) insisted that *Politics* was not the **main** barrier but the **only** barrier to inquiry at that time. The frequency with which *Politics* was selected into participants' Top 5 rose again as the participant neared the conclusion of their induction year. Notably it was mainly those individuals who had anticipated this barrier before starting their induction year that selected Politics again (4 out of 5) as they began to look ahead to their next school and acknowledged its potential to influence their classroom practice in that context.

I'd maybe say that [School/Department Politics], because especially with a new school, if you're going to do something... you don't really want to start off on a bad foot. Maybe when you're more established you can do things ... I think there's a bit of give and take, but if it's completely against, you know, what they're doing with their courses...

(Courtney, Physics, T3)

Curriculum Structure and Course Content

Implementation Issues	Term 0	Term 1	Term 2	Term 3
Curriculum / Courses	8	8	8	6

In the secondary sector one specific issue was that by and large existing courses were deemed to be too focused and prescriptive (courses planned out and lessons virtually scripted), with little scope for deviating or following up on lines of inquiry; this was especially true of certificated courses.

...they have got learning outcomes, they've got a summative test at the end of the year that will match the learning outcomes. You're almost going through the learning outcomes, ticking off, making sure they've covered everything.

(Courtney, Physics, T2)

This specific aspect was much less problematic in the primary sector as participants acknowledged that the 'new curriculum' advocates just this type of approach. Prior to starting there were perhaps some concerns over how CfE was being embraced and implemented but subsequent experience in school has been generally positive.

Other specific issues within this theme were the lack of familiarity with the curriculum and experience of teaching different topics (making it difficult to see opportunities for inquiry), and the lack of opportunity for (practical) inquiry within particular topics; for example, there is little scope for pupil inquiry in the *Space* topic.

I think that's again coming down to the fact that they don't really know yet how to investigate what they're asking. But then that could be because of the topics we're *studying, like we're doing rocks at the minute... so it's maybe that the question they're asking doesn't really lend itself to practical work. I'm not sure.*

(Courtney, Physics, T2)

Subject Knowledge

Implementation Issues	Term 0	Term 1	Term 2	Term 3
Subject Knowledge	5	6	4	4

These figures are made up predominantly of primary participants, who believed their limited science knowledge impacted greatly on their capacity to support scientific inquiry (reflected in the high ranking assigned to this barrier; see participant profiles, Chapter 6).

Subject Knowledge was a source of anxiety for several secondary participants, especially early on and in relation to teaching topics outwith their specialism, but, in terms of barriers to inquiry, was selected by only three participants, and not consistently.

I think as well, though, because the first topic I did was Body Systems and because my subject's biology, I felt confident doing that. Some of the stuff, like Chemical Reactions... if I didn't have this teacher guide I'd be talking all sorts of mince and doing all sorts of stuff that isn't right.

(Lisa, Biology, T1)

I'll go for Subject Knowledge because I'm often teaching out of my speciality, such as the biology one. They were looking into parts of the human body and they were asking questions like 'What does the pancreas do?' (gestures uncomfortable uncertainty). Look it up and tell me.

(Charlie, Physics, T1)

In discussions there was much cross-over into *Confidence;* indeed, across the time points T0 and T1, most participants who selected *Subject Knowledge* also identified *Confidence* as a barrier to inquiry (8/11), which is, perhaps, suggestive of a relationship between the two.

I would say the subject knowledge, if it's outwith my area of specialism ... again that might be a confidence thing?

(Charlie, Physics, T0)

Yeah, I think my confidence in my own subject knowledge because the kids can just ask so many different questions when it comes to the actual ... if you let them that free with it.

(Shona, Biology, T0)

The correlation between *Confidence* and *Subject Knowledge* was not as strong at T2- T3, with co-selection on only 2 of 8 occasions, however, there is the suggestion that the level of security they feel in their own subject knowledge – apprehension about not knowing 'the answer' or where it will lead - has the potential to impact on beginners' flexibility and capacity to improvise as illustrated in the following contrasting positions.

I think one of my strengths is that I know I don't have the answers to everything, but I'm quite happy to say so. I think that does come with confidence... being confident to say you don't know the answers all the time or you're not too sure about something, and then going on and finding it out... which I'm happy enough to do.

(Courtney, Physics, T3)

I think you need to make sure you're prepared if you're going to go down that route... I would need to make sure that I'm prepared, to make sure that I'm not going to mess up or say something wrong or anything like that. It's quite hard to plan for inquiry.

(Dee, Chemistry, T3)

Confidence

Implementation Issues	**Term 0**	**Term 1**	**Term 2**	**Term 3**
Confidence	5	7	2	5

These figures represent confidence to implement inquiry (which was variable throughout the year and with no significant differences between sectors) but probably reflect participants' general confidence levels also. The relatively high frequency of selection at T1, when participants had not long taken up their induction posts, is perhaps understandable as many struggled to establish boundaries and expectations, both in class and outwith. In other words, what was expected by colleagues and what could realistically be achieved in the class given their limited experience and lack of familiarity with the curriculum. The relatively low figure at T2 may be indicative of most having achieved a degree of comfort in their teaching role, perhaps having established a level of authority in the classroom and credibility in the staffroom, which allowed them to be more flexible and creative in their teaching.

In discussions *Confidence* crossed over into several other areas, predominantly *Classroom (behaviour) Management, Subject Knowledge, and Understanding of Inquiry*, but there were also references to *School/Departmental Politics* and how that impacted on their capacity for innovation.

Practical Support

Implementation Issues	Term 0	Term 1	Term 2	Term 3
Practical Support	4	2	2	3

Practical Support is 'hands on' support from other staff, such as technicians and classroom assistants, which help to make the job of teaching easier, and lessons run more smoothly. Such support may include provision and set-up of equipment, organisation of resources (including differentiation), and in-class support with particular individuals or groups of pupils.

Few participants perceived the level of support available as one of the top five issues for implementing inquiry, and generally it was assigned a low ranking (1-2) when selected. Surrounding discussion suggested that perhaps participants had resigned themselves to the economic climate in schools and the necessary reduction in auxiliary staff.

I don't know if it would affect it really because I just have to kind of get on with it without [Practical Support] now anyway.

(Jill, Primary, T2)

We do have a classroom assistant who's in sometimes. I can only use her for reading groups though... I can't really use her for anything else. But, I just do everything else myself so I guess I'm used to that, working without a classroom assistant.

(Rose, Primary, T2)

Learning Intentions

Implementation Issues	Term 0	Term 1	Term 2	Term 3
Learning Intentions	4	2	1	1

Learning Intentions was discussed in two subtly different ways depending on whether the participant was conceptualising pre-planned inquiry or spontaneous inquiry moments. Before they started teaching, some anticipated that this would be a major consideration in making pedagogical decisions. In terms of deliberately setting out to incorporate inquiry the issue was whether or not an inquiry oriented approach was the best way to achieve the intended learning outcomes.

Learning Intentions... you need to make them fit or you need to find something that fits what you want to learn, and you can't always do that.

(Dee, Chemistry, T0)

I think you need to be really clear about what the learning intentions are for an inquiry based lesson. Otherwise they're just having a play and there's absolutely no purpose to the lesson at all.

(Ruth, Primary, T0)

In practice, however, the dilemma was accommodating questions arising in the course of lessons whilst remaining mindful of the overall plan and objectives for that lesson.

I have it in my head what I want them to achieve and how I want to steer them. Because you have... you've got your Es and Os so you're not just going willy nilly out into the abyss, you have obviously got a lesson planned ahead. You need the equipment there and you need the resources so you have to have a plan in place.

(Joanne, Chemistry, T3)

Could I change it? Yes. I would generally not really though... I'll maybe have like learning intentions, success criteria, where I want them to be at the end of the day, and I'm sort of concentrating on that... But in between that, if somebody... which will often happen... it's some really left field stuff that comes out their mouths sometimes. (laughs) I think you need to be a wee bit flexible, but you need to have your eye on... what you want to do. I mean, ultimately... you're there to sort of nudge them in the right way.

(John, Physics, T2)

Learning Intentions did not appear to be a big issue in practice. It was acknowledged and discussed but it was rarely selected as a major barrier to inquiry.

Understanding Inquiry and How to Implement

Implementation Issues	**Term 0**	**Term 1**	**Term 2**	**Term 3**
Understanding & Belief in Approach	2	6	-	-
Understanding (Implementing) Approach*	-	-	11	5

Apparently this was not an issue for any of the secondary participants at T0, however, two identified this as a major issue at T1 (Lisa and Shona) and a further three acknowledged a limited understanding of inquiry and how to go about it (Courtney, Dee and Joanne - below), although they did not select it in their Top 5 barriers at that time.

I'm not entirely sure always what I could do or how I would go about it really... how I would set up an inquiry lesson, or series of lessons.

(Dee, Chemistry, T1)

> *Even though I've got ... I have an understanding of it but it's always the way to use that understanding to make it work kind of thing, if I'm making any sense what-so-ever. (laughs)*
>
> ***(Shona, Biology, T1)***

> *I really want to start doing inquiry stuff but I just don't even know how to go about it really.*
>
> ***(Joanne, Chemistry, T1)***

From discussions at this point it became apparent that that the category *Understanding and Belief* did not quite 'fit'. Participants had an understanding of scientific inquiry and advocated an inquiry approach, however, the real dilemma was how to implement it in the classroom. Thus, from Term 2, *Understanding and Belief* became *Understanding and Implementation*. Apparently this struck a chord with many as it was the most commonly selected 'barrier' at the end of Term 2 across both the Primary and Secondary sectors. Thus the problem seemed to be one of facility rather than advocacy; how to 'make it happen'.

In the case of primary participants specifically, based on their student experience, two predicted *Understanding and Belief* as a major impediment at T0, assigning it a high ranking (4-5). Once they began teaching, however, this increased to (and remained at) four participants, all of whom struggled to translate their ideas of scientific inquiry into classroom practice in the primary context. Interestingly, the one primary participant who did not feel this was an issue was Rebecca, who has a background in science (Forensic Science and Forensic Psycho-Biology).

Assessment and Achievement Implications

Implementation Issues	**Term 0**	**Term 1**	**Term 2**	**Term 3**
Assessment / Achievement Implications	2	3	6	4

Prior to starting only a couple of participants (both secondary) placed this in their top five barriers to inquiry, and even at that, the ranking was low (1-2). By the end of Term 1, this number had risen to three (again all secondary), both now with moderate ranking (3). By the end of Term 2 the number had risen to 6 (once again all secondary), and ranked high (4-5) for two of these individuals. Of note is that Term 2 is when preliminary exams are set, followed by a push to finish courses in preparation for the final exams so it is, perhaps, understandable that accountability would be felt most keenly at this time.

In discussing *Assessment and Achievement Implications*, participants made links with two other categories: *Time* (inquiry takes more time which risks not getting the course finished) and *Learning Objectives* (is the best way to prepare pupils for what they are likely to be examined on?)

Assessment and Achievement Implications did not feature in the top five of any primary participants at any time during their induction year. This may be because the 'deliverables' are not as explicit as those in the secondary sector (no examination results to be judged upon), but also there already seems to be more of an emphasis on skills over knowledge at the primary level, with success being measured by the demonstration of developing transferable skills through interdisciplinary learning.

Personal Commitment (Planning & Organisation)

Implementation Issues	**Term 0**	**Term 1**	**Term 2**	**Term 3**
Personal Commitment	1	1	-	-
Planning & Organisation*	-	-	7	7

Identified (somewhat reluctantly and with a degree of jest) by participants during focus groups, the original category, *Personal Commitment,* was based on individuals' inclination to 'take the easy option' - to deliver courses with the minimum of effort. However, whenever this issue was raised during early interviews, the issue of time and workload came into the discussion: were they willing to put the time and effort in because it took a lot longer to plan, organise, resource and monitor – and in the end, was it worth it?

I think there's going to be a lot of pressures I would imagine next year... from different things, meeting different deadlines and whatever else... And I just think it's dead easy to take the easy route, if I'm just being honest here. (laughing)

(John, Physics, T0)

Apparently it was not a straightforward case of laziness or apathy, but more a case of balancing priorities and acknowledging what can realistically be achieved in the time available. Thus, following analysis of T1 data, the original category *Personal Commitment* was combined with *Classroom Management* (organisation aspect) to give *Planning & Organisation*. Thinking about commitment to inquiry in terms of workload and time available seemed to resonate with many participants and following revision of this category, a number of participants selected this is their top 5 barriers to inquiry

The main issue would be the Planning & Organising... It's more difficult to organise for something that's not planned, if that makes sense? Then if you've managed to plan and organise it, the resources and funding... do we have the stuff available if we then came up with a good idea.

(Joanne, Chemistry, T3)

Classroom Layout

Implementation Issues	Term 0	Term 1	Term 2	Term 3
Classroom Layout*	-	-	0	1

This was identified as a potential issue by two individuals at Term 1 and was introduced for selection at Term 2 to explore any wider resonance. At this time it was briefly discussed then dismissed, however, it was selected by one individual at Term 3. Perhaps not surprisingly, this was the only participant who did not enjoy the privilege of her own classroom, and instead went between two rooms which were generally occupied the period immediately preceding hers, making it difficult to organise the room and set up equipment effectively.

CHAPTER 9 - SCHOOL CONTEXT

Schools are idiosyncratic places and, as the participants of this study found, many aspects of the school context conspire to shape one's practice and make the overall teaching experience a positive or negative one. Such aspects include the general ethos and quality of relationships, style of supervision and support, expressed (or apparent) values and priorities, and particular classes and pupils being taught. As learners themselves, beginning teachers look to other teachers and supervisors for support, not only in a practical sense, but also in terms of moral support and encouragement. Thus developing confidence and pedagogy, including the capacity for inquiry and other pupil-centred pedagogies, are dependent on how they are introduced to and received by the school, including how hospitable staff are and efforts made to inform and include. Significantly, these new teachers seemed to experience this differently depending on whether they were going in as a student or a newly qualified teacher.

Experiencing Schools as a Student Teacher

In discussions, both on and off tape, the number of participants who described contrasting student teaching experiences was striking, the quality of placements being judged largely in terms of the attitudes and dispositions of the staff encountered. The attitudes and 'willingness' of science technicians was particularly salient to secondary participants in their attempts to incorporate inquiry, or general practical work.

> *That whole placement was just the best place I could have been for my first placement, they were just great. The class was a really, really good class but they were just brilliant teachers … and it was really good to be able to see two different teachers and two different styles of teaching, but they were both just brilliant. Really good first placement.*
>
> ***(Carol, Primary, T0)***

… on my first placement I was terrified of going in and asking for equipment, because if you didn't order it the Friday before you didn't get … [One day] the PT was off and I couldn't take the class because it was practical, you know, so it had to be moved back and, I mean, I had to go in and plead with them to put back my experiments by one day. It was just horrendous, whereas on my second placement the technicians … I mean, you name it and they did it for me. They couldn't have been more helpful.

(Donna, Biology, FG)

I had really good technicians in my second school; in my first school they were just a bit of a nightmare.

(Dee, Chemistry, FG)

Many participants faced staff negativity on placements, ranging from teacher apathy through superiority to outright hostility.

People from CERN[14] were willing to turn up at the school... I just find it incredible; it's almost like there's too much hassle and stress for most of them to be bothered with that anymore ... and I realise that will probably happen to us after 3 or 4 years (laughing).

(Sean, Physics, FG)

Apparently, you know, student teachers shouldn't be expressing an opinion at all. And neither should people my age coming from business into teaching. It's not really what we're looking for in the profession!

(Douglas, Chemistry, T0)

Oh, I thought I can't do this... I can't believe that I thought I was doing ok. I went home and I was just devastated. I mean, the teacher said to me before we started that he was going to make me cry, and he has made another student cry.

(Caida, Physics, T0)

[14] CERN is the European Organization for Nuclear Research, however it is commonly referred to as the European laboratory for particle physics which aptly describes the research conducted there.

Without having directly asked participants about the culture and politics in school, many volunteered commentary on issues such as relationships, ethos and apparent agendas in such a way as to suggest a bearing on their classroom practice; for example, what they were ‘allowed’ to do and the nature and timing of feedback. The following observation gives an idea of the political minefield that some new teachers have to navigate.

> *I think once you’ve figured out which staff will be amenable to that sort of stuff that makes a huge difference. Like the technicians are very good ... you know, you could probably petition them to let you do that ... And most of the technicians will tell you it’s quite possible to do this type of stuff but many of the teachers were quite averse to it, you know. But quite often I would get the technicians to bring me the stuff and [they’re] saying, I’ve brought it only because you’ve asked for it but don’t say [to the other teachers] I’ve brought it to you.*
>
> ***(Sean, Physics, FG)***

Sometimes co-operating teachers, and even designated supporters, had the effect of stifling development by restricting pedagogy to those approaches that they themselves valued or were comfortable with. Teacher age or length of service seemed significant in this regard; this was alluded to by several participants in connection with culture, expectations and autonomy, particularly in the context of CfE.

> *I would say I was actively discouraged from inquiry based teaching. I was always told, keep to your lesson plan, keep to your lesson plan, don’t go off at a tangent, don’t let the kids take you off at a tangent. See, I don’t agree with that … and I still don’t agree with that.*
>
> ***(Douglas, Chemistry, T0)***

> *I think it depended on the teacher in the class because the old, you know, the old school teachers, the older ones who were very much kind of like dictating to them and there wasn’t the ... they were in control of the questions and the way the questions were asked rather than the pupils really having as much opportunity to ask questions.*
>
> ***(Joanne, Chemistry, FG)***

Whilst it was acknowledged that following up on pupil questions had a positive effect on the learning environment, several participants complained about co-operating teachers' disposition in this regard which, it was felt, did little to encourage curiosity.

> *It was like the regular kids asking the questions, like I totally found that, but also in a lot of classes a lot of the ... like the cheeky kids, you know, would maybe throw in a lot of stupid comments and things, but a lot of the time they would also throw in a lot of good questions and they would be genuinely interested. But if I was observing, I would observe a lot of the time that these kids would just ... that their questions would be ignored, because it's another stupid comment from John, or whoever. I saw a lot of that actually, which wasn't great I didn't think.*
>
> ***(Jennifer, Biology, FG)***

> *I think it's the idea that a lot of teachers are scared to go down these routes because they don't know a lot of the answers themselves. Quite often when I was watching a lesson [a pupil] might say, what about this? …and [the teacher] didn't know the answer and they'd say, oh well, we'll look at that another time, just at the minute we've got to get through this. And it's like... (feigns frustration). More often than not I found that a lot of teachers weren't willing...especially as they start to move up the school.*
>
> ***(Gary, Physics, FG)***

> *I found that as you got higher up... because it is a private school and it's all based on grades... it's just spoon feeding, like, you need to know this information to get this grade. So when it came to fourth years they didn't ask as many questions... the only questions they asked were: Do I need to know this for the exam?*
>
> ***(Dee, Chemistry, FG)***

> *Some teachers just don't like the 'going off the track' questions. Some teachers felt it was just the pupils' way of getting out of the work. Like asking these questions, that were still scientific and slightly relevant, but it was just their way of getting off track so they didn't have to do the work.*
>
> ***(Courtney, Physics, FG)***

The observations that most pupils were not moved to ask questions and that pupils' questions were often deferred or ignored was perhaps evidence for the persistence of traditional teacher and pupil roles, indicative of the continuing pressure to cover course content in the most time-efficient manner, or diagnostic of teacher insecurity in terms of their own subject knowledge or behaviour management.

Experiencing Schools as a Newly Qualified Teacher

In both sectors the general feeling in taking up the teaching role was that it was harder than expected; the steep learning curve, arduous workload and degree of responsibility were quite *'overwhelming'* for some. However, most participants experienced a welcoming, friendly and supportive environment (which exceeded the expectations of some based on their student experience), although John conceded that colleagues took a while to *'warm up'*, presumably making it more awkward to seek support early on.

> *I wasn't really expecting it to be as welcoming... [based on] placements during my teacher training.*
>
> ***(Charlie, Physics, T1)***

> *I would say, to be fair, I can see it's changed. I think, it's like everything, I probably feel a wee bit more ... this sounds terrible ... I feel a wee bit more welcome now than I probably did ... or more welcome now than I did right at the beginning, but that's not because of anybody making you feel unwelcome, I think it's sort of ... they're going to wait and see what you're like. (laughs) Possibly.*
>
> ***(John, Physics, T2)***

Thus, despite being somewhat overwhelmed by the enormity of the role and the level of responsibility they were taking on, most participants had a much more positive school experience during their induction year; they felt more accepted and included – *'part of the team'* - than during student placements. On reflection, both Douglas and Charlie offered a similar rationalisation for this:

> *... there is a big difference in the way you're treated. You are treated as a member of the team and that's the fundamental difference. And you are treated as someone doing a job ... you've got deliverables, you are accountable for the first*

time and ... yeah, that's nice. But that shouldn't be a surprise because you're a burden as a student let's be honest, you're a pain in the arse. Plus you're messing with their kids. I mean, God ... You know, I'm just thinking of my own situation, if I had a student teacher come in now and they were going to effectively be teaching, let's say, a tenth of the Standard Grade in effect, that could affect my exam results, you know, and you get quite ... well I do anyway ... you get quite possessive about the kids. They're my kids! (feigns dramatic possessive) I know how to teach them and I know how they're going to respond and ... I can understand that, I really can.

(Douglas, Chemistry, T1)

I would say you are treated more as a teacher because you are, you're more of a kind of permanent fixture, whereas as a student you're just in for a few weeks… I think it can be perceived that students can do damage ... not so much 'damage' because you're in the same room, but it certainly has effects, like they can work at a slower pace and things like that, and when you are kind of pressurised to meet deadlines it can be seen as a bit of a burden.

(Charlie, Physics, T2)

Despite the typical pattern of ‘ups and downs’, for most the first year of teaching was constructive and rewarding – even enjoyable - contributing significantly to their professional development, confidence and teacher identity. However, for a significant number of participants probation was a challenging period, and even for those whose overall experience was positive, there were often aspects of their school context which impacted negatively on their confidence and/or professional development (pedagogy/practice/flexibility). Specific aspects of school context and their implications for teachers’ competence and flexibility, including capacity for investigative pedagogy will now be discussed.

Orientation

Cognisant of their ‘probation’ status and the requirement to successfully complete the year, ‘fitting in’ and meeting expectations were key, not only in terms of personality, but also in complying with extant school systems. In order to achieve this, however, it was important to know how the school operated (policies, procedures, hierarchies), have knowledge of, and access to, important resources and information needed to carry out their job, and have some understanding of what was expected in terms of work ethic, classroom practice and pupil attainment, all of which would come under the umbrella of ‘orientation’.

Seen as a basic introduction to one’s workplace, orientation was taken for granted by most participants. However, for two participants (Rose, Primary; Joanne, Chemistry) for whom there was no orientation - no tour, few introductions, no policies, protocols or procedures, and no signposts to important information - it lead to a great deal of uncertainty and insecurity, a lot of time wasted, and a reluctance to try new or innovative things because it meant asking more questions of more people.

> *I don't know, maybe confidence is a problem. I feel like there are procedures that I'm sort of supposed to know how they work and I don't really know how they work, or how they work here, or what I need to do in particular here to make that happen... [There’s] nothing for the new probationers. Find it out as we go... There's like no orientation, and there's no policies either. They said ... I asked could I see the policies and they said, oh they're all outdated and we're redoing them this year, so no. Yeah, every time you have to go find out. It's a bit daunting.*
>
> ***(Rose, Primary, T1)***

<u>Expectations</u>

Although most participants felt welcome and supported, more problematic was the idea of expectations - what colleagues and managers’ expected of them, and indeed whether these expectations were explicit. Lack of explicit expectations was undermining; in Rose’s case it led to second-guessing with inevitable mistakes; in Joanne’s case, missed opportunities; and in Carol’s case, overworking to make sure she’d covered every conceivable eventuality.

> *I would be hoping (laughs) for a place that had explicit expectations of me, so that I didn't have to slowly figure them out by doing them wrong, do you know what I mean? I think it would have been easier... I imagine that at the beginning of the year I still would have chafed against some of the expectations, but at least if they were presented to me at the beginning, like, here's how the school works, these are the things that everybody does, you know, that all the teachers do in the their classes, this is what is expected of you... it would have been easier to cope with... to be more successful from the beginning. I think... I mean, to be really cheesy about*

it, it's sort of giving people success criteria... These are the success criteria, this is what you need to do to be successful, and so even if I don't like it at least I know what it is I have to do.

(Rose, Primary, T3)

I didn't go to any of the external ones, like SSERC, or anything like that, but I wasn't sure whether I was allowed to. So no-one had given us any guidance to say...

(Joanne, Chemistry, T3)

I don't know, sometimes you just think, am I doing ... like, is this the right way to do it... I think it's just there's so much paperwork and I think that's the thing that I'm always like ... (feigns panic)... Is it up to date, is that how they want it to be..? And, like with plans, I'm always kind of like ... they're done but I'm never sure if that's what they're actually looking for. Or tracking, for the first two or three terms I just did loads of it and then eventually somebody said, you only really need to write a sentence, and I was like... thanks! (feigns frustration and laughs)

(Carol, Primary, T2)

Time management was a major issue for both sectors in terms of managing the workload, meeting deadlines and getting pupils through the requisite work. This was amplified by the amount of teaching time lost due to bad weather, although this would probably be the case for any additional or unforeseen pressures, such as strikes, HMIe inspections or illness. To accommodate their professional development needs, NQTs are allocated a 0.7 teaching timetable, however, many participants found that they were expected to give of their time in other ways, such as contributing to curricular and staff development, and getting involved in extra-curricular activities. This ate into valuable planning and preparation time, which had obvious implications for investigative pedagogy which was seen to be more time consuming in the first place.

I've had advice for and against running a club because I'm finding... I've been on full timetable for, this is my third week now... it's exhausting. I get about one free period a day and you just find yourself knackered at the end of the school day, and you just think running a club on top of this would be quite all-consuming. But it's *quite expected... or it's a big plus point when you're getting interviewed, so I suppose you probably should. (laughs)*

(Charlie, Physics, T3)

I just think as an NQT you feel obliged to be constantly doing as much as is humanly possible, and this term I feel they're still asking us to do more and... I don't really know how much more I can do and not just totally fold under the pressure... because I already do two clubs and that means my Monday, Tuesday, Wednesday lunchtimes are full, and I do an afterschool club on a Tuesday, and then I'm trying to do that NQT handbook and then I'm in my literacy working party so we're trying to organise stuff for events in May and I just kind of feel that as well as my reports and my tracking and my... you're just kind of like... (shakes head in frustration) And then you're helping at concerts or school shows... I mean, I'm quite happy to help at that kind of thing but I already miss my Monday, Tuesday, Wednesday lunchtimes, and it's a good time to get marking done and sort yourself out.

(Carol, Primary, T2)

Departmental Colleagues

Laying important foundations for the year ahead was how beginning teachers were received by the school generally, including attitudes of colleagues and efforts to provide a support network, as this shaped their sense of inclusion and affiliation, impacting greatly on professional confidence.

You could really go to anybody and ask them stuff and they would tell you or help you, so you do feel that other teachers' doors are open to you, that you can always go and ask people and they would help you if you were stuck.

(Jill, Primary, T1)

Everybody's super supportive and you can really go and ask them anything and they'll, you know, point you in the right direction or... Like some of the experiments I've not done before because I've never had to teach the courses, and I go along and say, look, I don't know how to do such and such an experiment, what do I do? And they'll take time out to help me with it.

(Donna, Biology, T1)

I mean, because it's quite a small school, there's not a huge amount of teachers, so it's quite nice that everyone's familiar with each other and everyone's quite happy for you to come into their class and watch and observe and to give you ideas.

(Ruth, Primary, T1)

The willingness of colleagues to offer help and share ideas was important for their developing pedagogy and classroom management, but departmental dynamics, including relationships, personalities and co-ordination of work, were also important. For example, Carol was the only primary participant who felt completely unsupported within her department. Carol's stage consisted of two probationers, an NQT from the previous year, two jobsharers and a 'specialist' whose remit was to deliver Religious and Moral Education across the school. Timetabling issues meant that stage meetings were difficult to co-ordinate, and the fragmented department led to a perceived lack of coherence and consistency between same stage classes.

There's the three of us, there's two probationers, an NQT from last year and there's a job-share, another P3 that's taught by a job-share. So it's tricky. And obviously there's myself and my 0.3, [other probationer] and her 0.3... there's one [full-time] and then there's another job-share, so it's really broken up. And no-body had taught this stage before this year, so none of the people that are here have got any... So that was another reason the first few weeks were like, what are we doing, what are we teaching? Anybody?! Ideas?! Our stage meetings don't go very well… We've been told that there's not enough... that was one of the things the inspection brought up... there wasn't enough consistency across the school. And I think that's definitely... across P3 there isn't any consistency. And I don't know why really. We don't have many stage meetings, but when we do it just... nothing seems to get done and it's really like all over the place and it's like, well I'm doing this, and that's it. It's not a negotiation, it's 'I'm doing this'. And obviously as an NQT I don't really want to say, 'Well, I'm not doing that'.

(Carol, Primary, T1)

Inequity of workload seemed to be a significant issue for some secondary participants. Sean experienced what he described as male superiority within his department; curricular development work was not divided equally but mostly fell to the younger female member of staff. Sean was eager to be involved in this work and was able to develop many of his own innovative ideas and resources, resulting in increased confidence to teach the courses. Paradoxically, this departmental shortcoming led to an increased propensity for inquiry in the classroom.

Dee and Lisa, who worked within the same science faculty, had a similar experience in that the two members of staff who would normally drive any new initiative were two female teachers who were currently on maternity leave (and whose posts Dee and Lisa were covering). Consequently, curricular development work was lagging because no-one would take the lead or make any decisions; meetings were described as frustrating and unproductive.

Supervisory Support

The two most significant individuals in this regard were the subject PT and the designated mentor, the PT for day to day supervision and support within the department, including behaviour support and subject specific advice and ideas, the mentor for more general guidance and support in meeting the Standard for Full Registration (although these individuals were sometimes one and the same).

Not lost on these new teachers, however, was the ultimate power these individuals held in determining their fitness for the teaching profession - pass or fail! With this in mind, maintaining positive relations and meeting expectations were key.

> *It is a hugely important relationship. Your mentor teacher has a large amount of power over you and your success during the year depends hugely on the relationship. ... So that's a huge deal. I've worked on my relationship, and as I've been ... like the success criteria for me is doing what my managers want me to do. That is how I am a successful teacher and pass my probation year. The more that I was able to be who she wanted me to be, she's been happier. And that makes it easier for me, and she trusts me more and I feel like she's not watching me quite as closely, which is much more comfortable.*
>
> ***(Rose, Primary, T2)***

> *There's been huge rows here... massive rows. I handed my resignation in... just before Christmas. But I mean, it's been sorted out. They had to re-write, completely re-write, my interim report because it wasn't evidence based and I was able to produce evidence contrary to what [HoD] had written... I just had a very long meeting with my mentor today about this issue. She knows there's a problem, and so does the Head ... You know, basically do absolutely precisely what you're told, that's the advice I've received, and that's what I will do to get through this year, but I don't enjoy working in that sort of environment.*
>
> ***(Douglas, Chemistry, T1)***

In terms of style of supervision, Douglas and Joanne lay at two extremes of the 'managed' continuum: Douglas was 'micro-managed' and obliged to conform to the letter, Joanne was autonomous to the point of neglect.

> *Em ... a very prescriptive way of working in here. Oh, incredible. No deviation off the course what so ever... I've been pulled back formally; I've been in a bit of trouble actually, to absolutely stick verbatim with the prescribed courses. It's her style. She's very OCD. She's a nice woman but she's ... When we moved into this building ... Well [physics colleague] ... she had printed out all of his labels and everything; she told him what went into which drawer in his classroom. It's just micromanagement to the extreme.*
>
> ***(Douglas, Chemistry, T1)***

> *I think I'm almost envious after being on placements and chatting to people who ... especially on my last placement, there was a teacher who'd, that was her second year after probation and she said 'oh, don't worry about it, you'll learn so much on your probation'. She learnt so much from her PT and I'm like ... I'm not getting that. It's more like I'm kind of teaching myself. And I don't know whether I'm doing it good or badly. And I think the last few weeks I've kind of taken a bit of a dip.*
>
> ***(Joanne, Chemistry, T1)***

McNally and colleagues also identified such extremes of supervision, which he termed ‘stifling’ and ‘abandoned’ (McNally et al., 1997). Neither of these situations was supportive; indeed both Douglas and Joanne felt deluded and let down and seriously considered leaving the profession after only one term. Fortunately most participants perceived a high degree of professional autonomy and at least an adequate level of support from their mentor or PT (or both), the combination of which provided a sound basis for personal and professional growth.

> *I think, to be honest, it’s nice to know that I have got a certain freedom to go and do and try things without people being on top of me saying you have to do it this way or this way or this way. And I think in the beginning I almost needed that structure of, right, what do I do next and what's the next step. But then, now looking back over that first term, I actually think it's been better that they've stood back a wee bit and just let me make mistakes and let me go through it and, you know, helped and guided me when they needed to, but definitely I think the freedom that I've had has probably been the best thing for me.*
>
> ***(Ruth, Primary, T1)***

> *The support given to me by my mentor has been really good because the most challenging part of it was learning the curriculum for me, because I've got a mechanical engineering degree, so a lot of the theory isn't fresh in my mind. And there was two periods set out during the week explicitly for me and a lot of that time was spent discussing good ways of teaching classes.*
>
> ***(Charlie, Physics, T3)***

In terms of the mentoring specifically, it was quite apparent that different people approached this role differently, but three issues in particular seemed to influence the quality of the support perceived by these beginning teachers: availability, approachability and experience.

Availability: For some participants timetabling, illness or aspects of the mentor’s role within the school made it difficult to schedule regular support meetings.

> *Well, she's a Depute so I kind of feel she's quite busy. I don't feel she's unsupportive. Whenever we do have our meeting, you know, I think she's really willing to help, but I just don't really see her very much.*
>
> ***(Carol, Primary, T1)***

My supporter's great, she's lovely but we've had no timetabled time off together so for us to have meetings we have to have it after school or at lunchtime, which is wrong because they're supposed to be timetabled. But there's just really me and her doing chemistry in the department really.

(Joanne, Chemistry, T1)

My mentor is good but my mentor went off [sick] about a week after I started and didn't come back until after the October week... And we did go out to her house a few times and visit her there ... although we were still trying to have meeting, she wasn't there to speak to.

(Jill, Primary, T1)

Approachability: The tone of the relationship and type of support the mentor was willing to give had implications for developing practice.

I'm completely comfortable to ask him for anything and he seems very, very realistic about work loads and he knows what it's like to be a day-to-day teacher.

(Charlie, Physics, T2)

I've got a great supporter, who I can go and speak to about anything...

(Rebecca, Primary, T1)

[My] mentor's nice but she's quite... she's not really that approachable to be honest. She's just quite kind of, not standoffish, but she's very businesslike and I don't know if I'd approach her about things that ... I don't know how to say to her, I don't really get what you're saying... I tend to talk to the class teacher more than I do [her].

(Jill, Primary, T2)

Experience: In Sean's case this was his mentor's first year taking on the role and his inexperience manifested in disorganisation and sidestepping formalities.

My mentor was fairly out of his depth doing the task and so I've basically written his reports, informally and that sort of stuff, and guided this thing along, you know... like turning up for my appointment, it takes him nine or ten reschedulings to *actually turn up. He gets into a panic when he has to write something. So I find myself doing critical assessments on myself and saying ... Would you agree?*

(Sean, Physics, T2)

Classroom

All participants except Donna were fortunate enough to have their 'own' classroom. This allowed them to develop their teacher identity by experimenting and learning from their mistakes without someone looking over their shoulder all the time. Donna, who went between two classrooms and was the main teacher in neither, was not afforded the same privacy because other teachers frequently popped into the classroom, but more significantly perhaps, this had major implications for any sort of practical work. More often than not the class was occupied the period immediately before her lessons which made set-up difficult, and occasionally the seating plan had been changed which made the planning of group work tenuous.

Classes

The issue of whether assigned classes were appropriate to their experience and development level was raised by some participants. For example, when Dee started in the school she was given lower ability classes, and higher ability classes were assigned to more experienced teachers. She put this down safeguarding results rather than offloading unwanted assignments.

I'm sort of an unknown quantity and I mean, I don't think it was out of any malice or anything like that, I think it's just obviously they need to do the best for their ...(contemplates). I don't see it as a slight on me.

(Dee, Chemistry, T2)

Commonly reported was the wide range of abilities within the same class, which had its implications for classroom management, but whereas most primary participants were pleased with their class allocation, many secondary participants described and discussed difficult classes and challenging behaviour.

I must admit I haven't done any investigative pedagogy because I just haven't ... I don't feel confident enough to do it. And I think ... I've got four classes - 1st, 2nd, *3rd and 4th year. My 1st year is a real mixed ability, there's people who are on IEPs[15] in it. There was so many mixed needs in that class that have been put together to specify that they should get additional support, and my additional support has been hit and miss. One period I might have them, the next complete week I'll not have anybody. And it's all double periods which is hell. So I've 1st year for an hour and fifty minutes, I've got 2nd year for an hour and fifty minutes, and I've got probably one of the worst 2nd years as well. (laughs)*

(Joanne, Chemistry, T1)

Shared classes were also problematic, particularly when the beginner only taught one out of three or four lessons. In Charlie's case the issue persisted for the duration of the induction year and made any sort of pupil-centred or collaborative working impracticable.

For the Int 2s and the Highers I actually only see them one period though. Their main teachers take them four and then I see them for one [period]. So it can lead to problems, such as they think it's a holiday when they see me ... (laughs)

(Charlie, Physics, T1)

Training Provision

In terms of CPD, the amount and quality of training offered varied across participants, but frustrating for some was the restriction imposed on attending external (LA) CPD, particularly when the focus was an identified area of weakness, such as Collaborative Learning or Behaviour Management (both of which may have supported their efforts to implement inquiry in the classroom).

I suppose one thing that has been slightly disappointing is that ... because there are so many probationers here, the school's quite unwilling to let us go to these CPD things. Yeah, actually that is disappointing because there was an assertive discipline one that I was very keen to go to but I couldn't.

(Charlie, Physics, T1)

[15] IEP: Individualised Education Plan – a personalised learning plan for learners with special educational needs.

All NQTs in this school, I don't know if it's [LA] wide, have only been allowed to attend the absolute minimum CPD run by the council and I think that's a disgrace. There's CPD I would like to attend ... there are absolutely first rate Kagan-based co-operative learning courses we've been told we're not allowed to attend them ... And co-operative learning is absolutely their number one priority at the moment, which is why it's disappointing that we're not allowed to attend the two day course. It's supposed to be a training year and I think it's a pretty bad show personally.

(Douglas, Chemistry, T1)

One form of CPD which was highly valued was the opportunity to observe other teachers and learn from them. This would extend to inquiry also as it turned out that most participants had a limited understanding of how to incorporate and support classroom inquiry.

I think experience of observing teachers and taking lessons myself will have helped me because I'll be able to sort of take a step back but still be in full control and manage it and know what I need to do initially to get the inquiry approach going in the class.

(Courtney, Physics, T0)

I'll watch another physics teacher. I'll have a wee look at other teachers and sort of talk to them. I think it's learning your trade, if you like, if that's an ok phrase. Do you know what I mean?

(John, Physics, T1)

Well going and observing other people actually doing it, I think that's the best way for learning everything. Going into another classroom ... it's the quickest way of learning about teaching anyway, definitely. Seeing other people doing it, stealing ideas... (dramatic emphasis then laughs).

(Shona, Biology, T2)

One of the teachers in [placement school], he always turned around whatever the practical was and kind of gave the ownership to the kids, getting them to design the *experiment... even though you already had his design there, but then they felt like they'd designed it, the experiment, which was good.*

(Joanne, Chemistry, T3)

In terms of the participant themselves being observed, as Courtney points out, this had the potential to be very useful.

I've found the observed lessons really good, because you go from being a student and being observed all the time... and it's quite a nice transition being observed just nine times throughout the year. It's still a chance for you to think about what you're doing and why you're doing it, and there's someone there and you're getting to discuss how it could be improved and what went well, and things that they would notice that you wouldn't think of. And I think it is quite encouraging, even when a lesson doesn't go so well, there's always something constructive that you can take out of it.

(Courtney, Physics, T3)

However, for a few participants observed lessons were a source of stress and frustration; for example, missed observations, unannounced observations or scheduled observations being cut short (eg. due to mismanagement of diary); several observed lessons in succession to catch up on those missed; observer interrupting/intervening in the course of a lesson; and feedback based on areas other than the agreed focus, which at times appeared to be *'nit-picking'* and pedantic. Such situations had the potential to seriously undermine relationships and professional confidence.

I've just had my learning visit today with the Head ... it was supposed to be two weeks ago and she forgot, and then it was rearranged for the following week and there was the snow so it got cancelled again. So I feel like it's been looming (exaggerated) for like three weeks ... And then she left early so she didn't get to see my plenary or anything so I was like, aarrgh ... (feigns frustration)

(Carol, Primary, T1)

But just after October was quite stressful, up until a couple of weeks ago because we had to get all our observations practically one after another, so for about 3 or 4 weeks I had an observation every week. ***(T1)*** *I found that quite stressful because at*

> *times, you know, when she's sitting in my room, if she sees anything she doesn't like she doesn't leave me to deal with it, she would be on them in a [flash]... I had an observation with my mentor that was a bit ... hmm. So ... em ... when I spoke to another couple of teachers, they didn't quite agree with her... I mean, I think other people felt she was probably kind of nit-picking with me...* ***(T2)***
>
> ***(Jill, Primary, T1/T2)***

Thus, it would seem that observed lessons had the potential to develop confidence and support professional development as long as they were scheduled, there was a clear, pre-determined focus, the feedback was timely, constructive and appropriate to the agreed focus, and the observer took a passive or at least secondary/supporting role.

Priorities and Agendas

An important influence on these new teachers' practice were the general aims, values and priorities of the school itself (or more accurately, the staff and management therein), and how these align with participants' own aspirations.

> *And this [inquiry], quite frankly, gets you shot most of the time if you're trying to get those tasks done because they're time consuming, they're much more risky, yes, it may benefit the kids long term but like my HMI report here for this school was unless they get a 15% increase in the Higher results they're getting inspected again.*
>
> ***(Sean, Physics, T2)***

> *I've had to change my priorities basically, to match what the priorities of my superiors are. Because you can't succeed otherwise, because no matter what you do, if you're not doing the things that they think are important you won't pass.* ***(T1)***
>
> *I guess there's always a ... there's some conflict between what people want me to learn and be good at and what my interests are to learn and be good at. For example, inquiry in science, this is something that's interesting to me. It is much more important to my supervisors right now that I become good at co-operative learning than that I become good at inquiry based learning. So that's a conflict.* ***(T3)***
>
> ***(Rose, Primary, T1/T3)***

The school's priorities could be inferred from what educational initiatives were being pushed, the nature of CPD offered, the common practices of departmental colleagues and the focus of meetings (for example, pedagogy or results). A major factor in this respect was the school's position with regard to CfE, including attitudes and efforts to encourage and support CfE-oriented practice. Did management and staff subscribe to the aims and philosophies of CfE - teacher freedom and flexibility to make learning relevant and meaningful using pupil-centred, active, collaborative and inquiry-based approaches – or was it business as usual?

Participants' sentiments with regard to CfE initially swung between scepticism and optimism, reflecting a developing appreciation of the realities of the classroom and accountability of the teaching role, but also recognition of CfE's potential to impact positively on the teaching profession and consequently children's education. Freedom and flexibility with respect to content, pedagogy and timing were perceived to be the main benefits of CfE, and furthermore it had features in common with participants' notion of inquiry (pupil led, active learning, collaborative). In the primary context it held the prospect of incorporating (investigative) science, previously not well accommodated within the primary curriculum.

> *I think, with regards to science, actually the Curriculum for Excellence will be a really good thing because ... because there's no place in the timetables at the moment for science ... So it's not like we'll be replacing anything, we'll just be enhancing learning with science, which I think will be beneficial.*
>
> ***(Ruth, Primary, FG)***

However, even before starting induction participants were concerned about the prevailing culture and agendas in their placement schools (based on student experience) as this would ultimately determine the extent to which CfE was embraced and set expectations for their own practice.

Participants' experience of CfE during their induction year was predictably variable, although some participants perceived less resistance to CfE than during student placements, a move forward in a sense.

It feels more natural now, it feels more like ... I mean it's a lot of work because it is just brand new, but it feels like they're getting to grips with it, whereas [on] my first placement it was ignored... (laughs)... it didn't exist. It was 5-14... and my last placement they were trying to kind of more match up the outcomes with the topics in the 5-14.

(Rebecca, Primary, T1)

I've not heard very many negative comments about CfE ... On placement all you heard was ... (laughs)... It was kind of the unspoken word, a bit of a taboo subject. Here people just seem to get on with it, it's not like all the teachers love it or think it's wonderful but they just kind of get on with it, it's a reality...

(Courtney, Physics, T1)

Most schools were at least attempting to engage with CfE; some had re-written, or were in the process of re-writing, S1/S2 courses. Others had taken a more transitional approach, either teaching old courses in a more pupil-centred fashion, or adapting existing courses so that they were taught in line with CfE. However, as with any change there was still a bit of resistance on the ground. Some teachers welcomed the flexibility and the autonomy that CfE was bringing, some not so much for all sorts of reasons, not least of which is that it involved 'yet another change'!

But there's opposition; there's a whole department that does not want to do Curriculum for Excellence and they make it plainly obvious, and in science faculty meetings it's just whingeing. It's terrible.

(Charlie, Physics, T2)

By the end of Term 2 (Easter), other than two schools with a distinct 'achievement agenda' where CfE was paid little more than lip service, S1 (and sometimes S2) were being taught via CfE in most of the participants' schools, with 'teaching as normal' in certificated classes.

Well that's came into play a lot more I think with 1st and 2nd year ... 3rd, 4th and 5th year it's basically I talk, notes are taken, they do questions, eventually they do exams, whereas 1st and 2nd year is a lot more group work, a lot more activities, different projects if you like, and they do their cross-curricular stuff as well.

(Lisa, Biology, T2)

By this time many participants were capitalising on opportunities for formative assessment which provided scope to develop pupils' thinking and assess understanding verbally. Curiosity was encouraged and questioning had become a key strategy from both the teacher's and the pupils' point of view, and in this respect CfE did indeed seem to be compatible with inquiry.

> *And we've got time to do these kind of, you know, your active learning and AifL stuff ... Just making them think a little bit more. Why do you think these things have fossilised but other things don't? ...getting them to come up with the ideas.*
>
> ***(Donna, Biology, T2)***

> *They're probably allowed a wee bit more ... I suppose maybe less prescriptive. I mean, as part of that lesson we talked a wee bit about it and just said, ok, take a few wires ... a bulb, and a battery and stuff, and just let them play with it. So from that point of view just let them work out themselves, does it work, does it not work, why is it not working? And I think one of the things was, one of the pairs had a bulb holder that didn't have a bulb in it, so thinking, does it work? ... I'm like, ok, so it's not working, why do you think it's not working? And they came up with the bulb holder, and I said, so what is it about it? And I can see that the cable's connected, what's up? And they worked that out for themselves that there was a break in the circuit. So it was like ... That's a dead wee thing but they're only 1st years and they've never done it before.*
>
> ***(John, Physics, T2)***

> *Just doing things like different assessment techniques... Getting the kids to maybe be more involved in the planning. The last theme that we did, I said, right this is the heading, this is what we're going to do, and these are the things that I have thought would maybe be quite good, talked a bit about it, gave them the overview and said, what would you like to learn?*
>
> ***(Rebecca, Primary, T2)***

> *I think CfE has definitely got it built in with it. I think definitely the teachers have been doing that this year, they're more inquiry based, but that's one of the reasons we're all so behind with the 1st year courses, because it's been taking longer.*
>
> ***(Shona, Biology, T2)***

However, some participants expressed some frustration that the objectives and aspirations of CfE were being misinterpreted.

> *That's what people were saying, you know... How do you know what your kids have done and where they're supposed to be at the end of the year? It's probably a contradiction really in the idea of the Curriculum for Excellence, I don't know. If you're going to have flexibility but your kids need to all end each year at the same point, like what flexibility do you really have, do you know what I mean? And the idea that each kid is going to progress at the same rate and they're all going to have... I don't know.*
>
> ***(Rose, Primary, T1)***

> *Across the school as a whole, pretty well - there's some very, very good teachers in this school. There are some superb teachers in this school. In science we get a course like this and what they've done is gone through these notes ... tick, yeah we do that; tick ... tick ... A complete misunderstanding of what C for E's about. It's treating C for E and these notes on C for E as a body of knowledge rather than ... It's not understanding the word 'experience'. But there you go.*
>
> ***(Douglas, Chemistry, T1)***

Apparently Douglas' Head of Department felt that lecturing and lock-step practicals were the basis of good teaching and valued note writing and rote learning for the purpose of passing exams. Retaining a similar achievement agenda was Charlie's school which attempted to cram all of the Experiences and Outcomes intended for the first three years into one year, and further, pose regular tests in order that pupils could select their subjects for further study in S2 onward.

On the other hand, entering the staffroom at the end of an interview, Courtney and Donna's Faculty Head interjected that the department were very keen to promote inquiry in the science department, and colleagues in the department were good role models for active and collaborative learning.

> *We ... this school has always been good, this department in particular, for like Assessment is for Learning and all the sort of active learning stuff, they're really into that.* ***(T1)*** *Being here this year I've definitely ... active learning is a huge part of this school, we use active learning a lot and I've definitely built up my repertoire of active learning things to do...* ***(T3)***
>
> ***(Donna, Biology, T1/T3)***

Similarly, Dee and Lisa's Regent expressed an interest in the study and pledged her support for their efforts to implement inquiry based pedagogy. Thus the prevailing attitudes towards CfE, and Inquiry, had a significant bearing on these beginning teachers' practice.

Curriculum and Course Materials

In the secondary sector, generally speaking CfE had been adopted in S1 (and sometimes S2), if not the courses themselves then certainly the philosophies and strategies. New courses were being developed in the majority of participants' schools with many of the new teachers themselves being involved in that development work, which had the effect of improving not only their subject knowledge and understanding of CfE but also their confidence in teaching the courses and flexibility to expand or deviate where appropriate.

> *The 1st year course has been great because that's all the new stuff that we've written here over this year anyway so ... So that's made it very easy because it's stuff I've created and experiments we've got... and a lot more fun. So because there wasn't too much restraint on that, being able to do lots of things, you know...*
>
> ***(Sean, Physics, T1)***

> *It's probably making me more confident at doing things like that, letting things go off on a tangent. Having more discussion, active learning.*
>
> ***(Courtney, Physics, T2)***

All participants could appreciate the flexibility inherent in CfE (even when that did not apply to their own context), however, whilst some welcomed the freedom to branch out and try new things, even pursue pupils' interests and engage in projects, others felt slightly insecure in relation to consistency and progression. And although the acknowledged that there was more scope for inquiry within this format, some participants nonetheless felt insecure about the validity of inquiry activity within the context of specific topics and would have preferred more guidance and examples by way of reassurance that the pursuit was 'worthwhile'.

> *So to incorporate more inquiry in my teaching... As long as there's the opportunity to do it, that's encouragement, the flexibility of the course. Knowing that their achievement or attainment won't be hampered by it, i.e. you're not having to rush other parts of the course because you're doing a lot of inquiry in a certain part.*
>
> ***(Charlie, Physics, T3)***

> *Yeah, as long as I was confident myself that it was in the course if you like, or it was covered by one of the outcomes, then I'd be happy doing it, but if I just thought that might be quite good to do but I've no idea where it would fit in then I'd then be worried that I was wasting everybody's time.*
>
> ***(Lisa, T2, Biology)***

> *With the 1st and 2nd year, yeah, I don't think there's enough structure to it, like, broken down, exactly what you're learning intentions should be and what you're trying to tick off. I don't know whether that's ... should I be deciding what exactly the learning intention is? Surely if the course if over two years I need to know what's going to be covered at a later date?*
>
> ***(Joanne, Chemistry, T2)***

> *With the first years it's definitely, as I was saying, we've got a bit more time and a bit more, you know, freedom to go off and do little things ourselves, you know, little projects... [BUT] I'm worried that CfE's not prescriptive enough... For any pupils who are maybe moving between schools and stuff, how are you going to ensure that they're going to have covered, you know ... how are you going to ensure that every school in Scotland is assessing to the same sort of criteria so that if you're Level 3-secure in one school, you know, are you going to be Level 3-secure in another school, or are you going to be something different, you know.*
>
> ***(Donna, Biology, T2)***

In this respect Curriculum Materials could be conceptualised as a form of support for new teachers. Having a course outline, appropriate resources and guidelines and suggestions for delivery appears to be incredibly supportive for beginning teachers - this can be illustrated by Lisa's reaction to the prescribed courses in her school which provide security in knowing exactly what you're doing as well as saving valuable preparation time.

> *I came down for a visit in June and they said what topics we would be on and ... but there's actually, there's kind of lessons set out for a lot of the first and second year stuff and it's step by step, which in some ways is good because it cuts down on the preparation that you have to do... There's teacher guides of lessons... So there's one of these for every first and second year topic, so basically a big folder and the lessons are numbered. It's good because it tells you what you need to order from the technicians... it tells you the aim, the outcome, the resources. And they also put on a PowerPoint as well... but you want to have your own stuff in the PowerPoint too. So if I'm reading this and I think they'd be better off knowing something else first, I'll just do it.*
>
> ***(Lisa, Biology, T1)***

Douglas, too, had access to comprehensive course materials, however, unlike Lisa he was required to stick rigidly to the course outline and follow detailed lesson plans (which were virtually scripted for him), with little or no scope for deviation or professional judgement. The level of prescription and conformity left Douglas feeling quite stifled.

> *I've been pulled back formally, I've been in a bit of trouble actually, to absolutely stick verbatim with the prescribed courses. I have been told that my three 1st year classes and their notes in their jotters should be identical. That's how prescriptive it is. And I find that quite bizarre, both from a pedagogic point of view because, I mean, classes are different, kids are different. Where's the flexibility in that? Where's the discovery learning? Where's the inquiry-based learning? There isn't much really. It is very much about transferring a body of knowledge to the class, and it's not what I thought teaching would be about but it is what it is here. But I mean, who am I? I'm just an NQT with hardly any experience so let's ... it's got to be put into perspective as well.*
>
> ***(Douglas, Chemistry, T1)***

Although existing resources had been retained and adapted in most cases, in two instances old materials had been trashed altogether constituting a completely fresh start, much to the chagrin of some! Joanne, for instance, was left entirely to her own devices about what she taught and how she chose to cover particular topics, down to actually sourcing ideas and resources because there were no course materials for many of the courses and there was a reluctance to share ideas within the school generally.

> *Very sink or swim I'd have to say, I've been really shocked. I think I had it quite easy in comparison when I was on placement, the schools I was in had very much designated, you know... the course was set out, you ordered certain experiments for certain parts of the topic, they had booklets for the kids, you knew for experiment 4.3 or 5.1 that's all you'd have to really order, you didn't have to think up an actual experiment yourself. I've got timelines, you know, of what part, what topic I should be doing at certain times, and learning objectives ... but there's no ... that's it! And I'm just kind of like ... (feigns lost)... I think basically the Curriculum for Excellence came in so they just got rid of everything they had and then started again, which I think is just stupid... we could have adapted it.*
>
> ***(Joanne, Chemistry, T1)***

In all participants' schools, S3-S6 were still following prescribed certificated courses culminating in an exam at the end of the course. Although on reflection a couple of participants could identify CfE approaches in their teaching of certificated classes, both the degree of prescription and pressure to cover content for exam purposes hindered inquiry efforts, and indeed in most cases 'necessitated' a more traditional teaching. Therefore decisions about pedagogy largely hinged on what course was being taught.

> *Well, I think there's more scope for it in the first year course just because of the kind of ideals of Curriculum for Excellence. I think there's that bit more time there to do it. Whereas with the senior courses just now, you know, I'm maybe adapting practicals that are already in place that they've got to do anyway and just kind of getting them to actually think about it and investigate it a little bit more.*
>
> ***(Donna, Biology, T2)***

Thus, by and large secondary participants experienced relatively well-structured courses with relevant materials available (except Joanne) but perceived a considerable degree of flexibility within those courses in terms of adding/adapting materials and adopting suitable pedagogical approaches (except Douglas). Most concede that there is less flexibility with the upper school. I say concede because the accompanying tone is one of regret/disappointment which suggests that they value a certain amount of flexibility in their practice, perhaps to improve learning, perhaps to forge their own stamp and style; either way it seems to enhance their self as teacher identity.

> *So they get these booklets and everything's in there and all they need to do is just write in the answers, and you've got a prep... That's the file there that's got all the work cards in it, the lesson plans... everything! And it's just you do this and that's the way you do it, because the lesson plans follow the workbook, so you can't go, well, I don't really want to do it that way, I'll just do it a different way. You've got to do it that way because that's the way it falls... There's no scope for... In S1/S2 at least there's no scope for kind of veering off and doing something else, which is what we are trying to change now I think. It's not what I... no. Definitely not. There's just no... [flexibility].*
>
> ***(Dee, Chemistry, T1)***

All primary participants were experiencing and adapting to a new system of planning and assessing based on the new guidelines, although in all participants' schools the previous arrangements documents (5-14 Development Programme) were still very much in evidence and referred to for the purpose of 'levelling' the pupils, breaking down the broad levels of CfE into specific learning outcomes or selecting appropriate resources. Attitudes towards CfE were generally positive although it added to an already overwhelming workload and vagueness was still an issue. Devising completely new schemes of work was labour intensive and time consuming, and because CfE was new to everyone this had implications for the nature and amount of support these new teachers could reasonably expect. Thus although CfE had the potential to support inquiry, time constraints and insecurity in their own interpretation of the Experiences and Outcomes were a major impediment to investigative pedagogy.

There weren't any plans, we had to start and re-write them basically. So you had to kind of take the skills and find the resources and match them up. So it took ages and they're still not really finished.

(Carol, Primary, T1)

I just felt overwhelmed... getting to grips with planners, because they've been re-written for Curriculum for Excellence and in some respects they are a bit vague. And of course the teacher who's in my class the other time, she's an experienced Primary 4 teacher, she's taught P4 for years and years and years, but this is her first time looking at these planners too and, you know, I feel as if there's been a huge kind of learning curve in the school, as there probably is in loads of schools, because of Curriculum for Excellence and because it's changed all their forward plans.

(Jill, Primary, T1)

Science and Inquiry in the Primary Context

The five primary participants enrolled in this study expressed an interest in science generally and believed it had an important place in the primary curriculum; their experience in the field suggested this sentiment was not shared with the wider primary community. During student placements science lessons were infrequent, rarely featuring in timetables and planners. Often when it was taught it was either not made explicit that the children were learning science; it was actually another activity 'disguised' as science, such as a writing task; or it was too trivial to support meaningful learning. The situation in Primary schools with respect to science in the curriculum was not helped by the apparent lack of priority given to Science within the PGDE Primary course itself.

I've never seen specific 'we're teaching science here', it's always been in an Environmental Studies topic… They don't even have a jotter that says 'Science' on the front of it. I think that it kind of gets lost, just another thing that they're learning as opposed to understanding that it's actually science that they're learning.

(Ruth, Primary, T0)

To be honest I haven't really seen a lot of science in classrooms… I must admit I've not... I think that the actual course at [university] is far too quick and too fleeting *and doesn't really give you a very great depth... I mean, Science isn't a core subject… you have to take it as an option, therefore, if you think of the amount of people that are now going to go on to teaching who haven't actually had any experience of Science… and they don't have science degrees, then you realise that, in actual fact, it's not really that wonderful.*

(Jill, Primary, T0)

I've seen one science lesson so I don't think that I can really comment on it. I don't think they give nearly enough science in primary, from what I've seen... I have failed to acquire any further knowledge on science ... in the curriculum, in school, in uni. I think we got one lecture on science. That wasn't... It was a good lecture but it doesn't really stand you in good stead.

(Rebecca, Primary, T0)

In this school there wasn't anything timetabled for science... We did a few things about sorting and looking at shared characteristics in animals and things but not any real science, it just wasn't timetabled. And my teacher had a very specific idea of what she wanted me to cover in the time that I was in the class so you just obviously have to do what your teacher wants...
I don't know, science just hasn't been a focus at all of the course, it was very add-on, like if you do the module you'll get some... and if not then there won't be. To me it makes me think it's obviously not a priority… it's obviously not something that they feel needs to be pushed.

(Carol, Primary, T0)

Um ... to be honest I haven't seen very much science taught. In fact I would say that I've seen no science taught in schools the entire year... I didn't learn very much about science this year unfortunately, we didn't have very much science content. We had ... I mean we had some lectures and I feel like there was something that we had in a tutorial but I don't know what it was.

(Rose, Primary, T0)

As Ruth pointed out, their capacity to teach science, and in particular in an investigative manner, is highly dependent on the school's orientation towards science in the first place.

> *I think if you turned up to a school which was really interested in science and was scientific and it had a bank of resources, just like you turn up to any school and they've got a bank of maths resources and a bank of language resources… if you turned up and they had a bank of science resources you'd get far more teachers saying yeah, I'd love to do that. If you spoke to any teacher, of course they want children to learn through investigative procedures, of course they want the children to be hands on and doing all that, but it's just... it's not in the school, I don't know where to go and get 40 batteries and lights and bits and pieces from, so ...Yeah, just avoid it, just do something else because it's easier... and with a crowded curriculum anyway, the last thing you want to be doing is spending every lunchtime running around trying to source materials... because it's crammed enough as it is, so... I think if the schools behind you scientifically then you'll have an easy ride.*
>
> ***(Ruth, Primary, FG)***

On taking up their induction post most participants noted a similar lack of effort on the part of management and colleagues to accommodate science in timetables, or to support teachers in the delivery of science courses. In the opinion of these participants too much emphasis was placed on maths and language, and the occurrence of unplanned events (school visits, impromptu meetings, etc) led to science being dropped before other subjects. Further, the lack of resources and explicit expectations for teaching science in some schools made it easier to ignore.

> *I have no idea what people's expectations of me are whatsoever in terms of science. Nobody's brought it up all year basically. I think I could easily have gone through the entire year without doing any science and nobody would have said anything about it.*
>
> ***(Rose, Primary, T2)***

This is not a novel finding (see Appleton & Kindt, 2002), but it does point to the continuing lack of priority given to science within the primary sector generally. This is not due to a lack of attention given to science within national curricula, as science has been designated a 'core' subject since the early 1990s, but most probably a consequence of decisions based on values and pressures at a more local level, including a disproportionately strong emphasis on literacy and numeracy, limited funding for appropriate resources to support the learning of science, and teachers' lack of confidence to teach it in the first place. Rather than addressing the confidence issue, some schools have opted to employ a 'science specialist' (Carol's school) or elect particular members of staff to teach science across the school (Jill's school). However, some primary schools seem to be very open to ideas and suggestions for teaching science and willing to learn from individual teachers' initiative, even beginning teachers. For instance, Ruth's Head Teacher granted Ruth permission for a week-long science-based activity (albeit it was between topics and in a quiet period in the lead up to Christmas); it was with her own class primarily but it would ultimately involve other classes and staff in the school. It was very successful and the Head Teacher vowed to incorporate similar learning in the future. Similarly, because Rebecca was very knowledgeable and had lots of ideas for teaching science, colleagues fed on her enthusiasm and were eager to learn from her. She delivered science CPD to help raise confidence in teaching science in line with Curriculum for Excellence.

The introduction of the 'new' curriculum seems to have created a real tension for primary participants; although keen on the child-centred approaches advocated by CfE, including inquiry, they acknowledged the practical implications of such an approach in terms of planning, time constraints and meeting expectations for academic achievement. In terms of science specifically, there are so many things to cram into the week that science is squeezed anyway, never mind trying more innovative, eclectic and open-ended approaches which take more time and may involve more risk. Thus, although all primary participants felt that inquiry was supported within CfE, it was acknowledged that the prevailing preoccupation with planning made it more difficult to incorporate than some other CfE strategies, and that the lack of guidelines and examples made it difficult to break away from the security of that structure.

> *I think it's a more active approach which they're always trying to encourage, more active learning, and I think it probably engages the children more if they've came up with the question. I think if it's something that they're asking about then they'll be more interested in it so it'll be more ... like the whole lesson will go better because they're interested in finding out the answer... And I think maybe that... like Curriculum for Excellence is all about, you know, responsive planning and, like, the*

needs and the wants of the child and the interests of the child, but then you still need to get through the curriculum, you still need to teach all your subjects, so I think that kind of makes you think, oh, but we've not planned for it. Like it's not in the planning file, so is it ok? Is it ok to do it because it's not been planned for? (laughing)

(Carol, Primary, T3)

I think it does but there's no framework to show us how to do it. I think the theory and the ideology absolutely reflects that but there has been no teaching and no framework for us to actually build upon that, and I think for teachers that have been very structured that would be an incredibly difficult thing to do.

(Ruth, Primary, T3)

CHAPTER 10 - PROFESSIONAL LEARNING FOR INQUIRY

This chapter examines the data for insights into new teachers' learning for the purpose of developing pupil inquiry. It explores the substance of their cognitive development in terms of acquired knowledge, skills and understanding, as well as how they are learning. It uses Shulman's knowledge categories as an organising model for discussion (see Shulman, 1987) but suggests additional knowledge needed for inquiry not accommodated adequately within these categories.

SHULMAN'S KNOWLEDGE CATEGORIES

- Content Knowledge
- Curriculum Knowledge
- General Pedagogic Knowledge
- Pedagogical Content Knowledge
- Knowledge of Learners and their Characteristics
- Knowledge of Educational Contexts
- Knowledge of Educational Ends, Purposes and Values and their Philosophical and Historical Grounds

ADDITIONAL KNOWLEDGE CATEGORY

- 'Proprietal' Knowledge

Content / Curriculum Knowledge

Essentially this category represents familiarity with the courses - what they are required to teach - and how they fit with the overall scheme of the intended curriculum. Although Shulman itemises Content and Curricular Knowledge separately, for the purpose of this discussion it was difficult to separate these aspects of professional knowledge, firstly because the participants themselves tended to conflate the two, and secondly, because curricular areas are becoming more integrated (with an increasing focus on skills development), and content less discrete.

Four aspects of learning identified within this category were:

1. understanding of science as a discipline, that is, how science is conducted and new knowledge generated;
2. knowledge of specific topics, including basic scientific concepts and theories, current debates and common misconceptions;
3. appreciation of how the content fits with the overall curriculum, both horizontally (links with other curricular areas) and vertically (appropriate level of complexity to foster progression);
4. knowledge of curricular materials and what resources and activities are available and appropriate for different purposes.

Of the primary participants, only one had a science background; in fact, Rebecca had two science qualifications and was keen to promote science learning in the primary curriculum. She was bold enough to venture into areas outwith her comfort zone, taking a practical inquiry approach, and in the process developed both her own science knowledge and her pedagogical confidence and flexibility.

> *For as much as I have a science background, I'm not very good with plant science, I have no idea about it. So basically we've gone to the allotment, we've planted things, we've weeded, we've dug it up. The kids have just got in there and done all that and basically made predictions, what do you think will happen? They've designed an experiment, what does a plant need to grow? ... And things like when it didn't have light but it still grew they were quite surprised, but what they noticed was the colour difference, so that opened up a whole other discussion. And the whole theme, because I didn't know as much... Because I feel sometimes where I fall down is, well I know what I want them to learn, and sometimes I kind of angle the questions in a way that guides them, whereas I was just saying to them, right, just go for it. And it's helped me a lot and I feel like I can let go a wee bit and I'm getting to the stage where I think, this is not bad. Just because I don't know doesn't mean that I can't teach it.*
>
> ***(Rebecca, Primary, T3)***

Having had little experience of science, the other primary participants' understanding of science concepts and the process of scientific inquiry was limited; they acknowledged this deficit and its impact on their capacity for classroom inquiry.

> *One of the things that makes me nervous about teaching science is that I would not know how to explain the small variations... I mean, what if you plant seeds and even within a group of seeds, some of them grow and some of them don't?*
>
> ***(Rose, Primary, T3)***

> *Certainly for inquiry, I think you need to really understand what you're talking about because I think you need to be able to question the children, draw out what they know, so I think for you to be able to do that then you need to really understand the crux of what it is you're talking about. And that makes me nervous. (laughs)*
>
> ***(Carol, Primary, T3)***

> *My own personal knowledge? Having the confidence in the subject that you're teaching, definitely. Because the children ask so many different questions and if you can't answer them then, you know, then you have to go down the, right, let's research it together, and then that takes up time and then the pace of the lesson's lost and... Yeah, if you're up there with the understanding of what you're teaching then it just keeps the learning and pace up.*
>
> ***(Ruth, Primary, T3)***

> *It means something that scares me... It means, like, showing them a picture maybe and asking them why do you think that's happened or maybe just to try a concept cartoon where you're looking more at something and then thinking... which kind of makes me go arrghh...! (laughs) Because I'm scared I can't answer the questions!*
>
> ***(Jill, Primary, FG)***

Nevertheless, references to 'methodology' and 'fair test' (Ruth) and 'the scientific method', 'controlling variables' and 'reliability' (Rose) pointed to at least a rudimentary (if somewhat naïve) understanding of nature of science and an attempt to engage in inquiry and apply scientific principles.

I mean, we did kind of design the experiment on placement about plants growing, and they kind of came up with the thing about controlling variables by themselves. [We] were talking about where shall we put them, and some of them started saying let's put some of them over there and some of them over there, and one of the kids said, no, if we put them in different places then that might have an effect. And I was like, good point, we should probably put them all in the same place, shouldn't we?

(Rose, Primary, T1)

I think sort of making a connection to the scientific method is probably important. Like, there is a way to do scientific... to try to find something out. I think the hardest thing for them is probably actually going to be the questions. How do you ask a question that's small enough that you could test it and get an answer that will tell you... that would be a reliable answer?

(Rose, Primary, T3)

They had to make sure that the ramp was at the same angle for each experiment, they had to use the same car for each experiment... So they were introduced to the idea of a fair test and introduced to the idea of what different things might cause, you know, different outcomes. But then they were just left to get on with it.

(Ruth, Primary, T0)

The focus of the week is not so much the science itself but the methodology and procedure involved in undertaking science experiments. With emphasis (I think at the moment) on a fair test, safety, and documenting results.

(Ruth, Primary, T1 Blog)

In terms of scientific inquiry, the realisation that investigable questions were a necessary starting point became apparent for some.

I'm saying this and I haven't done very much science with them, but I feel like a lot of the questions that they tend to ask would be very difficult for us to investigate, like, to prove in class by doing experiments.

(Rose, Primary, T2)

Maybe just that sometimes you don't always find out the answers right away, and maybe that's something they've got to realise as well... They [the questions] are too wide, like, I don't know, what does a minibeast need to grow? Well, specifically what minibeast, in what country, under what conditions, you know? So there was that as well, that they kind of got that from it too, because then they would say, right... that's too wide, let's think about... So that was quite good as well.

(Jill, Primary, T3)

In terms of the whole curriculum, the transition from 5-14 to Curriculum for Excellence proved challenging for all primary participants; the planning and paperwork were new to all so the amount of support offered was limited. Identification with the aims and philosophies of CfE through active engagement with the Experiences and Outcomes allowed them to make informed pedagogical decisions and source and select appropriate resources to support the learning. This was a necessary part of their professional learning, with the potential to support inquiry and other pupil-centred pedagogies in the future, however, in the early phase this involved a huge time investment and a degree of insecurity in their own interpretation of the Experiences and Outcomes and as such was a major impediment to investigative pedagogy, which was deemed to be more time consuming anyway.

They would need to know what an experiment was like to a certain extent... Like, if I was going to do an investigation with them or we were designing an experiment, we'd spend most of our time talking about an experiment and what it meant and what it was like, and that would be important learning, but that would really be me telling them what it's like.

(Rose, Primary, T1)

I think if I got more into it, it would become less of a concern, if I could incorporate it more. Because I suppose there are times when I do it in Maths, probably kind of sub-consciously, and maybe half way through the lesson I'll think, oh, there's a bit of a wee investigation going on over there. But to actually plan specific investigation lessons, then yeah, time.

(Rebecca, Primary, T2)

Secondary participants all held degrees in a science discipline, however teaching their subject often required a much broader coverage of the discipline than their degree course had prepared them for. Further, all were required to teach the full range of S1/S2 topics, covering all science disciplines (which is, generally speaking, the situation across Scotland). This had major implications for confidence, and consequently learning about the curriculum and understanding course content was a major focus for most in the early stages.

> *But once all that was kind of sorted [orientation], I think our main focus was probably figuring out what we were doing for the Curriculum for Excellence stuff, the new courses... trying to get to grips with what we would actually need to be teaching for Curriculum for Excellence, 1st year.*
>
> ***(Lisa, Biology, T1)***

> *I would say a big focus was on learning the curriculum and how to teach it in an interesting manner.*
>
> ***(Charlie, Physics, T1)***

> *The main thing I was sort of trying to get to grips with was just actually the curriculum content, like the Standard Grade Science.*
>
> ***(Sean, Physics, T1)***

> *Learn the behaviour management system... and just making sure I was clued up on what I was actually having to teach... just kind of keeping up my subject knowledge as we're moving through the year, you know, new topics are coming around so I've got to kind of keep my subject knowledge up to [scratch].*
>
> ***(Donna, Biology, T1)***

> *Some aspects of the course, not too bad. The ones I started with I was fairly confident with but there was just little aspects of the course... you always want to be a few steps ahead of them, so you're trying to maybe learn just above their level just in case they ask you questions.*
>
> ***(Courtney, Physics, T1)***

As this last quote suggests, the level of security in their own knowledge and understanding of the subject matter being taught tended to influence their propensity for inquiry and willingness to follow up on pupils' questions.

> *I'm often teaching out of my speciality, such as the biology one, they were looking into parts of the human body and they were asking questions like, What does the pancreas do? (gestures uncomfortable uncertainty)... You look it up and tell me! (T1) Like a question? Again, it depends on my knowledge of the subject... (T2) I'd need to know what, I suppose, what type of conclusion they might come to or what they're expected to do at the end of an investigation... to produce something. (T3)*
>
> ***(Charlie, Physics, T1/T2/ T3)***

> *On my last placement, the second years were doing a forensic science unit and a lot of the stuff I've either not done or haven't done since I was at school... I think it did impact on like ... because the class teacher said, you don't seem as confident... and I was like, well I'm not as confident with this unit of work. I know that I can't know everything and every school's units are going to be slightly different as well. I have now done most of that unit so I'm more confident about it...* **[whereas] ...** *I had a first year class and I just took them as a one-off... It was a Biology based unit and we were talking about... I was introducing blood in the heart and circulation to them, and that's my speciality... We started a discussion about what they already knew about blood, so we went round the class and we got a really good class discussion going. They were asking me about blood transfusions, transplants... that's stuff I know quite a lot about... then I got them to try and answer each others questions as well. Probably the best class discussion I've ever had with a class. And they seemed to really enjoy it as well because it stemmed from their questions...*
>
> ***(Donna, Biology, T0)***

For many, deliberate learning of subject matter was for the purpose of teaching a particular lesson or topic only, and taking a more pupil-led approach which could potentially stray outwith the scope of these preparations was too risky. However, it was acknowledged that familiarity with the curriculum, including what resources are available, would help beginners to realise more opportunities for inquiry.

...it's understanding and knowing your curriculum structure and content, and understanding... having the time to kind of unpick your experiences and outcomes in the curriculum, and see where you can then put that into an inquiry based lesson. I mean, if it comes out of your class that's fair enough but if you specifically want to do it you really need to know what it could... where it could come from.

(Dee, Chemistry, T2)

What resources are available if you're talking about the practical side of things. Equipment. Resources within the school. So ICT suites or if there's like a laptop bus, that kind of thing.

(Donna, Biology, T3)

Most secondary participants were involved in developing new CfE courses, generally as a department or faculty in co-operation with colleagues, and in so doing developed a strong grasp of the science content and resources at their disposal for teaching those courses, as well as the approaches advocated by CfE.

The 1st year course has been great because that's all the new stuff that we've written over this year anyway... So that's made it very easy because it's stuff I've created and experiments we've got... and a lot more fun. So, because there wasn't too much restraint on that, being able to do lots of things... so when they're doing optics they're making pin-hole cameras, they're making a small film projector, you know, and they're getting things they can take home and that sort of stuff.

(Sean, Physics, T1)

...course development, because we've been involved, heavily involved, in developing the S1 courses and we're starting to work on the S2 courses so that's been really good from the word go, learning how you should develop a course, incorporating in learning outcomes that meet the E's and O's... and assessment as well.

(Courtney, Physics, T2)

General Pedagogical Knowledge

This category encompasses knowledge of classroom management (including planning, differentiation and behaviour management), learning theories and teaching approaches.

Initially the main concern for most participants was taking control of the classroom; organisation, routines and setting expectations. Teaching at this time seemed to be very discipline-centred (in the sense of controlling behaviour) and teacher led, with great emphasis being placed on tight lesson planning, leaving little scope for deviation or pursuing pupils' interests. This lack of flexibility was probably due partly to insecurity about their own subject knowledge and ability to follow up on emerging themes, but it also reflects beginners' general concern over classroom management and the potential for mayhem should pupils not be held rigidly to a plan.

Early on University learning and pre-conceived expectations had to be tempered somewhat through the medium of experience. For instance, in terms of behaviour, idealistic notions of authority and compliance were harshly dispelled as these new teachers began to appreciate what was possible and practical in their classroom.

> *I think my expectations of what I could have achieved as far as them being calm and sedate was, for me, I appreciate that now, was probably too high. And I think now where... Doesn't matter, get something down, get them on task, get them doing something... you will get a percentage that will follow your instructions, and you just concentrate on going round using your positive behaviour management on the rest of them. And the ones you really can't, well you just have to begin disciplinary procedures, and there's not much you can do about it unfortunately. I found that was probably ... that's what I learned.*
>
> ***(John, Physics, T0)***

Although there was a real focus on lesson planning during the ITE course, and participants went into school ready to implement in-depth and fairly rigid lesson plans (a much-needed crutch for some), they soon realised that not only was it unrealistic (you can't plan for all eventualities), but it did not cater to the needs of the class and was not conducive to inquiry either.

Now that I'm in and I'm doing things I feel more like, oh right, this is working a bit better actually, although if anyone asks, I'll say that I am doing that stuff [planning] that they told me. But the kids seem to respond better to it [more free-flowing]...to being questioned and getting them to kind of think more. I mean, some of my lessons haven't really went where I was meaning them to go (laughs), but not in a bad way. Whereas, in uni, it was all like plan, plan, plan... plan every lesson, do your lesson plans, and there wasn't really room for manoeuvre. I know it was just to get us into the way of it and everything, but when I got in, the first few weeks, I mean, things were not going to plan, and I'm going ... (feigns panic) 'Oh my goodness!'... and I was having a flap. And then I was realising, actually, ok, we could take it this way... Right, that's fine.

(Rebecca, Primary, T1)

Early insecurity in dealing with behavioural issues stemmed from a lack of experience to draw on when new challenges were met in the course of teaching, which was often in the early stages. In terms of implementing inquiry this was especially problematic.

Obviously like every new teacher, I do find it quite a challenge to be so unstructured... Letting them free can be a bit nerve wracking. You need to have a lot of knowledge to build on, like other teachers have the knowledge to build on to be able to do it like that (snaps fingers), whereas I still need... Plan A, B, C, D. (laughs)

(Shona, Biology, T1)

There was evidence of experimenting with different classroom management strategies and using that experience to inform future practice. For example, using incentives to promote positive behaviour; structuring the lesson to provide an appropriate level of challenge; and organising resources for ease of access and to minimise disruption and confusion.

My management I really had to work on. Just trying different methods... I've got a jar of marbles which it's supposed to take about 2 weeks to fill it but it's been about 2 months. We've got a rewards corner, so once the marble jar is filled they'll get to do one of these tasks, but it's not happened yet. I've tried recently doing the lollypop sticks with their names, which is good. I've got raffle tickets there that I'm going to try this week, so I'll do a draw every lesson.

(Joanne, Chemistry, T1)

I did that in one of the lessons I did with my 2nd years, [but] it was just too ... It depends how much you structure it. I've learned that with inquiry, you need to structure it depending on the abilities in your class because then it just ends up with them struggling and then leading to behaviour issues because they don't feel like, you know, like they can do it. So they take it as too much of a challenge.

(Shona, Biology, T3)

I tried a practical with them where... we got the idea of parachutes and air resistance again... I was giving them the freedom to go and design their own parachute. And it was a bit chaotic because I'd had too much of the resource up there, and some over there. And then it was suggested that maybe for that class I should make sure everything's ready in trays, so it's ready just for them to take it.

(Joanne, Chemistry, T1)

Some participants had identified specific strategies as useful for maintaining order and authority, including regulating voice for effect and using positive feedback.

One of the things they came up with was I tend to be quite a slow speaker... We were talking about this, about the ideal discipline, like fire fighting... and he was saying about the pace of the voice... So I'll vary my pace now. So it depends, if I'm speaking about some things I'll be quite laid back and other times I'll use the pace of voice just to - tic-tic-tic - and keep them engaged.

(John, Physics, T2)

Also letting them see that they're successful, because a lot of them... Well, you get the less able ones and they probably never hear 'well done' or 'you did that really well', so positive praise helps.

(Charlie, Physics, T3)

Participants recognised that through experience of having met and dealt with different situations, 'things' had become more automatic, and decisions more intuitive. They became better at progressing a lesson through its requisite check points, gauging time allowances, keeping behaviour in check, and monitoring the learning taking place. This led to increased confidence and, for many, teaching became more flexible and there was a growing willingness to take risks.

> *So, as you learn techniques of dealing with kind of harder to deal with children, you do have the confidence of meeting it and having met it before, like you know how to resolve these things and it's not a massive issue... Also, just feeling a lot more confident in actually even just managing a class and not having to do so thorough lesson plans. Like on placements I would spend a lot more time... too much time compared to now where I kind of map out the structure and the main questions, and I've got a lot more confidence that I can make a good lesson out of it, a good discussion, rather than just crashing and burning. (laughs)*
>
> ***(Charlie, Physics, T2)***

> *I've had a couple of really good behaviour-wise lessons with them so that's kind of boosted my confidence... I'm going to do slightly more adventurous things with them.*
>
> ***(Donna, Biology, T2)***

> *I don't probably do as much of it as I would like to but I think it's something that will develop as I get more confident with just knowledge of courses and classroom management, because I think sometimes you focus too much on thinking, if I do this is it going to descend into chaos. But as my confidence in that, and as I get better at managing classes, I think probably it will become easier to do inquiry because you won't always be thinking, is this going to happen, is that going to happen?*
>
> ***(Lisa, Biology, T3)***

For many participants, their capacity to engage pupils in inquiry was limited by their understanding of inquiry as a pedagogical approach. Although participants intuitively knew what ‘inquiry’ was, for many making it happen was problematic, and this was not something which was covered, or even discussed, during ITE. Although it may have been modelled by some university tutors, most participants felt they would have benefited from more explicit coverage of this pedagogical technique, and the opportunity to observe inquiry-oriented lessons in real classrooms.

Clearly it's not something we've learned about this year in our training and so it's something that we need to figure out how to do ourselves, so that's going to be what underpins our ability to do this… It would be helpful to see it I guess. It would be helpful to see somebody trying it, doing some inquiry based [teaching] to see what other peoples' ideas of what it looks like are. I guess I just sort of made up my idea of what it looks like.

(Rose, Primary, T0)

Certainly Courtney appreciated the opportunity to observe and engage in inquiry during student placements; she felt this would help her structure and manage inquiry in her own class.

I think the inquiry approach is excellent but you really need to be on the ball in terms of how you're going to manage it. So although it's not as dictated as maybe experiments would be, you need to really get the management correct. So I think experience of observing teachers and taking lessons myself will have helped me because I'll be able to sort of take a step back but still be in full control and manage it and know what I need to do initially to get the inquiry approach going in the class.

(Courtney, Physics, T0)

As they moved through the year, their understanding of inquiry was shaped to a large extent by their growing familiarity with the curriculum, especially CfE which, most agreed, seemed not only to advocate an inquiry approach but actually provided opportunities to make it happen, inherent in the experiences and outcomes. Being involved in the current study and having the opportunity to discuss and reflect was also influential for some.

Definitely. It's made me think a lot more about ways in which I can introduce inquiry into lessons... and kind of looking for new opportunities to do things... maybe trying to adjust it to get them to find out about it instead.

(Dee, Chemistry, T3)

It's given me the chance to reflect on things... because before I probably hadn't... well, a very fuzzy idea of what it was about. Now I feel a bit more... [knowledgeable /confident?]

(Shona, Biology, T3)

Well, now I know what inquiry means. (laughs) Yeah, I think it has. It's certainly made me think about things that I should incorporate.

(Charlie, Physics, T3)

Another powerful theme associated with CfE was collaborative (co-operative) learning. This was a major initiative in most schools and CPD in this area helped some participants conceptualise and implement learning structures conducive to inquiry; for example, ideas for grouping, activities for eliciting and sharing prior learning, strategies for developing interpersonal skills and fostering responsibility and independence. For some, however, although identified as a learning need, for economic reasons this CPD was not offered. Nevertheless, participants came to appreciate that learning was better when the learners were actively involved, or even steering the process, rather than just passively listening.

I've learned that the best approach is to get the kids to do it. Because I've seen teachers that don't, that prefer to stand up at the front and just talk for the hour or whatever it is, and you're not only watching the teacher but I'm watching the rest of the class and they're just like ... (gestures boredom and indifference)... **[Whereas]*...*** *I would get them to do it and they were just definitely more involved in it... Even just like research projects, like the kids loved getting the netbooks out and doing the research themselves and finding things and going on Google and seeing what they could find and then asking, is this relevant? They loved doing that, whereas if you just stand and tell them, they do tend to drift and it doesn't go in as much.*

(Dee, Chemistry, T0)

I mean, some of my lessons haven't really went where I was meaning them to go (laughs), but not in a bad way... And if the kids are the ones that take it down that track, they're taking it that way because they're interested in it. If they're interested they're going to learn more, they're going to take more responsibility for it.

(Rebecca, Primary, T1)

Indeed, many found that using an inquiry approach also had the potential to improve behaviour through its impact on engagement.

Well no, I've found that's changed. I mean, if you can't manage the class you just don't do it, but if you're doing an inquiry or an investigation or something like that, the kids are more likely to behave for you. So I don't think it's so much of an issue.

(Dee, Chemistry, T1)

I would certainly say there was a marked response from some of the less engaged pupils who, to be fair, maybe shouldn't have been put in Physics to begin with… But certainly they were a wee bit more engaged, without a doubt.

(John, Physics, T2)

Pupils and behaviour, I think it often improves it... a total improvement in engagement, definitely...

(Douglas, Chemistry, T3)

Finally, in terms of general pedagogical knowledge to support inquiry, most participants came to appreciate the importance of pupils' prior knowledge, both as a basis for asking questions, and as a framework for contextualising new learning. This called for more dialectic (as opposed to didactic) methods being employed to elicit and build on pupils' current understanding.

But today we were looking at prisms and I was using a wee laser pointer... Right ok, this is a denser material, what do you think is going to happen when I shine this through? ...I'm not saying I would have did that even when I started all the time, but as you learn... I suppose sometimes you fall into the trap where you tell them ... (laughs) ... you know what I mean, and you want to get away from that.

(John, Physics, T1)

They need to know a little bit before they can make up questions, because otherwise they just can't think of anything to ask. I guess I've learned that... So I would say that probably the best time to ask kids for questions is actually not at the beginning of the unit... I would maybe make up a bunch of introductory stuff to do that wasn't really inquiry-based, and then after they've gotten a taste of it and now they've got a bunch of questions, then maybe I would start doing... [inquiry?]

(Rose, Primary, T3)

Pedagogical Content Knowledge

Developing PCK involves selecting effective teaching strategies in order to transform teachers' own knowledge and understanding of the subject matter into forms that can be understood by the learners and thus requires not only a thorough understanding of the subject matter itself but also a repertoire of methods and ideas to select from to teach that subject matter depending on the group of learners concerned. It is often conceptualised as the intersection of content knowledge, curricular knowledge and knowledge of general pedagogy, but as Courtney suggests, knowledge of pupils may be a crucial element.

> *Finding out would they enjoy it or what you would need to do to get them to be more confident with that type of approach. Some of them might naturally be like a duck to water with, you know, setting them tasks where they have to go and find out more themselves. Others you might have to develop skills in them, like research skills, skills at being practical. It depends. Just getting to know the pupils I think would be the first thing.*
>
> ***(Courtney, Physics, T3)***

To begin with PCK was typically lacking in these new teachers, discipline specialists included. Even among those with a solid understanding of the subject matter and creative ideas for teaching it, their PCK was limited by their lack of experience of teaching it in their particular school context.

> *Because I think, yeah, definitely some of these things were working very, very well in one context [class] and quite different in another one.*
>
> ***(Sean, Physics, T0)***

In the early stages many participants sought ideas and advice from others, typically departmental colleagues who not only had a good grasp of the subject but quite often had knowledge of the pupils and would therefore have a good sense of what would work and what wouldn't.

> *I'm not familiar with the experiments and things, I want to know what's there and how to get the best out of things. Sometimes I'll alter stuff, I'll alter what's there to maybe suit a particular lesson or something, a learning outcome, something I want*

to get across, and I found especially the technicians really invaluable and helpful to actually do that… (FG)

I think it's the skills side of things so I'll tend to... because it's physics I'll watch another physics teacher, I'll have a wee look at other teachers and sort of talk to them. (T1)

(John, Physics, FG/T1)

I think, future learning, probably just learning for myself and experiencing it and trying it. Also maybe having someone experienced in teaching it kind of talking you through how it works and the potential pit falls and what you should do. (T0)

The meetings I have with my mentor, I see him twice a week... [If] I think maybe a lessons a bit dry, a bit sparse, he'll show me how to ... little tricks that he knows how to make it more exciting. (T1)

(Charlie, Physics, T0/T1)

However, their own PCK was to develop over time and with experience of teaching different topics and working with a range of pupils; for example, understanding their abilities, learning styles and how they approach different tasks, and identifying problematic areas including misconceptions would make them more confident and better prepare them for teaching that subject matter in future.

It was really good for me to see how they think when it comes to investigations and the things that they find tricky and the things that they do really well and the bits that they enjoy. And their understanding of how things are worded in particular stood out for me, you know. A lot of them when it said 'draw a conclusion' actually thought that meant draw a picture... So for me it was a really good experience.

(Courtney, Physics, T0)

I think experience of having a go at actually using this approach. So practice, like everything I suppose, because the more you have a go the more, I suppose, you can gauge this worked, this didn't work, things like that.

(Shona, Biology, T0)

Learning? This term? Again course content, I've been focusing quite a lot on that.... Becoming more familiar with the curricular content will make me confident, even for next year, that I've gone through it all before, I've seen problematic areas, things I would change.

(Charlie, Physics, T3)

An important awareness in some was that sometimes adopting an inquiry approach and letting the pupils discover and arrive at new knowledge for themselves was potentially the best strategy for fulfilling a particular learning intention (for example, a concept, process or skill). In that way, using the platform of their own understanding as a starting point to ask questions, pupils could explore and experiment, observe and analyse, interpret and explain, and thereby arrive at new or more sophisticated understanding which was more 'connected' and would allow them to make logical generalisations or reliable predictions, or simply reinforce important science process skills and attitudes.

You could have blabbed to them, but without showing them or letting them touch things and see things it's not as memorable… I think you always need to encourage them to think about things. If they don't think about things it's not going to go in and they're not going to make any connections with it.

(John, Physics, T1)

I do get a little bit of time to do some project work with my S1/S2s, and the way it's been presented to me is tightly focused projects and you hand the projects out to the kids and they do them. Whereas I've not done it like that, I've been a naughty boy; I've let them develop their own questions and then they can take that wherever they want. And there's no question the kids get engaged in that, you know.

(Douglas, Chemistry, T3)

For some, even having this awareness was not enough; there was also the issue of being able to recognise and seize such opportunities in the course of teaching.

Yeah, more time or enough skill, I think, in being able to react quickly, to be able to see the opportunities. And I don't know whether that just comes with experience or whether that's something you can teach yourself to do. I kind of think about it a few days later and think, that would be really good... and the moment is lost.

(Ruth, Primary, T3)

One of the teachers in [placement school], he always turned around whatever the practical was and kind of gave the ownership to the kids, getting them to design the experiment... even though you already had his design there, but then they felt like they'd designed it, the experiment, which was good. I wish I could do that... Sitting chatting about it now... I don't know why it just doesn't even pop into my head.

(Joanne, Chemistry, T3)

I think it's just making sure that I've got my ear open for it, because sometimes you're just like, there's 20 people with their hand up wanting to ask me a question, which can happen sometimes. So it's like, making sure I've got my ear out and saying, right, that's a good question, what we'll do is I'll write it down and we'll try and come back to it at some point ... Yeah, and try and make sure that I do.

(Dee, Chemistry, T3)

But hopefully as we move through I'll be able to see opportunities where I can say well, we could do this as a more inquiry based one.

(Donna, Biology, T3)

If knowing how to teach particular topics was dependent on having an understanding of that topic, then understandably primary teachers felt particularly insecure in this regard.

One of the topics that the specialist taught was Sun, Moon and Stars and, I mean, I just couldn't have taught that, I have no idea about that kind of thing. And when I went in and he was doing all this like floating round the room as the sun, I was just like ... argh ... I would have no idea how to teach it.

(Carol, Primary, T3)

This situation was not helped by the lack of science content in the ITE course, and the lack of opportunity to observe science lessons in school during student placements. Carol did observe a science lesson and Rebecca attended a practical science course and both felt they had gained from the experience, but participants were generally quite dissatisfied with the lack of priority given to science in the primary curriculum.

...obviously watching any other teachers, like in time out of class it would be good to watch... Like, if I could still sit and watch [teacher] do her science lessons, because I just think the way she did it was so clear and consistent and the children got it and it was a nice pace for them and it wasn't too much. But definitely, observation and any CPD that I could do would be good.

(Carol, Primary, T0)

We were taking wee coloured beads out into the sun, UV beads, and then discussing, oh why does that happen? And then leading on to the effect that the sun has on our skin, which is really simple but genius. So things like that kind of remind me to keep it simple and interesting, and start off with something like that, like a wee bead that changes colour. I really enjoyed that course and it kind of got me back into thinking, actually maybe I could do this in class...

(Rebecca, Primary, T0)

Ruth experimented with her own ideas but, acknowledging her inexperience and lack of familiarity with curriculum and supporting materials and resources, was concerned that there may be better ways of getting a point across than the approach she'd chosen to take.

I come up with an idea, I implement the lesson but at the back of my mind I'm thinking is there another way of doing it that could be so much better and the children would learn a lot more. Because of my lack of experience in it I think, you know, is there something else I could be doing here? Is this quite lame?

(Ruth, Primary, T0)

Knowledge of Learners and their Characteristics

This category includes knowledge of individual pupils' abilities and learning styles, likes and dislikes, interests and motivations, as well as whole class dynamic and styles of interaction. It also includes an awareness of how teachers' own behaviour in the classroom can affect behaviour and learning.

Participants learned very early on (during ITE) that different approaches were needed with different classes; what works well in one context may not work in another.

I did one into probability, when they were throwing dice and trying to find out the most common combinations... And that worked really well with one class, and I thought that was quite good because they were all doing it and they were finding things out, and then I did it with another class and it was a disaster.

(Lisa, Biology, T0)

Even understanding learners' demeanour at different times of the day, week and year, as well as how they behave coming from different classes was important for making pedagogical decisions!

I suppose there are a few aspects. How kids are reacting, so sometimes you get them and they're fine and then other times you get them they're just mental, and it's so much more tiring if they're fighting against you, obviously. Last period they're a bit mental. First period they're nice and tired but you won't get any reaction out of them. And it seems to be when they've come from certain classes, so either where it's been a really strict regime and now they're in the next lesson they're like, oh, we can talk a little bit again... or they've been in a mental class, like drama, where they've been rolling about the floor or whatever and... acht.

(Charlie, Physics, T2)

I get them Tuesday period 5 and I get them Thursday and Friday period 2; Thursday/Friday period 2 they're angels [but] Tuesday period 5 they're a nightmare... It always affects what I plan for them... It affects how I lay my room out... everything... I know that's to do with... it's not just with that class, it's with other classes, it's acknowledging that you need to assess your classes - when you get them, who sits with who, that's all to do with professional development.

(Dee, Chemistry, T2)

In terms of inquiry, experience on placement taught them that using a more open, pupil-centred approach required an adequate level of control and classroom management, and that that in turn depended on 'knowing the kids'.

I think you'd have to have the confidence in knowing that you know your pupils would... you could trust them to work properly in that environment. Some classes you would have kids that would just completely run riot. But I guess that comes *down to your classroom management, you need to know your kids and know you can manage them adequately and safely before you allow them that freedom.*

(Joanne, Chemistry, T0)

I think probably with him, knowing... was it because I put him in a group with someone that he shouldn't have been in a group with? Yeah, so knowing the background to how they work together... that probably would have been a knowledge thing... Sometimes you just can't put people ... they just can't work.

(Shona, Biology, T0)

Upon overtaking the role of class teacher with full responsibility for classes, the idiosyncratic nature of classes became increasingly apparent and the relationship between classroom management, pedagogical decisions and knowledge of pupils even more pronounced.

The classes are so different, I didn't really appreciate this. You kind of are completely different with different classes and different rules apply. Like, for example, that 2nd year class, it works really well having the pupils who need a lot of support together, when in other classes I've found that, no, it's good to have them spread out. So it's just kind of learning your classes, learning what works... seating plans, learning who you should put with who... The other issue I was going to say ... with discussion, quite often classes are not mature and responsible enough to take part in discussion. I find that a real issue with some of my classes.

(Courtney, Physics, T1)

There's definitely an amount of trust you're putting onto the kids to have a certain responsibility to get on with their own work. Some kids take it as a kind of cue to just have a chat and have a good wander around.

(Charlie, Physics, T1)

The 'structuring' dilemma which coloured early discussions on inquiry seemed to derive from the issue of differentiation. Before participants began teaching proper they had little experience or expectation of the range of abilities in a classroom and so they struggled to contemplate how they might structure an inquiry episode (or any activity for that matter).

However, once they got into class and got to know the children and their interests and abilities and so forth, they began to intuit how to structure lessons for their pupils.

> *Yeah, because everybody's different and different classes have different abilities. I've got one class who are, you know, very bright and they know an awful lot more than my other classes so we tend to go into things in a lot more detail with that class. The other class we're just kind of getting through the work and making sure they've got the basics in place.*
>
> ***(Donna, Biology, T1)***

> *I feel some of them need that... not spoon-fed but, you know, some of them in the class are more able to find their way round things and get information out, interesting facts, and other ones definitely need more help with it.*
>
> ***(Jill, Primary, T1)***

> *Some of them are very good if you just say like 'what do you think will happen?' 'what would you do next?' ... Other people in the class need much more, 'do you think this would happen?' and giving them actual scenarios to draw from.*
>
> ***(Rebecca, Primary, T1)***

The following quotes from Rose show learning in the sense that, before experimenting with inquiry for herself she was of the mind that this type of approach could be easily implemented at any level (T0); however, we then get the sense of her struggling with her P2/3/4 class in terms of ability, motivation and management (T1). Knowledge of pupils, it seems, underpins this approach more than she initially appreciated.

> *I think you could do it pretty much with any level. You'd just be at a higher... a deeper level of inquiry I think if you were at... like upper primary. And if it's coming from the kids anyway then you'll get from them where they are. If an inquiry based approach is about children asking questions and then figuring out how to answer those questions, then the questions are going to be naturally suited to their level…*
>
> ***(Rose, Primary, T0)***

> *I tried to do a lesson on good scientific questions but I felt that I was really struggling… They're used to teachers asking them questions and them answering*

questions... and we tried to come with questions that you could ask about an animal to find out what they were like, and that was very difficult for them, to come up with questions... I gave them computers in pairs and had them try to find more things out on the internet. This was probably a stupid idea, given that the P2s can't really read, and were super dependent on the P4s to share information with them.

(Rose, Primary, T1)

At the end of Term 2, when asked to describe their teaching style (in terms of authority, flexibility and instruction) and what they might typically do in a given situation, a common response was 'It depends ...' and this was elaborated in terms of classes and pupils. This reinforces the importance of knowing classes (individuals and collectively) for making organisational and pedagogical decisions and also illustrates participants' growing awareness of this.

Douglas provided an interesting perspective on his perceived development as a teacher in which getting to know his pupils was central: in the early stages he was getting to grips with the subject matter and in particular how he would teach it (egocentric), then progressed to teaching the class in terms of managing an 'organic whole', then to teaching pupils as individuals, which ultimately was his idea of developing professionalism.

I think there's quite a big transition from Jordanhill to probably a period just after Christmas in your probationary year. I mean, I can remember being on placement and just fighting to get to grips with the subject and what you were going to say next, and I think you progress through your placements to teaching a class. But I think the big progression is you start to identify with individual pupils and their learning needs and you start teaching individuals. You start treating your class of 20 kids as 20 individuals, each of whom have their own learning requirements and I think that's the big transition you make professionally to a teacher.

(Douglas, Chemistry, T2)

At the end of the year, participants were asked to consider what knowledge would help them implement inquiry in the future. Reflecting on their induction experience typical responses included pupils' abilities, maturity, interests and style of learning and classroom interaction; in other words, knowledge of and familiarity with pupils/classes was key. It would be difficult to structure a lesson, plan an investigation or 'make inquiry happen' unless you know your class.

> *I think you need to get to know your kids really as quickly as you possibly can. You need to know their strengths, their weaknesses. You need to know how they behave in different situations, how they react to different situations, who they team up well with for co-operative work, all that kind of stuff.*
>
> ***(Douglas, Chemistry, T3)***

> *And then also gauging the pupils, just how well they would respond to being given a research task or a practical experiment, or just given, you know, very little information... Whether they're going to respond to it well or whether they're just going to treat it as a bit of a skive, you know, a bit of a time to cause chaos. In some places, I know from experience, you've got to have structure, like serious structure to the lessons. You give them any kind of freedom and they're swinging from the lights. So I think it just depends on all that.*
>
> ***(Donna, Biology, T3)***

> *The pupils. How the pupils behave, who they work well with. Their ability as well, particularly if you wanted to do, say, mixed groups to see who could support each other.*
>
> ***(Shona, Biology, T3)***

> *I think it is a class based thing. You identify the individuals that can do things and who can't do things, you know, who will flourish doing an activity and those that wouldn't, and that is a group of children that, you know, they might be different in different situations... I think if the children were slightly older and a bit more independent it would happen a lot more. Not necessarily good questions because the Primary 1s can ask, you know, spectacular questions, but just the independence they need to be able to go and find out for themselves.*
>
> ***(Ruth, Primary, T3)***

> *You'd need to know about your kind of differentiation, learning needs, you know, issues with classes, if there's going to be something that's just going to wind them*

up because it'll be doing something new. If it's a class, like an Int 1 class, who you literally have to tie to the chair, then doing... If it's engaging them then, yeah, it's worth it, but you need to kind of weigh up the risks against the kind of benefits.

(Dee, Chemistry, T3)

I think I would want to have a few weeks getting to know my classes first of all before I maybe did anything, just for practical reasons. Just knowing them, knowing a bit about their abilities. If it's group work as well knowing how to arrange the groups. I'd be looking to do it [inquiry] as soon as possible but once I knew all the names and a rough idea of their abilities.

(Lisa, Biology, T3)

What motivates them... And trying to keep in mind what they like to do and what they're interested in... And also it's a lot dependent on the age you've got too. In P4 they were at the right age to take up that independence themselves, maybe further down the school it maybe wouldn't have been quite the same.

(Jill, Primary, T3)

Courtney and Sean recognised the importance of building rapport with pupils and classes in order to establish an ethos conducive to open discussion and inquiry.

I think to establish a good rapport with the classes because for good discussion, good question and answer sessions they have to feel confident and comfortable with speaking out in class to me and in their class as well. So getting to know one another, and that they get to know one another as well, so that there's that kind of comfortable ... there's that ethos of discussion and question and answering and exploring together. That's probably one of the main things.

(Courtney, Physics, T3)

It hinges very heavily on whether they actually like you sort of thing to some extent, you know, are willing to actually listen to you. I mean, because if I come in there and do these sorts of things, it would be very easy for it to go into total chaos. They could easily jump up, pop the bubbles, you know, and then start swearing and tell me where to go, you know.

Professional Learning

(Sean, Physics, T3)

It would seem that knowing your class(es), both individually and collectively, is central to classroom practice. It is important for the purpose of classroom management (particularly maintaining order), for providing an appropriate balance of structure and challenge, and for appealing to the interests and motivations of pupils and thereby maximising engagement, all of which are crucial aspects of implementing an inquiry based pedagogy.

Knowledge of Educational Contexts

This category involves an understanding of how institutional contexts (such as teaching culture and style of governance) and socio-cultural influences (such as character of the local community) affect teaching and learning, as well as an appreciation that what is appropriate or valued in one school may not be acceptable in another. Gaining knowledge of this type was probably participants' biggest priority for learning going into their respective induction schools (and similarly for moving on after induction year) in order that they could fit in with existing structures and systems. This involved getting familiar with different policies, admin and procedures, learning about relational and communication hierarchies, learning about timeframes and deadlines, unpicking values and agendas – generally just understanding what was expected of them, both in and out of the classroom.

> *What I want to learn about when I first go in is... learn about the school, what the school's policies are, behaviour and discipline policies, what their Curriculum for Excellence kind of goals are as well, so what they want to do, how they do things differently to what I've done before, because I've been in two really, really different schools. I've been in a private school and… quite a run down school, so it was all really different. So it's kind of finding out where they lie on the spectrum that I've seen with regards to kind of reporting, teaching, discipline and stuff like that.*
>
> ***(Dee, Chemistry, FG)***

> *I suppose just the general politics, for want of a better word, of how things run in the department really so you sort of fit in with it; things like using technicians and other stuff like that really.*
>
> ***(John, Physics, T1)***

Sometimes these aspects of learning were explicit and intentional; at other times they involved learning through experience and from mistakes.

> *For example, displays have been a topic of contention for me, and the Head Teacher called me in first term and he said, 'I'm disappointed in you. Everybody here knows how important displays are to me.' ... I didn't realise that... I don't know, it took me by surprise, it was on the pretext of something else and I didn't realise that that was going to come up... But, you know, if displays are important to him they have to be important to us.*
>
> ***(Rose, Primary, T1)***

> *So the first one basically has an exit card which allows them just to leave the classroom at any time at all and so that's thoroughly abused because she sort of walks out, has a chat and all that sort of stuff. I impeded that for the first two or three weeks, I had her sitting down in the class and everything and then I got a polite letter saying, no, she should get allowed to wander around...*
>
> ***(Sean, Physics, T1)***

Knowledge of this basic type seemed crucial for these new teachers' growing confidence and developing a sense of affiliation with colleagues, but importantly from an inquiry point of view, it had the potential to influence their propensity for innovation and risk-taking in the classroom.

> *I think one of the other classes did it so I should've just done it, I just didn't feel confident about it. I don't know, maybe confidence is a problem. I feel like there are procedures that I'm supposed to know how they work and I don't really know how they work... I just don't feel confident about anything I'm doing anymore.*
>
> ***(Rose, Primary, T1)***

Understanding the general aims and values of the school was also important for making pedagogical decisions; was there a prevailing examination agenda or emphasis on wider achievement?; was the school embracing CfE or merely paying lip service?; was there a general ethos of innovation and pupil-centred learning or an assumption of traditional instruction?; was the teaching culture one of autonomy or conformity? Whatever the politics, it was important that participants grasped these in order to meet the expectations of colleagues and managers, even if they did not share their values. After all, the main concern at this time in their career was ‘passing probation’ and becoming fully qualified.

> *School/Department Politics, especially as a new teacher, you don’t want to do something that other teachers are not happy with. Even if you think they’re wrong, you’re not going to... I’m not the type to go and step on someone’s toes... I’d want to fit in.*
>
> ***(Courtney, Physics, T0)***

An early learning goal for many, and one which would ultimately shape classroom practice, was gauging how much autonomy they were allowed in the classroom.

> *I think your next hurdle would be the actual politics within the department, how much freedom you were going to be allowed and the opinion of the investigative pedagogy. You know, you don’t want to stick your head above the water.*
>
> ***(Joanne, Chemistry, T0)***

> *I guess for me it’s figuring out how radical they’re going to let me be with what I’m doing in classes.*
>
> ***(Rose, Primary, T0)***

From Douglas’ point of view, he failed to grasp just what his supervisor’s expectations of him were in terms of classroom practice and was severely reprimanded as a result.

> *Em ... a very prescriptive way of working in here. Oh, incredible. No deviation off the course what so ever... I've been pulled back formally; I've been in a bit of trouble actually, to absolutely stick verbatim with the prescribed courses.*
>
> ***(Douglas, Chemistry, T1)***

In terms of pedagogy it meant learning what was valued; which approaches were being pushed and where did inquiry practice – or their conceptualisation of inquiry practice – sit in relation to the agendas of the school generally, and other staff specifically?

> *I think it’s really dependent on the school and how much emphasis they’re willing to give to science in the timetabling even.*
>
> ***(Carol, Primary, T0)***

The head teacher, the deputy or whoever, some will be all for lessons like this and other places are really, really structured. It does depend a lot on the management whether they'll allow it to happen or not.

(Rebecca, Primary, T0)

I could foresee that there would be quite a lot of resistance to want to do something that was outside their vision or what their plan was... I see that as being potentially one of the biggest barriers to doing these things, possibly. If you want to try something new, if they're not doing it already, I think it would be difficult...

(John, Physics, T0)

And this [inquiry], quite frankly, gets you shot most of the time if you're trying to get those tasks done because they're time consuming, they're much more risky... Yes, it may benefit the kids long term but, like my HMI report here for this school was, unless they get a 15% increase in the Higher results they're getting inspected again.

(Sean, Physics, T2)

Most secondary teachers perceived a difference in expectations for teaching and learning in the upper school compared to the lower school, with much more scope to experiment with inquiry in S1 (and sometimes S2 depending on how progressed individual schools were in CfE uptake) and 'teaching to the test' in certificated classes.

I tend to do it with 1st and 2nd year this year, just because they're not working towards end of topic tests by certain dates. It'll probably be the same next year actually, but then once Standard Grades are done away with and we're looking at Curriculum for Excellence further up the school, I would, provided my department were happy, happily do it with all year groups.

(Lisa, Biology, T3)

A major learning point for all primary participants was the expectation of detailed planning, with an emphasis on the core areas, maths and language; although other curricular areas were expected to be covered, it was felt there was little time to do them justice. Also, most appreciated that the level of planning expected was counter to inquiry in many ways.

There's not a lot of time to get everything you plan in, or everything that you're supposed to plan in, and then let them kind of explore it a wee bit.

(Rebecca, Primary, T1)

I haven't done very much really, inquiry-based stuff. Everything has to be planned out ahead of time, that may be part of the thing. I could plan a time when we're going to investigate this but you have to say what they're going to learn ahead of time, you have to know what they're going to learn out of the things that we're going to do ...

(Rose, Primary, T1)

I don't have enough time to do exactly what I want because there's so much to put in. I mean, you could make a whole day out of inquiry lessons and the children would get so much out of it but you can't feasibly do that... There is definitely a compromise... I actually find that time, you know, plays that card.

(Ruth, Primary, T2)

In terms of socio-cultural influences, participants came to appreciate that the location of the school itself had a bearing on what was possible pedagogically as the character of the surrounding community tended to colour pupils' mindsets and expectations. From the language and tone of the following responses one gets a sense of disappointment in the lack of intrinsic motivation in some pupils.

I think it's good to be a wee bit idealistic... but I think certainly reality has kicked in a wee bit with some of the pupils and things like that, and it's not so much what I expected of them but their expectations and their sort of... I suppose you think before you get out among things too much, you think everybody thinks like you really, don't you? And they don't. I still try to gee them on, like, but if anything, that disappoints me a wee bit.

(John, Physics, T1)

...with certain pupils, and quite a few of them ... they were asking 'When's the test?' Well there isn't actually a test, we're just going to be like producing our work at the end. And that equated for some of them that, I'm not going to bother, like, this isn't

important, because I think there is kind of a culture now where it's test, test, test... Very level driven! Yeah, because there's a desirability for, I would say, all parents in [area] to get their child here... I think they think it's like a private education at a state school and it's not... And there is a lot of pressure from parents I would say at this school, more so than other schools I've been at, for them to achieve...

(Charlie, Physics, T1)

I do think it's modern kids as well, you've got a very wide ability range anyway, but the ability range has got nothing to do with your approach - this is what I've discovered - to science, to learning actually. I've got some very low ability learners who have got a fantastic attitude... Then, in my 4th year chemistry class I've got three exceptionally bright girls, they all get over 90% in end of topic tests... Great, they're obviously all going to get 1's, da-de-dah. None of them are interested in science, they just want to tick a box to get into medicine or veterinary medicine or dentistry... They're not interested in the acquisition of the knowledge for its own sake, none of them are. That I think is sad.

(Douglas, Chemistry, T1)

Looking ahead to his next teaching position, Sean recognizes that his next school is demographically quite different to his induction school and acknowledges that pre-existing attitudes and expectations of pupils are likely to have a bearing on his classroom practice, including pedagogical approaches.

I need to get a real idea of just how their pupils actually respond and stuff. It's a different dynamic, different demographic of kids altogether. A lot of the stuff I was doing was for fairly well mannered, polite kids, you know. This school is a lot rougher, I need to sort of get an idea of what would actually float, you know, in that sort of environment.

(Sean, Physics, T3)

Knowledge of Educational Ends, Purposes and Values (and Philosophical and Historical Issues)

When asked individually before beginning their induction year, all agreed in principle with an inquiry approach, and further were able to justify their advocacy in terms of authenticity, scientific literacy or its impact on learning. Mostly this advocacy was on a philosophical level, but some were also able to draw on experience for justification.

> *Like for me it's really important to teach that there are ways that we know how to find things out... how to figure things out about the world. And the fact that reason and, you know, human curiosity are really important in science... it's about reasoning and using our brains and, like, we can figure things out.*
>
> ***(Rose, Primary, T0)***

> *Because it's more inquiry based for the children, it's more likely to provide an interest for them and allow them to investigate it and kind of discover for themselves, kind of like trial and error, which in science I think is a good thing. In a lot of things it's a good thing.*
>
> ***(Rebecca, Primary, T0)***

> *I think just basically that's the only way you do learn, by actually inquiring to what bits and pieces are and stuff, to your own interest. Otherwise all you're doing is sort of memorising something momentarily and then you're going to forget it because it has no relevance to you.*
>
> ***(Sean, Physics, T0)***

> *They had to go out and they had to look at things, you couldn't have just done it by showing them pictures. They had to feel it, touch it... they had to experience that much more than just looking at pictures in a book... Because I think it's good for them to investigate it and try and find it out themselves. And to ask questions, just to try and, you know, have some ownership of how it could go.*
>
> ***(Jill, Primary, T0)***

I think there was [good learning], because instead of just kind of hearing about the different techniques, they were applying it to achieve an outcome and I could see how, having done that, having a bit of control over it, that they could kind of link that to real world processes.

(Charlie, Physics, T0)

I think the learning was effective because they developed the methodology themselves. I think it gave them a kind of perspective on, not necessarily the topic, like Biology itself, but the actual process of investigation, the process of like practical work and how to write up a report kind of thing... When people learn things for themselves by doing it themselves, they tend to retain more information as opposed to just being told something and saying that's fact. If they can see it for themselves and discover it for themselves then they'll be more likely to remember, more likely to learn.

(Dee, Chemistry, T0)

This pedagogy would seem to satisfy the purpose and aims of science education which, for 17/18 participants, was the development of practical knowledge (which has application in the real world) and transferable skills, including critical thinking, problem solving and inter-personal skills.

I think it probably encourages a kind of more logical way of thinking. I don't know, just to let them be able to change a fuse and do things like that... and understand the world around them and the environment and the way they live... and how their bodies work.

(Carol, Primary, T0)

I think it's really important for everyday life... science comes into so many different things... how their TV works, you know, just how anything works in their house and stuff. Like in biology, how the human body works, you know, keeping yourself fit and healthy, there's a lot of science comes into that...You need it for almost anything... at least a basic sort of knowledge in science so you can understand the goings on of life.

(Donna, Biology, T0)

Especially at the secondary level, there was a growing awareness of the range of school leaver destinations; that not every pupil will go on to study science at a higher level, and few will take up careers in science. Consequently there was a focus on science for living and science for citizenship.

> *... first of all to have a scientifically literate population, even if you're not taking that further than standard grade, so that people can read and understand the political implications of science, which are going to be major... well, they already have been major. I mean, if you don't understand science you can't understand the world around you. I mean, just out of sheer curiosity...*
>
> ***(Douglas, Chemistry, T0)***

> *I think to inspire the next generation to be... you know, to get them thinking about science because everything, you know, everything surrounding us is... chemistry and science. And just to get them to have the problem solving skills that you develop through science which they can apply, if they don't then go on in science, to use in other aspects of life.*
>
> ***(Joanne, Chemistry, T0)***

> *I think science education is for developing scientific thought in the students, which is important for the country really, and future industry and development. Also I think it's a good way... well, it's important to give the student the tools to understand world issues which are kind of increasingly becoming more... renewable energies and what naught. If you understand the science you've more chance of having a kind of rational view to it rather than just kind of the media spoon fed sort of thing.*
>
> ***(Charlie, Physics, T0)***

For many, involvement in CfE course development called for active engagement with published curricular materials (including *Experiences and Outcomes* and *Principles and Practice*). This fostered identification with the aims and philosophies of CfE which encouraged more pupil-centred, inquiry-oriented, active and collaborative learning.

'Proprietal' Knowledge

Based on student placement experience, the priority for many on taking up their induction post was 'fitting in' and meeting expectations. As discussed earlier in '*Knowledge of Educational Contexts*', this involved becoming familiar with policies and procedures, learning about systems and timeframes, and unpicking values and agendas; but it was apparent that 'fitting in' was also dependent on developing informal knowledge of a proprietary nature, or 'proprietal' knowledge.

Examples of this type of knowledge may include what you can and cannot do, or can and cannot say; who to approach for different things; when to seek permission and of whom (eg. taking pupils outside); protocols for borrowing books/equipment, booking rooms or using/copying resources from a shared drive; requisition procedures including obtaining classroom stock; expected conduct at meetings; when it is acceptable/unacceptable to interrupt a lesson; knowing where to sit in the staffroom (among others). This is not the type of knowledge which is generally volunteered by mentors/colleagues but is acquired through experience and trying not to step on toes along the way. It may often be assumed knowledge or knowledge so implicit (tacit) to more experienced teachers that they may not think to tell.

> *But do you not find you're holding your own opinions back quite a lot to let them all sort of interject everything for quite a while... because I was amazed that if you even said vaguely 'Curriculum for Excellence' you could generate a small argument around the whole room there. And they were all telling endless stories, and if you interjected too strongly or laughed in the wrong place that put you into a huge scope of problems.*
>
> ***(Sean, Physics, FG)***

> *I was going to say, who to pay the tea and coffee money to.*
>
> ***(Ruth, Primary, FG)***

> *… finding your way in the staffroom.*
>
> ***(Carol, Primary, FG)***

And routines as well; what the children... what's expected from them. Are they expected to finish five minutes early to get ready for lunch bell or are they expected to work right up to the end. There's some schools that almost frowned on you if you started packing up ten to because you think, I've got to get them organised, and then there's other schools that I've been to where, fifteen minutes before the end of the lesson, they're like, right, 'pack up now', it's fine, we'll get you ready before we go, and it's all a bit more relaxed. So it's kind of knowing your boundaries.

(Ruth, Primary, FG)

I'm working with one of the new principal teachers at the moment to kind of make a NQT Handbook for next year, and I think that would be really useful if it was just laid out in a way that was like, this is what's expected of you... Because the Depute said, you know, you kind of want to just say... and obviously she's seen somebody doing this ... I don't want to see people running down the corridor with a cup of coffee after the bell's went. And you're like, obviously (laughs); you should be bringing in your class. And she's like, but these are the kinds of things that you need to say but you can't put it down in black and white...

(Carol, Primary, T2)

It's kind of knowing that you can ask other people but not wanting to offend the teacher of the class.

(Joanne, Chemistry, FG)

There's just lots of rules that are not, like, explicit. Like ... It's like explicit expressed rules and then unwritten rules, there's lots and lots of unwritten rules that I guess I don't get, that you sort of figure out. And a lot of it is sort of like little stresses, things like what you're allowed to go to the office and ask for, and what you need to get for yourself and, you know, things like... The office always seems upset no matter what it is you go and ask for, they always seem like... (feigns irritation). It's like, oh, why are you asking me for this thing? (feigns exasperated) What a big pain in the butt that you're asking for this thing.

(Rose, Primary, T2)

Proprietal Knowledge is an additional category, not characterised before but important nonetheless. Conceptually it involves teachers' knowledge of protocol and etiquette both within the department and across the school. Although perhaps not perceived as 'professional knowledge' it invokes ideas of initiative, sensitivity, tact and diplomacy, and in many ways underpins professional development and capacity for inquiry through its impact on confidence and sense of affiliation. Failure to pick up on implicit things like staffroom etiquette, departmental dynamics and protocols can leave beginners feeling foolish, or worse, vulnerable, especially if someone perceived to hold a position of power or influence is involved. Further, their perception of how they are regarded outwith the classroom is likely to shape practice and pedagogy in the classroom.

The How of Learning

When participants were asked to reflect on learning which had impacted on, or consider learning that had the potential to impact on, their capacity for pupil-centred inquiry in the classroom, as expected many participants found it difficult to articulate exactly what they were learning, invoking 'experience' and 'confidence' by default, although from their elaborations we get a sense of experimenting, trialling and snagging in an effort to improve practice. Initially they relied heavily on the ideas and experience of others, for example, university lecturers, peers and school colleagues, using this 'theoretical knowledge' as a starting point for their own practice. However, as they applied others' wisdom to their own situation, it became apparent that adjustments had to be made. Professional learning, and in particular the development of useful PCK, was dependent not only on experience, but on critical reflection on the part of the participant. Several participants acknowledged that participation in the current research project had supported their professional development in this respect; discussion of practice had encouraged reflection, verbalisation had helped them explore dilemmas, clarify ideas and re-set goals.

> *Yeah, because it's made me think about it... and things that I've thought were going to be very teacher-led haven't been so teacher led, and other things that I've thought, well they can go and kind of investigate, and then, oh no, they're getting a*

bit haywire here, I'll need to pull them back in and give them a bit more structure. So it has made me more reflective.

(Rebecca, Primary, T3)

Yeah, I would have thought so, because reflecting... It's given me the chance to reflect on things... because before I probably hadn't... well, a very fuzzy idea of what it was about. Now I feel a bit more... [knowledgeable/confident?]

(Shona, Biology, T3)

Well, now I know what inquiry means. (laughs) Yeah, I think it has. It's certainly made me think about things that I should incorporate.

(Charlie, Physics, T3)

It's quite good to reflect and just say it out loud.

(Courtney, Physics, T3)

It's made me think, which is always a good thing.

(Douglas, Chemistry, T3)

Yeah, because it does make you think about what you're doing and why you're doing it... Not just doing it and then not thinking about it, but actually looking back on it and then planning things... it's been useful.

(Lisa, Biology, T3)

Definitely. It's made me think a lot more about ways in which I can introduce inquiry into lessons... and kind of looking for new opportunities to do things... maybe trying to adjust it to get them to find out about it instead.

(Dee, Chemistry, T3)

In terms of learning during induction, extensive discussion of the SFR (intended to guide and support learning) is not warranted as it seemed to have very little bearing on practice, including inquiry. Not a single person mentioned it as significant and when asked about it directly, it was generally considered a time-consuming formality, although some conceded, in retrospect, it may have been useful. Indeed, three individuals felt their teaching had benefited more from their involvement in the study than from the formal process of completing their professional profile.

> *I think this [research project] has made me reflect more on my actual teaching than the probation things have done...*
>
> ***(Ruth, Primary, T3)***

> *I think it really makes you think about your teaching and maybe why you're not so happy to do things. To me this would have been more beneficial than my profile... The profile was just pointless, but I think it's good to have conversation with people, you know, just about your teaching.*
>
> ***(Carol, Primary, T3)***

> *I think even the difference in hearing myself talking to you... and even reading the scripts when you typed them up... It's been a good blog for myself, you know, like a diary to see how I've progressed as the year's gone on.*
>
> ***(Joanne, Chemistry, T3)***

As these new teachers became increasingly familiar with their context, including their pupils, and the curriculum they were bound to deliver, they began to intuit what was acceptable, practicable and worthwhile, and in this way professional knowledge became much more practical and accessible.

CHAPTER 11 – CONCLUDING DISCUSSION

The first year of teaching is a testing time. In addition to gaining local knowledge, new teachers must diplomatically navigate school politics, integrate with existing practices and meet fresh challenges daily. It is a vulnerable time when emotions run high. Clandinin (1989) describes teachers' early experience as "a survival stage … a period of struggle that must be gone through in order to learn to be in control of a classroom and before one can get on with becoming an effective teacher" (p. 121). But for most it is much more; it is a time when new teachers seek acceptance among colleagues, affiliation with the profession and credibility as a teacher. Consequently, the development of professional relationships is high on the agenda (McNally et al., 2008). Formation of beginners' 'self-as-teacher' identity is contingent upon positive interactions and feedback from colleagues and pupils thereby feeding the belief that they are perceived in a positive light by significant others. Respect and reputation are preserved by not only being seen to be 'doing a good job' but also by avoiding 'stepping on toes'. Mistakes made early on can compromise relationships, potentially damaging general self-confidence and ultimately pedagogical confidence.

Implementing an investigative pedagogy brings an additional set of challenges; it imposes new roles on both teachers and pupils, is relatively time consuming and requires a degree of creativity, flexibility, and relaxing of classroom control mechanisms, which runs the risk of exposing beginners' vulnerabilities. Incorporating inquiry also relies on teachers' understanding of the processes of scientific inquiry and the nature of science itself, as well as holding core beliefs about learning and teaching and the purpose of science education which are compatible with this approach (Cronin-Jones, 1991). Furthermore, the prevailing departmental culture may suffocate any early creative aspirations; as Hipkins et al. point out: "beginning teachers who do wish to implement more innovative curricula are quickly pulled into line by the modelling of their more experienced colleagues" (2005, p. 247). At a time when teachers are concerned with establishing their authority and conforming to peer expectations, and given the already high demands placed on new teachers generally, is it realistic to expect them to create an inquiry-based classroom? If it is, then it is important to understand the implications of implementing such pedagogy from the perspective of beginners themselves; how they understand the phenomenon, what risks and challenges are implicit and what their educational and institutional contexts contribute.

This study attempts to arrive at just such understanding. Its wide ranging research design (following multiple cases from different sectors/disciplines over a one year period) was ambitious, involving the management and analysis of large volumes of data, but served to re-emphasise sector specific issues, such as lack of subject confidence among primary teachers and an over-riding examination agenda in many secondary schools, as well as the impact of context, time and experience on beginners' developing pedagogical repertoire.

This concluding chapter discusses findings in relation to the research questions (about beginners' developing conceptualisations of inquiry and conditions and learning which support inquiry respectively). As far as possible these questions are addressed separately, however, as will become apparent, there is a clear interconnection, with context influencing conceptualisation and enactment of inquiry, and personal notions of classroom inquiry directing beginners' learning in some ways. Some theory is posited on beginners' developing understanding and confidence to implement inquiry, for example, the relationship between knowledge gained and confidence, how autonomy is embraced depending on support perceived, and the extent to which the school's general stance on CfE affects beginners' propensity for inquiry based practice. Practical and contextual implications of such practice are also discussed and suggestions made with respect to preparing and supporting beginners in their inquiry endeavours.

Conceptualisation and Enactment of Inquiry

In early meetings, which took place at the end of the one year long ITE Programme but before the start of the induction year, participants were asked to discuss their ideas of inquiry and investigative pedagogy. Their tentative formulations revealed a lack of confidence in their conceptualisations of inquiry as a pedagogical approach and suggested that, despite being widely referenced in CfE documentation, this was not something which had been deliberately covered, or even explicitly discussed, during ITE, either in lectures or in the field. The idea of 'pupils discovering for themselves' featured highly in the data, however, whereas 'discovery learning' might suggest an unstructured and unguided endeavour leading to unplanned or chance learning, for these beginning teachers inquiry involved intent, structure and direction. Initial conceptualisations seemed to be founded largely on an intuitive understanding of what it means to inquire about something, and these notions were developed through discussion with peers and reflection on both their own and co-operating teachers' practice during placements to create a general picture of inquiry as an active (practical), collaborative and learner-centred approach (as opposed to teacher-driven), which is based on a question or problem.

Whilst none of the participants in this study were trained explicitly in inquiry oriented instruction - and indeed many had little notion of what this approach entailed (a situation which could be addressed by ITE) - all were open to what constituted a more progressive, pupil-centred and interactive approach. It was widely advocated because it held the potential to improve engagement, deepen learning, develop skills and help create a positive learning environment. These educational aims apparently sit well with prospective and beginning teachers who, by and large, see teaching as a vocation and an opportunity to effect positive outcomes for young people (Pajares, 1992). Indeed, many of the participants voiced disappointment in co-operating teachers' disposition with regard to teacher-pupil roles, style of instruction and interaction, willingness to pursue pupils' questions and practical investigations, suggesting that they themselves would take a different approach, and to better effect. This suggests some support for Pajares' claim that prospective teachers believe not only that they have the requisite attributes for successful teaching but also that they will be better teachers and face fewer problems than their more experienced peers. It seems (according to Pajares and supported by data herein) that beginners harbour visions of going into class, connecting with the young people and creating a nurturing and motivating learning environment which encourages learners to question and solve, discuss and collaborate... and, one may well argue, this is as it should be. However, it is only as beginners assume the full responsibilities of the teaching role that they perhaps gain a better understanding of the constraints that inevitably context, and in particular the expectations of others (for pupil behaviour, course coverage and achievement), place on their own practice as they face the institutional challenges to each of the key elements identified in early idealised notions of inquiry – that is, question-driven, pupil-centred, practical and collaborative.

Contextual and Institutional Constraints on Conceptions of Inquiry

The centrality of questions

Responding to pupils' questions was a strong theme in early data, perhaps because, from a personal perspective, inquiry was something that was derived from within themselves (out of curiosity or uncertainty) rather than something they were directed towards. Pupils' questions were discussed in such a way as to suggest that this was the ideal catalyst for inquiry, a natural starting point because the individual, or class, were already oriented to the particular problem, had shown genuine interest in extending their understanding, and had some prior conception (albeit misplaced at times) which provided a framework for any new knowledge to be gained. Also, as Rose (primary) pointed out, if pupils initiated the inquiry then the problem would be pitched naturally at their developmental level, and so more likely to be within their capabilities.

However, as they took on the full teacher role this ideal was challenged. Even when pupils were encouraged to ask questions, it became apparent that most pupils simply do not. Some ask off-track, trivial or even inappropriate questions (eg. Shona, p.115; Lisa, p.84); some questions are not investigable in that they are too grand or cannot be addressed in a practical sense (often because the requisite resources are not readily available, eg. Rose, p.121; Courtney, p.138-9); some questions take the teacher outwith the scope of their own subject knowledge and confidence (eg. Carol, p.121; Charlie, p.139). Also there is the issue of time: the delivery of any course invariably runs to a timetable to allow co-ordination of resources and testing, and taking time out to pursue ad hoc questions could disrupt this timetable and throw the beginner's competence into question. Holding strongly to the belief that pupils should be involved in discovering new knowledge rather than being told (with the aim of understanding as opposed to memorising), many participants still endeavoured to use questions as a starting point, but responding to pupils' questions was, for most, no longer a definitional criterion for inquiry. Posing more general, in-course or teacher-initiated questions or problems tended to become a more feasible, yet still valid, form of inquiry as long as learners were actively engaged in trying to answer those questions.

Practical Inquiry

Another dominant theme in early data was that inquiry in science should, where possible, involve 'hands on' practical work. This, too, was likely based on an intuitive understanding of scientific inquiry in the sense of 'doing science'. However, once again this conceptualisation was modified under the influence of institutional constraints. Examples of such constraints include: 1) meeting deadlines for course completion - because practical inquiry is time consuming and often not the most time efficient way of achieving specified learning outcomes; 2) pupils' aversion to, or lack of engagement with, practical work - possibly due to lack of experience resulting in low confidence (suggested by Donna), or lack of motivation generally (a major disappointment for John); and 3) budgets for resources - especially non-standard equipment and consumables extraneous to prescribed courses. Responsive inquiry was most difficult to facilitate in a practical sense because, even when the necessary resources were available in the school, being able to anticipate what may be needed in order to pursue, as of yet, unasked questions, was problematic. With a growing appreciation of these constraints, computer and book-based research and class discussion also became valid practices under the inquiry umbrella.

Inquiry as a collaborative activity

That scientific investigations ought to be collaborative was a notion that was retained throughout the year. However, several participants experienced difficulties with this approach, citing off-task behaviour, inequity of effort and squabbling. Group working was common in the practice of these beginners, however, roles within the groups were often imposed rather than negotiated by pupils themselves, and the activity 'scripted' and teacher-directed with little pupil initiative or independence expected. Most participants appreciated that the difficulties they experienced in this respect were due to lack of experience generally, lack of knowledge and understanding of collaborative learning structures, and lack of familiarity with the pupils themselves, all of which provided targets for professional development. It was acknowledged that formal CPD on collaborative learning (broadly synonymous with *Co-operative Learning*, a major educational initiative at this time) would provide ideas for initiating and managing group work; unfortunately, however, the budget for such CPD in many schools did not extend to probationers. Also, developing an awareness of individual pupils' strengths and learning needs, as well as class dynamic and relationships, would help them to structure and scaffold the activity appropriately to maximise engagement and learning; and more time under their feet would allow them to anticipate problems, develop contingencies and generally gain a better command over the class.

Pupil-Centred

The idea of inquiry as a pupil-centred endeavour held strong throughout the year, however, whereas initially this seemed to translate to 'pupil-initiated', where the question came from the pupil, as the year progressed its meaning came closer to 'pupil-driven', where pupils were expected to make decisions and take action in the course of learning. Making inquiry relevant in terms of pupils' lived experience, and making links and connections to wider knowledge were key themes. Although prior knowledge was mentioned early on, the real significance of pupils' existing conceptual framework for pursuing a line of inquiry became more apparent as the year played out, particularly when the question originated in course materials, or even the teacher's own head!

> *I suppose it's all about asking questions and then... not asking a question and getting told the answer, but asking a question and finding out the answer which I think is different. If they've asked a question and you go 'bla-bla-bla', that's the answer, they'd be like, that doesn't mean anything to me. So it's finding it out for themselves is more what inquiry is. So then thinking about things and thinking, oh, what would happen if...? It's them actually engaging the brain to relate it to something... either relate it to something that they know or that they've seen before and they think, what would happen if we did this...*
>
> ***(Dee, Chemistry, T2)***

Thus, whilst responsive, practical, collaborative inquiry may be the ideal in the eyes of beginning teachers with lofty aspirations for engagement and learning, and high expectations for pupil motivation and engagement, lack of opportunity or failed attempts to implement inquiry based on their idealised notions led to modifications in order to achieve some degree of success. The next section illustrates how participants' developing conceptualisations of inquiry translate into practice.

Making Inquiry Happen

Reporting on a symposium of Scottish Teachers (both experienced and novice) on teaching investigative science, McNally (2000) identified three main ways in which teachers incorporated inquiry; responding to ad hoc questions from pupil(s), eliciting questions from the whole class and re-writing existing investigative activities. However, McNally also indicated that the experience of beginners in attempting to implement inquiry was quite distinct from that of seasoned teachers, a situation which warranted further investigation. The current study confronts this issue, thereby extending the work of McNally, in that it examines the inquiry experiences of beginners specifically. Examination of participants' data over the course of their induction year revealed a range of ideas and strategies for implementing inquiry. Thirteen such variants identified in the data are now described and supported with actual quoted examples.

1. Pre-existing investigations.

There were several examples of question-initiated investigations in existing curricula, of which the following is just one example.

> *The aim was to find out what yeast - dry yeast or fresh yeast - would make the dough rise the most. Some of them have done it quite well and some of them haven't, so we'll see if that works. That was a question that came up [in course notes] ... they're on bread-making at the moment.* ***(Shona, Biology, T1)***

2. Adapting existing lessons/practicals to make them more inquiry based.

Some participants described deliberately modifying lesson plans with the aim of making practicals less 'lock-step' and removing the 'verification' element, thereby encouraging more thought and discussion.

> *I'd say with the 1st years... in most workbooks [they have] a practical investigation but it's still quite structured with the boxes and stuff with 'this is what you need to think about', but I'm trying to turn it so that they have to, more so in their group, think about it rather than me just saying it too them. But I haven't had the greatest success with that at the moment, it's so easy to revert back to the ... Because once again you have to get through it, and because they struggle.* ***(Shona, Biology, T1)***

I've tried my best to... for example, even just coming to the learning outcomes, not giving away the punch line... I don't understand, why put up on the board, today we're are learning, say, to find out that acid has a pH of 1-6...and it's like, well, you've just told them the answer. I've been making sure when I write my learning outcomes... it's not telling them how they're going to do it. ***(Dee, Chemistry, T3)***

3. **Present the investigation as a problem without direct reference to the course notes.**

   Posing questions in this way, which advance the current learning, may help to make the problem more 'real' and give pupils ownership of the learning.

   I gave them the questions... I asked my 4th year Intermediate 2 class to devise experiments into the effects of temperature and pH on enzymes.

   (Donna, Biology, T1)

4. **Provide materials necessary to solve a given problem (question or engineering task).**

   This tack was taken by most primary participants at some point. An extreme example was solving the mystery of the kidnapped teddy (class mascot) which was done over the course of a week through forensic type activities (Ruth).

   ... we might do just one or two small experiments to find something out about sound, so if I give them materials and I say, here's a question, can you guys work with these materials for half an hour, what can you find out, or can you make something like this, can you make an instrument with these things ... I'm giving them the materials and we're starting with a question, and they're trying to answer the question using the materials. ***(Rose, Primary, T1)***

   ... giving them whatever they might need to do it and then letting them work it out by themselves. ***(Carol, Primary, T1)***

5. **Strategically elicit questions as the lesson proceeds.**

   The idea here is to manipulate the situation so that pupils ask the question(s) that you intend investigating anyway, thereby giving them ownership of the learning, however, this remained an idea rather than an actual occurrence for some.

So make it... it is their lesson, they've decided they want to do it in a certain way. But obviously you've got that guidance where you can end up leading them towards it and make them think that they've come up with it themselves.

(Joanne, Chemistry, T2)

I think what I need to work on is focusing on being able to identify these questions that can be used later on... Or if there's any way of planning that would maybe get them to ask ***that*** *question. (laughs)* ***(Dee, Chemistry, T3)***

6. **Encourage interaction with materials which are likely to stimulate inquiry.**

By adopting this approach it was hoped that pupils would 'wonder' based on current understandings, and start to manipulate variables thereby arriving at new knowledge or deeper understanding. It is open-ended in that pupils don't know what outcome is expected but they act according to what happens, or is discovered, as they go along.

I just got them to get out the kits and play with them and then they started coming up with the questions, 'What if I only have one blade in, can I do that?' and I was like that, well, you try, do what you want to do. 'What happens when I put it on this setting on the fan?' ... and that's what I hoped would happen and it did happen. It was them coming up with the kind of variables we were looking at and that's when we kind of ... once they'd played about with the equipment we came back as a class and I spoke to them about ... that was really good. It's not quite inquiry but it's a little bit like it. It's prescriptive as in ... well, it's going to be covered anyway, but giving them the opportunity just to play with the equipment, not telling them ...

(Dee, Chemistry, T1)

I think you need to give them a bit of free reign, and I know it wasn't quite inquiry based learning but, talking about the electrical circuits and letting them go, you know... crack on and see what you come up with... Because I think intuitively they would probably ... in their mind they would have some sort of prior learning to an extent where they would probably know that a battery creates electricity for instance... I was talking about the starting point maybe, or a sort of catalyst or a prompt of some sort, but prior learning's got to be in there somehow... And once *they start to join the stuff together I mean, they were quite excited... They weren't getting told it. As far as they were concerned they worked that out by themselves...*

(John, Physics, T2)

7. **Ask the class what they would like to learn, or what they feel is important to learn, about a particular topic.** Pupils not only acknowledge the main ideas and questions within a topic but are likely to be more engaged in a problem of their choosing.

   I mean there's ways you can, you'll know yourself, to elicit those questions out of a class. I mean, I don't necessarily have to tell them all these things. I mean, you can speak to them and say, right, what do you think you need to know? What do you think you might need to find out? ... and you will get those ideas coming to you, and from that you could maybe get them to go and research something and find out and then you would use that knowledge to apply to that particular wee problem.

   (John, Physics, T0)

8. **Respond to pupils' interests through research activities (eg. projects).**
   This involves taking a bit of 'time out' to allow pupils to pursue a topic or answer a question in some depth.

   I think with science we don't know everything, like dinosaurs for example, I've no idea about anything about dinosaurs so they asked the question and they're going to find it out rather than me just giving them the information... Plus just making time in your lesson plan to do that, being flexible to allow that to happen.

   (Courtney, Physics, T2)

   In some ways with our Rainforest Topic, because... tarantulas, for some reason, is the one they seem to be obsessed by. So we did quite a lot about tarantulas and where they're from, and we've spent a lot of time in ICT doing research, and they brought in their, like a lot of them did their project on tarantulas... But, yeah, I think it's quite difficult because you think, oh ... (feigns panic) ... where's this going to go?

   (Carol, Primary, T2)

9. Defer pupil questions to allow planning of practical inquiry.

Although open to pupils' questions, rather than derail the existing lesson, some prefer to address them in a subsequent lesson, allowing lesson planning and organisation of resources.

I'm happy to take things from them but I would rather have it planned – for safety reasons as well – with anything to be honest, because you never know what's going to happen. I'd like to know what happens with the results so I'm ready to explain anything that happens as well. I don't want to get caught off guard and be like, I've no idea why that happened... (laughs) ***(T2)*** *It has come from one of the inquiry moments but I've been able to pre-plan it, which I would be much more comfortable with. As long as I've thought about it it's easy enough to say, why don't we hold on to that, put it up on the wall or the board or something like that, and then we'll come back to that at a later date.****(T3)*** ***(Dee, Chemistry, T2/3)***

10. Plan to allow deviations in the moment.

Some (mainly primary) participants' planning allowed for small deviations, even if only discursive, to satisfy curiosity and aid understanding.

I quite like to start lessons with a conversation and a discussion and let ideas kind of grow from there, which I find quite often then change my lesson because they've gone off in a completely different tangent than I thought and actually their ideas are better than what I'd kind of planned for. So my lessons tend to have a flexibility in them that if that does happen I can change it. ***(Ruth, Primary, T2)***

11. Respond to pupils' questions through class discussion.

This was common in the beginners' practice although the level of comfort varied depending on knowledge of the topic, time pressures and perception of class control.

I mean there are elements of inquiry, I think, what you understand as inquiry, in lessons but not like where it's a stand alone lesson, do you know what I mean? I think the kids do ask questions and you kind of ... you go with the flow, you let them lead the discussion. Like this morning we started doing gravity with the class and they were kind of coming up with all the questions and the discussions... So although they're not really getting to explore that themselves, they're kind of questioning it and then they're talking about 'what if you went up in a really high *aeroplane?', and we got to discuss how it would be the same as just letting it off here because an aeroplane will still be travelling through the atmosphere, it doesn't leave the atmosphere. In discussion it's quite easy but in practical things it's not.*

(Courtney, Physics, T1)

I have done that on occasion with the class if there has been a question, and especially when it's a really interesting question, get them all to stop and listen and go, well, what do you think? And then get the class to discuss what they think might happen and how they could try and find out. ***(Joanne, Chemistry, T3)***

12. Respond to pupils' questions through small extensions to set practical work.

This might occur when what pupils are asking is a simple extension to what they're doing anyway and so the resources needed are already to hand.

... even if they're doing something that's prescribed like that but they maybe say, 'what if we did something... what if we added this to the acid'... But that's usually just like 'No! Don't do that!' (laughs) ***(Lisa, Biology, T1)***

The one with the flowers, because we'd been doing colour and they did a colour wheel with the primary colours and the secondary colours. I'd bought primary colour food die, so we had yellow, red and blue, and one of the kids said, 'But Miss, what would happen if you put the red and the blue together, would it make a purple flower? Can we try that?' So we tried that ... No, it didn't, it made a brown flower! And they were like 'Why is that?!'... 'I don't know...why do you think it is?' And they were saying 'oh, but we just put them in, we didn't measure them, there might have been more red in or there might have been ... ***(Rebecca, Primary, T1)***

If there's a question that's come up in class and it's something that I can go, well why don't we find out? If I add such and such to that what's going to happen? Well, add it, let's find out... and actually stopping the class and getting them all to think about it... What do you think is going to happen?... and actually doing it. But that tends to be only if I've got stuff to hand... ***(Joanne, Chemistry, T3)***

13. Use pupils' interests and curiosities to direct course content and practical work.

This approach was apparent for only one participant. Sean was comfortable to let the pupils take the lead, but importantly had the time and autonomy to do so.

> *But having that sort of time to do other things... I've basically allowed that to be moments where I can actually let the discussion go a little bit wider... For example... growing crystals was the basic task we did, we then went on to doing liquid crystal displays, so actually making the crystals much, much smaller. Instead of just trying to make them bigger all the time, what would happen if we made them much more precise and higher quality? And so they were making their own liquid crystal displays, so you've got a great big panel, we'd manufactured the crystal mixture, you know, and then actually played around with that, so they could generate different colours... and they were then talking about how did they generate the colours... Yeah, so [then] the fact that I was a guy and technically, you know, most of the time you don't see colours well, whereas women tend to see colours a lot more because you actually absorb a larger spectrum with the eyeball. And then brown eyed people see in greater detail, so if you were a scientist how would you measure this... so you start measuring wavelength, so they're getting light detector systems... So we then discovered if we take a digital camera, dismantle it from the mobile phone... we've still got that left over from last time ... so you've got a device that can pick up infra-red. So then we get infra-red coming off the liquid display... One of them comes up with the infra-red thing because they've got their wee group that are doing infra-red, while one group does ultra-violet... I leave them to make that discovery. So they see the infra-red and they then go, oh my goodness. I will cheat slightly in the sense that I will put something in there to make sure it emits infra-red and generates an image. So it is a wee bit contrived when they come to do it, but if they don't see it, fine, it's just something that fades off.*
>
> ***(Sean, Physics, T3)***

All of the above meet the definition of inquiry outlined previously in that pupils are actively pursuing a question and generating new knowledge for themselves, but differ in two main dimensions: the novelty and origin of the inquiry, and the degree of pupil control and structure provided. The approach taken by particular individuals with particular classes is likely to be a reflection of that person's confidence and flexibility as well as the risk perceived in each case, be that pedagogical, managerial, political or 'health and safety'. For example, items 1-4 use existing course investigations but with varying degrees of structure; this removes uncertainty in terms of method and outcome at least, as well as any risk concerning health and safety. Items 5-6 are based on specific learning outcomes of the course, thus keeping the focus quite narrow in terms of subject knowledge needed, but rely on pupil curiosity and engagement to advance learning. Item 7 deliberately elicits pupils' questions and ideas for further study, thereby (hopefully) promoting pupil engagement and minimising disruptive behaviour, but risks moving the focus of the learning outwith teachers' comfort zone. Items 8-12 all respond to pupils questions but vary in approach (discussion, research, practical) and degree of spontaneity (immediate, deferred or over a longer term) depending on availability of resources, teacher confidence and flexibility, pupil engagement and time available.

Finally, item 13 is responsive, immediate and practical, although it was discernible in only one participant's data. Reflecting back on discussion during the primary focus group, Sean's approach seemed akin to that taken in nursery schools where teachers are sensitive to the children's curiosity and plan the learning in order to develop and satisfy that curiosity. Planning is said to be responsive, i.e. flexible and intuitive, which may be more difficult upfront but maximises engagement and focus (whilst minimising disruptive behaviour), and arguably aids learning as the children are already oriented to the particular concept or phenomenon in question. This approach is not likely to be representative or common, even among experienced teachers' practice, but Sean was responding initially to a very specific set of circumstances. It is of note that he used this approach with one class mainly, a class which consisted of a small group of pupils, all with significant support needs, who engaged more readily with 'practical' work than lectures and book work, and who were not expected to attain the course qualification in any case. As such, Sean was given special dispensation from management to follow an 'alternative' curriculum which catered to the needs and interest of those pupils for ease of management and to provide useful learning experiences.

Summary 1

There is an extensive body of literature exploring and defining inquiry as a phenomenon (theoretical models) and a growing literature advancing operational models, however, although it is probably useful to strive for some conceptual consensus with regard to inquiry in the classroom, it makes no sense to advance a single (perfect) model. Classrooms are complex environments and schools are politically and culturally multifarious institutions. Consequently, as Ireland et al. (2012) acknowledge, "...what teachers do in practice depends on their personal understanding of the phenomenon [inquiry] and the contextual constraints or circumstances influencing their teaching" (p. 161). Thus, what constitutes inquiry in practice is an interaction between teacher, class, topic and other situational factors such as school agendas and even time of day! It is also heavily dependent on individuals' developmental level and 'readiness' to experiment with more pupil-centred practices. Although responding to pupils' questions in the moment ('inquiry moments') is a very appealing idea and would arguably lead to more pupil engagement and interaction, thus improved behaviour and, again arguably, better learning (which some participants did find), such instantaneous responsiveness requires a degree of flexibility in managing the lesson and also an ability to improvise. Understandably, this takes time to develop in new teachers – to have confidence in their freedom to take it down a path other than the planned path. Also, it may depend on appropriate resources being available; in most cases this would be unlikely as, given the nature of organic inquiry, it is not possible to know in advance what direction the lesson, and inquiry, will take. Thus, pre-planned, structured inquiry seemed a reasonable compromise for many as it allowed organisation of resources in advance, retained the focus of the lesson within the teacher's subject confidence, made for easier management and progression of the lesson to a defined end-point, and kept the course running to the planned timetable - all whilst still getting the pupils thinking and 'discovering for themselves rather than being told'. In other words it fostered useful learning but removed many uncertainties of management for the teacher and, therefore, helped minimise perceived risk.

Conditions and Learning which support Inquiry

The general point that beginning teachers must teach whilst learning to teach (Feiman-Nemser, 2001) is pervasively evident in the data. They must learn to manage their time and a significant workload, and also adapt not only to their new work environment but also to the ongoing changes within the education system which are likely to impact on teaching and learning culture and classroom practice (specifically the introduction of Curriculum for Excellence in Scotland). Implementing an inquiry approach places extra demands on beginners and is risky for the range of reasons given. It requires confidence and flexibility, resourcefulness and creativity, but also autonomy to make pedagogical decisions. A major dilemma for them is whether adopting the more pupil-centred approach of inquiry will work against their need to meet general expectations for behaviour, pace, achievement and reporting. This section discusses aspects of beginners' context conducive to developing confidence and classroom flexibility, proposing a relationship between what is learned (the cognitive aspect) and beginners' developing confidence, and exploring how autonomy is assumed in light of support perceived. It then discusses the nature of risks and contextual barriers and how the introduction of CfE has impacted on teaching culture and classroom practice, before finally considering the impact that they themselves have on their environment and how that shapes their learning.

Components of Confidence

From as early as initial focus groups, the concepts of 'risk' and 'confidence' dominated discussions on inquiry-based pedagogy, an insight into teacher thinking previously discussed by McNally (2006a). Although in that study teachers made no explicit reference to particular types of knowledge needed for investigative work, McNally was able to identify certain 'components of confidence' underpinning such pedagogy – for example, pupil engagement, teacher biography and attitude, resourcefulness - all of which invoke experience and tacit knowledge. In an effort to reveal those aspects of experience which underpin pedagogical confidence, however, and thereby make the tacit more explicit, and appreciating that confidence is something that 'builds' over time, this issue was explicitly discussed at all four time points in the current study. At T0, all data relating to developing confidence, including those aspects of the student teacher experience which had the potential to impact on confidence, either positively or negatively, were coded as shown in Figure 4 below.

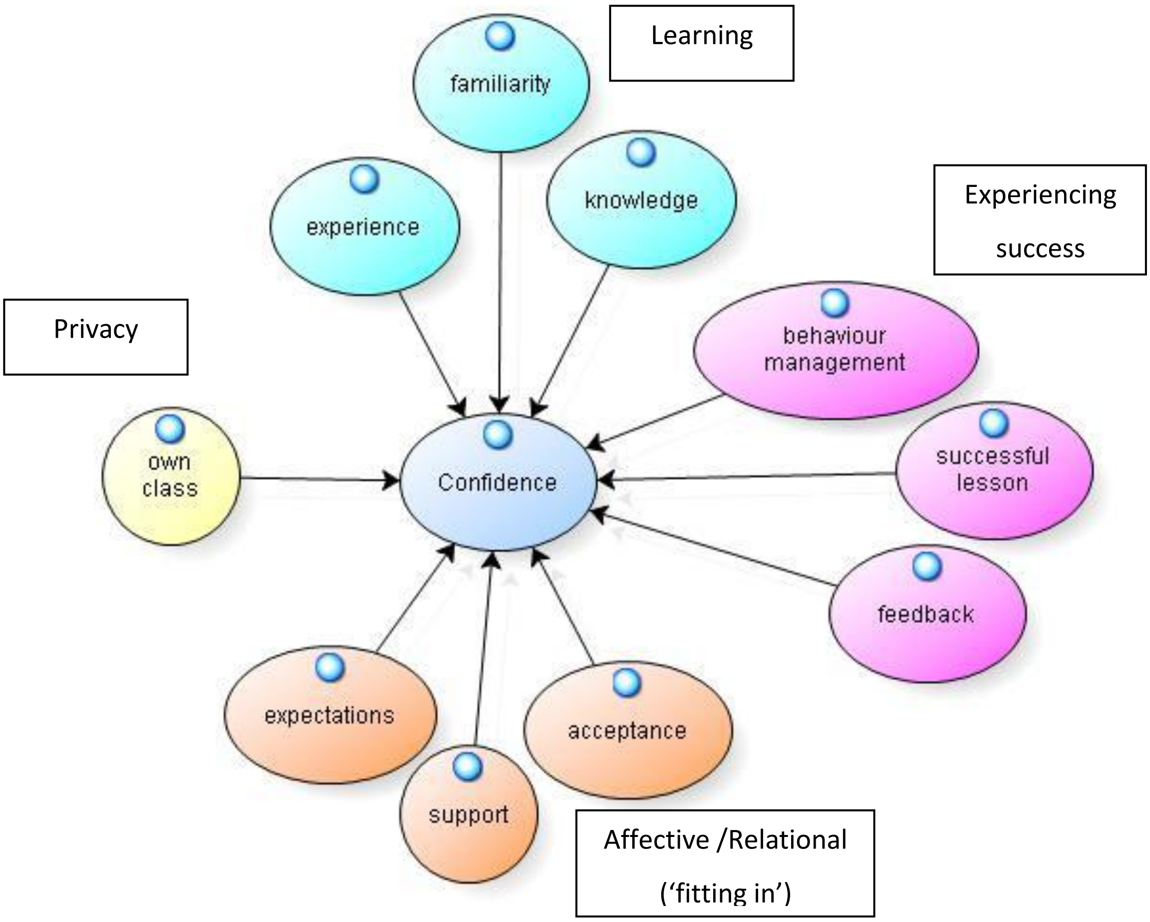

Figure 4 - Components of Confidence at T0

According to this model, confidence at the end of the student year was borne out of certain main areas, or components. Affective relational components, such as feeling accepted and supported were important, as was being given realistic expectations and targets to strive for, appropriate to their early developmental stage. Various aspects of learning were also relevant to their developing confidence, for example, familiarity with the school generally, with classes and the curriculum; knowledge of general pedagogy and subjects being taught. Experience was alluded to often and mainly in vague terms, however, it appears that confidence develops as a result of having met similar situations and thereby developing a repertoire of practices and contingencies to select from. Growing confidence was also contingent on experiencing some degree of success, including managing behaviour, having a 'good lesson' in terms of pupil engagement and learning, or simply feeling in control and being able to navigate a lesson as planned. Feedback from co-operating teachers was also an important affirmation of perceived success. Finally, being constantly shadowed and observed had quite a profound negative impact on confidence for some. Participants talked of 'teaching in another teacher's class', of being watched, judged, criticised and, at times, publicly undermined, which was inhibiting and stifled their natural teacher persona. This echoes the findings of McNally et al. (1997) who conclude that "students clearly find it hard to take control of a class in the presence of its normal teacher" (p. 490). As such, most of these new teachers looked forward to being in class on their own in order that they could do things their own way and learn from their mistakes in private.

Moving into their induction year, because all had experienced the politics within placement schools to some degree and were acutely aware of their learner status and developmental needs, a major concern was fitting in and achieving credibility as a teacher. At T1 many participants felt that university learning and student placements had not prepared them for the realities of teaching and the real learning began upon taking up the role of classroom teacher, however, most reported feeling welcome, supported and 'part of the team'. This suggests that, for most of them, the affective components of confidence were satisfied early on in the induction year. Also, with all but one having their own classroom, and on the whole being observed infrequently, they had the space and freedom to develop their teacher identity. For those who were not well supported or included, who felt they were being more closely watched than was warranted by their NQT status, or who experienced strained relationships, this could have quite a debilitating effect on confidence. Learning and experiencing success (or otherwise) continued to impact on confidence throughout the year (and general feelings of teaching competence) but examination of the data revealed that success was largely attributed to a better understanding of topics and the curriculum generally, growing familiarity with pupils and understanding their interests and learning needs, and learning from experience what works for what pupils/classes. These can all be seen as aspects of learning, and so the relationship between learning and teaching confidence generally would seem to be a close one.

In terms of implementing inquiry it seems clear that a level of confidence is needed, and that this is likely to be dependent on learning of a practical nature. Not surprisingly, developing an understanding of inquiry in the context of the classroom was found to be important. This learning need did not surface, however, until the last term of the academic year for most secondary participants in this study (not so for primary participants who were mostly insecure from the outset), suggesting that, for some at least, other areas of learning may have taken priority in the first two terms, thus laying the foundations for instilling classroom confidence, before consciously considering inquiry.

The data gathered in this study point to certain main aspects of knowledge influencing beginners' capacity to implement an inquiry approach in their classroom. The proposed relationship between these aspects and developing confidence is illustrated in Figure 5.

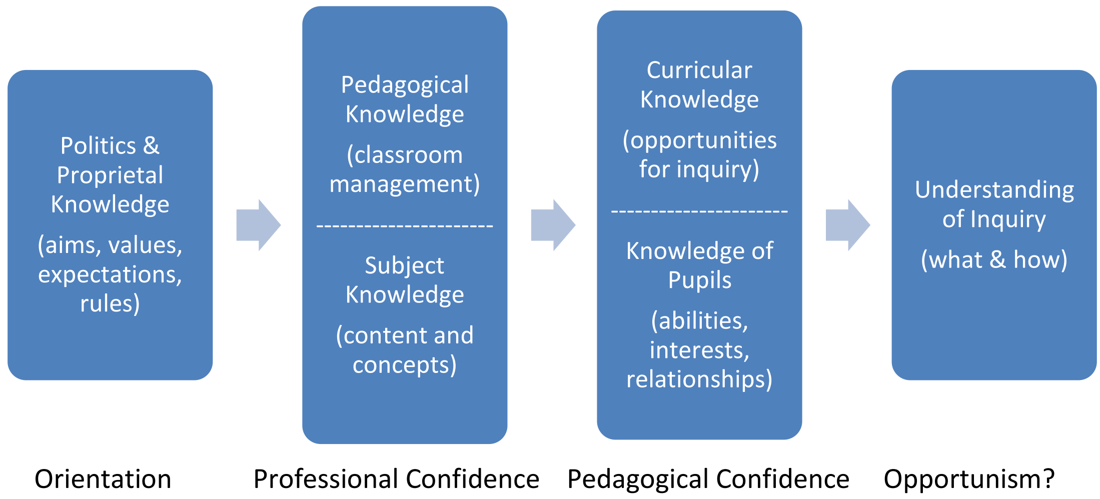

Figure 5 - Aspects of knowledge and their relationship to confidence to implement inquiry

On arrival at the school, the beginner's main priority is to understand how the school operates in order that they may 'fit in'. That pertains to inquiry in understanding what outcomes are valued, what approaches are being promoted and how much autonomy they have in making pedagogical decisions. They have to 'figure out' what and how they are expected to teach, including how much flexibility is allowed - in other words, what others' expectations of them are. That is the foundation. Aligning with school politics and developing knowledge of a procedural and proprietary nature establishes a very basic level of confidence.

Assuming inquiry is an accepted approach in the school (or at least that the individual perceives the autonomy to make that decision), the next issue is establishing authority in the classroom, both in a managerial sense (establishing a basic repertoire of 'things that work') and in terms of subject knowledge. Teaching at this time is generally teacher led and discipline-centred with a great emphasis being placed on tight lesson planning with little scope for deviation. This lack of flexibility is probably due partly to insecurity about their own subject knowledge and ability to follow up on emerging themes, but it also reflects a concern over classroom management and the potential for disorder should pupils not be held tightly to a plan. Classroom management, and specifically getting to grips with discipline and managing behaviour, is probably the primary concern of new teachers, and in tackling this they recognise that getting to know their classes is key; knowing individuals' names primarily aids discipline and facilitates smooth running of lessons, but also helps build rapport and lays foundations for positive classroom relationships and the achievement of a fundamental 'reciprocal ontological security' (McNally & Blake, 2012).

Experiencing a degree of managerial and pedagogical success (as well as the perception of meeting expectations of peers) develops a sense of professional confidence, a construct which aligned closely to participants' notion of teaching competence.

> *I've got an Int 2 class who were struggling... failing Unit 1… then Unit 2 they all passed first time round and I was just kind of like ... Woohoo! (feigns excitement) That was kind of on their learning, that was nice, but then my 4th year class, I've had a couple of really good behaviour-wise lessons with them so that's kind of boosted my confidence with them and I'm going to do slightly more adventurous things with them. So it depends on what the class is as to what the issues are.*
>
> ***(Donna, Biology, T2)***

Bolstered by pupils' acceptance of their authority status, and feeling generally competent, the next issue is where in the curriculum to incorporate inquiry. One aspect of this is being able to identify opportunities for inquiry within individual topics and understanding when such an approach would support the learning, but another aspect is knowing the pupils (their personalities, social groups, interests and abilities) in order to cater for their needs and interests, individually and collectively, and provide structures which are both motivational and challenging. Personal practical knowledge (gained from personal experience) plays a key role, for example, in experimenting with different approaches or groupings or classroom layout in order to find out 'what works' for them and their classes.

Until this is built up beginners are keen to learn through CPD and gain ‘practical knowledge’ in the form of surrogate experiences of other teachers (advice, tips and ideas) but until these are trialled in their own classroom they remain theoretically remote and, perhaps, idealistic. Until they understand the dynamics of classes through interacting with them it may be too risky to relinquish any degree of control (eg. collaborative learning, peer-assessment, practical inquiry).

This is not to suggest that learning in these areas is sequential; for instance, that they will completely understand the structures and systems within the school before developing their knowledge of the curriculum and individual topics. Nor does it suggest particular time frames for developing knowledge or confidence. Indeed learning in all four areas is likely to be simultaneous, ongoing and iterative throughout their teaching careers. What it does suggest is that one component has to be satisfied before the next becomes an issue for implementing an inquiry approach. For example, if conflicting agendas are perceived, expectations are not made explicit, or there is pressure to conform to accepted practice, the beginner may develop a limited ‘safe’ pedagogical repertoire which may not accommodate inquiry, and their knowledge of the curriculum, or pupils, is unlikely to change that. Similarly, no degree of familiarity with the curriculum and pupils will foster inquiry if the teacher feels lacking in fundamental subject knowledge and classroom management skills.

So, even for those who had a strong concept of inquiry from the start, it is only at the point when they are ready to begin to implement inquiry (when other learning needs are satisfied and confidence developed) that they realise they are unsure how to go about it – ‘how to make it happen’. At this point beginners may seek CPD opportunities, ask or observe colleagues or look for ideas online, but more likely they will experiment with inquiry in their own classroom, using existing curricular materials as a starting point. However, having received no explicit instruction on inquiry as a pedagogical approach, their confidence in their own interpretation of inquiry may be shaky; are they maintaining an appropriate stance with respect to introducing and structuring inquiry, and do the activities the pupils are involved in actually constitute inquiry at all? As McNally (2006a; citing Einstein) suggests, it may be that the required stance is simply one of ‘loose opportunism’ – of recognising an opportunity as it arises and having the confidence to run with it... As this research suggests, the required confidence may be borne out of certain critical aspects of knowledge acquisition.

Autonomy and Support

Implementing inquiry often involves deviating from course materials, derailing pre-planned lessons, improvising in the moment, or simply taking more time to cover the same material, all of which involve compromise and professional judgement with regard to relevance, learning gains and time available. This flexibility depends not only on confidence but on the perception of professional autonomy to make such decisions. Most participants did perceive a real change in the level of scrutiny and supervision going from placement to probation. However, the extent to which this autonomy was embraced seemed to be related to the level of support perceived, including clarity (and reasonableness) of expectations, provision of courses and supporting materials and, importantly, availability and approachability of colleagues, in particular an individual with whom they could share ideas, discuss problems and seek advice - generally the mentor or PT.

The only two participants for whom induction was an overwhelmingly negative experience were Douglas (Chemistry) and Rose (Primary), and for these individuals it was the nature of their 'supporter' relationships (mentor/PT), including the lack of professional autonomy and trust afforded to them, which seemed to underpin their discontent. Douglas had to stick rigidly to prescribed courses and follow virtually scripted lesson plans. Rose, although not directed in terms of pedagogy, was strongly advised not to try anything new, and deemed the expectations for planning unreasonable in terms of both what the pupils could reasonably achieve in a week and the narrowness of curricular focus. Further, she was on occasion publicly undermined and compared (not favourably) to the other two probationers in the school, and felt the support provided to beginners was inadequate. Neither situation was conducive to developing inquiry. However, at the end of the year Douglas's PT was absent for health reasons; a supply chemistry teacher came in to cover her classes and a 'like-minded' colleague became Acting Faculty Head. With the different style of management, including increased professional autonomy, and a subject colleague rather than PT and 'dictator', Douglas began to thrive and really enjoy his teacher role and was able to adopt a much more pupil-centred approach.

> *I've not had a good year as you know... But to be fair, I mean, the school's run, in many ways, a good NQT programme. The problem has been the lack of support from my PT... and complete micro-management approach, not just to me as an NQT but to her whole department, and she's infamous for it within the school... We've got a new PT, a Head of Department, I'm now left to get on with Chemistry... I'm absolutely loving it... I think the way I teach is very much to put the lesson in the hands of the children, ok? I don't like kids copying off a PowerPoint... I like to get my kids to design their own experiments, I like them to write them up in their own words, using the proper scientific format... what's happening is the kids are doing their own discovery learning. The kids are writing using their own words, they're creating their own text, it's literacy... [I've done it] a hell of a lot this term (laughs), [mainly] 1st and 2nd years... And the reason is because as soon as you get into a certificated environment, like Standard Grade and Higher, it does become a bit more prescriptive. But even then you can build lessons round inquiry. I do. But it can be more challenging because the learning outcomes are so much more specific.*
>
> ***(Douglas, Chemistry, T3)***

Jill (Primary) described her supporter relationship as 'businesslike'. Her mentor would deal with formalities and help address identified learning needs but was otherwise 'unapproachable'. Also, she had a tendency to interfere or interject during observed lessons and, on occasion, Jill felt that her feedback was overly critical and unjustified. The main problem, however, was that this person went off sick within a couple of weeks of Jill starting and did not return until the end of October. Jill was able to turn to her stage partner for support during this time but still felt insecure and uncertain about main things, interpreting and implementing the new curriculum and selecting appropriate resources in particular. With no affirmation as to her teaching competence the weight of responsibility and accountability sat heavily on her shoulders.

Carol (Primary) and Joanne (Chemistry) were in a similar situation in that, although both enjoyed positive supporter relationships (both described their mentor as 'lovely'), timetabling constraints made regular meetings impossible and so both mentors were largely unavailable for professional discussion and practical support. Also, within their department, communication was poor and there was no co-ordination of effort. Both Joanne and Carol looked to their peers for support; Carol's main source of support (until a new PT was installed half way through the year) was an NQT from the previous year from whom she took some advice and reassurance with regard to classroom practice; Joanne described her relationship with the other science probationer as a 'lifesaver' in that they could discuss ideas, and share successes and failures. However, both remained unclear as to what others' expectations of them were and therefore insecure in their ability to meet those expectations.

Joanne's insecurity manifested in the classroom; she had difficult classes with inadequate behavioural and learning support, little in the way of course materials, and her PT was a Social Subjects teacher and so of very little help with subject specific concerns. For Joanne, her new found autonomy was felt as neglect. She spent so much time and energy devising lessons, sourcing materials and 'fire fighting' throughout that, for most of the year, inquiry was not a realistic goal. In contrast, Carol described feeling confident in her classroom with her pupils, but insecure and somewhat inadequate outwith. Due to lack of guidance and explicit expectations regarding planning and paperwork she tended to err on the side of caution and often 'over-worked' causing frustration and exhaustion. Half-way through the year the management structure changed and Carol gained a new PT who was available for both moral and professional support; her experience thereafter was very positive.

> *I feel much more supported now... the lady who was kind of in charge of P3 retired and we got a new kind of principal teacher in and I just feel that she goes totally out of her way to make sure you feel supported... I definitely am much more flexible now... I think because you feel more confident you just don't need the rigid structure of it so much and I guess the structure's there as a kind of ... just a kind of comfort, isn't it. It just kind of makes you feel like, oh, I know exactly what I'm doing all the time. But once you feel like, I know what I want to get through this week, I can do that however I feel is best on the day ... and just do it that way.*
>
> ***(Carol, Primary, T2)***

The final two primary teachers, Ruth and Rebecca, like all other primary teachers, were simultaneously teaching whilst developing new curricular materials, however, both of these new teachers felt very well supported emotionally, professionally and materially, and embraced their professional autonomy.

> *Everyone in the school is lovely... Really supportive. I've got a great supporter, who I can go and speak to about anything... [Autonomy?] Loads. (laughs) As long as I can justify it there's no issues... as long as I can link it into my theme, I can do whatever I like ... as long as it's relevant and the children enjoy it, and they're learning.*
>
> ***(Rebecca, Primary, T1)***

> *Well, I've been lucky that, you know, everybody in the school has been fantastic, they've been really, really supportive... My mentor, who you've just met, she's been brilliant... She's let me go and do my own thing and, you know, try my own things without putting too much input in but, you know, she's always there if I need a bit of help or guidance, which is good... I think in the beginning I almost needed that structure of, right, what do I do next and what's the next step. But then, now, looking back over that first term, I actually think it's been better that they've stood back a wee bit and just let me make mistakes and let me go through it and, you know, helped and guided me when they needed to but, definitely, I think the freedom that I've had has probably been the best thing for me.*
>
> ***(Ruth, Primary, T1)***

Both talked about needing structure in terms of lesson plans and supporting curricular materials early on but then quickly becoming more flexible and responsive to the children and unfolding events. Also, both participants made significant contributions to their schools' science curriculum; Rebecca, by delivering a practical science CPD course for colleagues, and Ruth, by developing a very successful week-long forensic investigation which was to be adopted into the curriculum as a 'rich task'.

Sean, Charlie, John (all Physics) and Shona (Biology) similarly felt well supported emotionally, professionally and materially (although some would have appreciated more CPD) and all seemed to appreciate their new found autonomy as reflected in references to 'freedom', although for most this is overshadowed by a sense of responsibility and accountability.

> *Obviously like general schemes of work or general courses and things that they're covering, you'll get help with that but you are... you've certainly got total autonomy*

to do things the way... But whether it works like that in practice is another thing I suppose, with the pressures of meeting certain outcomes and whatever...

(John, Physics, T1)

I think you're given free... the freedom, yeah, of where you want to take your lessons... Obviously you get support, but... It's much more of a responsibility I think is the general gist of it ... keeping on top of things.

(Shona, Biology, T2)

Courtney and Donna, and Dee and Lisa, were in a very privileged situation in that, as well as an extensive support network, well developed course materials and a well organised induction programme (including regular mentor meeting and useful CPD), they had each other for moral support and to develop ideas. Although all felt somewhat overwhelmed to begin with, they quickly settled into the school and became integral to the department, contributing to curricular development work and developing strong teacher identities.

All participants agreed that the existence of a basic framework for courses and well developed curricular materials was not only supportive but fundamental as this would free up valuable time and energy and provide for some level of consistency across classes. However, within that structure it was important to have the autonomy to make pedagogical decisions based on your class and respond to unfolding events; for example, to add things in if pupils are interested, to deviate slightly, or to teach things in a different way.

It's quite good in here because we have our themes... the school has came up with a structure. [Then] It depends on the children that you've got there... obviously there are bits in there that they need to cover... I'm so glad that the science one was last, because my confidence is so much better... I can now feel like, right ok, we're going to do this and we're going to do it right, and we're actually going to learn things and plant things and grow our own food and talk about 'food miles' and everything. It just grows arms and legs and before you know it you're like, oh, wait a minute, we've only got 6 weeks to do this in. (laughs)

(Rebecca, Primary, T2)

It's like, this is the basic PowerPoint that's there with everything that you've got to cover, you know, and that covers all the learning outcomes, but if you want to go off and explore something ... so I went off and did a wee bit about the Large Hadron Collider... It's still part of the course but we've kind of gone a little bit further with it or gone into a wee bit more detail about how it works or something. And obviously it depends on the ability of the class. I've got one class who ask some superb questions and we can go into a lot more detail. I've got another 1st year class who are not such high ability so you've got to kind of ... you're covering the basics and maybe going ... answering some more advanced questions but not maybe as many as the other classes. And I think that's one good thing about CfE, it's kind of this is what you've got to cover but you can go off and do your own little bit ... you know.

(Donna, Biology, T2)

I think with the Curriculum for Excellence the theory and the ideology behind it is excellent... I think teachers, you know, as a profession ... we're professionals that are doing this, we should be given the freedom to say, actually, that way of teaching that isn't working, I'm going to take another approach and I'm going to get them to learn it in a different way, that ... the idea of that is absolutely brilliant. Without that I think the whole teaching profession falls flat a wee bit. But as a new teacher coming in and I've just been given a list of ideologies to work towards, I've found that I've needed a lot more structure in place and I feel like I've been going back to 5-14 guidelines to go, what bit do I teach next?

(Ruth, Primary, T2)

Barriers, Constraints and Dilemmas

It is established that inquiry can be risky, especially so for beginning teachers. The type of risk perceived (health & safety, behaviour management, waste of valuable time, political, subject knowledge, too challenging) reflects the issues they are struggling with at that point in time, which are likely to change as they settle and grow into their teacher role and become more creative or resourceful. In implementing inquiry it is generally acknowledged, and so perhaps stating the obvious, that perceived barriers reflect beginners' specific teaching context, with some 'barriers' being more pervasive than others.

> *It's funny how it changes, isn't it? I'm recognising the ones that I picked before and I'm not agreeing with them anymore.*
>
> ***(Ruth, Primary, T2)***

> *I think it's just ... even within that there's some things you could probably work around, if you know what I mean, you could find alternatives to with a bit of lateral thinking, but some of these you just can't really escape from.*
>
> ***(John, Physics, T1)***

Thus, the previously discussed 'barriers to inquiry' may be extended to a wider consideration under the heading 'Barriers, Constraints and Dilemmas'. In this discussion, **barriers** may be regarded as those issues which are insurmountable and may only be removed by changes at school or department level. Amongst the issues identified by participants, only *Politics* and *Assessment/Achievement Implications* would potentially come into this category; for example, if policy and agendas are such that an emphasis on assessment and examination results is conveyed and beginners perceive pressure to conform to extant practices. In some cases expectations in this regard can be quite explicit and accountability keenly felt. This may, indeed, thwart inquiry, other than pre-planned investigations which form part of set courses or brief discursive inquiry moments.

> *I would be reluctant to derail a lesson to go look into a question that came up... Like, I'm trying to cover the things that I put on my forward plan. But ... Yeah, we should be able to do a detour. Honestly, I think that I've... and I've had to to a certain extent... absorbed the little, like, pedantic voice that's going, why haven't you gotten through all three of those maths groups?... I'm very afraid of not teaching all of the things that I'm supposed to have taught... Just meeting expectations... You need to spend your time on what the school prioritises.*
>
> ***(Rose, Primary, T3)***

More than half of the research participants (#8) acknowledged *Politics* as a potential barrier to inquiry before taking up their induction post based on student experience. By T1 this had dropped to one third (#5); for three participants *Politics* was a real and persistent barrier, five conceded it was not an issue in their school, but two participants selected *Politics* who hadn't before. By T3 the number had risen again (#7) as participants began to consider their next post. This suggests that it is dependent on the school in question and that removal of such barriers would involve either a change in context, personnel or policy.

> *I'd maybe say that [School/Department Politics], because especially with a new school, if you're going to do something... you don't really want to start off on a bad foot. Maybe when you're more established you can do things... I think there's a bit of give and take, but if it's completely against, you know, what they're doing with their courses...*
>
> ***(Courtney, Physics, T3)***

Constraints may be considered as those issues which are outwith the control of the beginner but which may be worked around. Such issues may include *Classroom Layout*, *Practical Support, Resources, Time and Curriculum & Courses* (although the latter two may also be considered 'Dilemmas' as will be discussed).

Issues surrounding *Classroom Layout* ranged from not having their own classroom, to wide pillars obstructing the view of certain areas, to fixed seating which was not conducive to group working, but in all cases these were an inconvenience rather than a barrier.

Practical (Classroom) Support was something that many participants found lacking and which placed limits on what was achievable in the classroom. However, most were resigned to the fact that the situation was largely attributable to the current economic climate and were intent to make the best of it.

Resources (quantity and quality) were an issue for many, again due to lack of funding. In some cases this necessitated fewer but larger working groups, or meant buying or making things themselves which had obvious implications for time and money, but importantly these options were taken by some, mainly primary participants.

> *Resources ... Yeah, because, like, if we were going to do the plants and things next term I would have to buy all of it.*
>
> ***(Carol, Primary, T2)***

> *If somebody would just give me resources and money to buy resources it would just make it so much easier. (laughs) Because again, that comes into time to make the resources ...*
>
> ***(Rebecca, Primary, T3)***

Resourcing was also an issue from the point of view of anticipating what may be needed, however, this problem could be circumvented by pre-selecting inquiry topics, deferring the inquiry to allow gathering of resources, or by dealing with the inquiry on a discussion basis.

Time (in terms of meeting deadlines for course completion) was the main and most persistent constraint on inquiry practice, discussed by all participants over all time points, even when it was not selected as one of their five main ‘barriers’. Closely linked to this for secondary participants was the issue of *Curriculum & Courses* in that this time pressure (and accountability) was felt most keenly in certificated classes when their teaching competence would likely be judged on results achieved. Many acknowledged that, although worthwhile, inquiry was generally not the most time-efficient way of delivering the course, however, many conceded that planning and pacing of lessons had improved and that they may have been panicking unnecessarily.

> *I think that [Time] would be an issue anyway. I think, with the 3rd and 4th years definitely. But I think with the 1st and 2nd years it wouldn't be so much of an issue, because I think you have got more freedom. I think the way the course ... well, especially the courses that I've got, they're so woolly and there's big gaps that you could fill with inquiry based research things.* ***(Joanne, Chemistry, T2)***

> *I think time is an issue because it was more time consuming. I don't think time's so critical now because I think it was over exaggerated how much time you require to actually teach the course. Now that I've seen the course in its fullness I think I could teach that in a much smaller timescale and so I could generate enough time to do the other aspects.* ***(Sean, Physics, T2)***

Finally, **dilemmas** may be regarded as those issues which have uncertainty at their root, and which manifest in low confidence. They are often eliminated (or at least appeased) over time and with experience. For example, at T0 a prominent theme with respect to inquiry in the classroom was the dilemma over how structured it should be. This dilemma has many uncertainties at its roots; uncertainty over classroom management and control, about pupil abilities, motivations and ways of working (all encompassed within *Pupils and Behaviour)*, and how best to plan and organise the activity to accommodate all learners (*Planning & Organisation*). Over time, largely as a result of familiarity with classes and knowledge of pupils as individuals, beginners get a sense of what approach will work in a particular context. As these new teachers are finding, engagement, and by implication behaviour, are contingent upon pitching the task at an appropriate level, with just the right balance of structure and challenge.

> *My new 2nd years were doing energy transfers, and I got one class to design and set an experiment for the other pupils in the class... It was a really good lesson, but then... I didn't think it would work so well with my other 2nd year class, they're quite different... so I didn't try it because I was kind of thinking, well, it might just be a complete disaster and they might not get it and you're ending up doing the experiment for them so it's not really inquiry.* ***(Courtney, Physics, T3)***

> *I did that in one of the lessons I did with my 2nd years, it was just too ... It depends how much you structure it. I've learned that with inquiry, you need to structure it depending on the abilities in your class because then it just ends up with them struggling and then leading to behaviour issues because they don't feel like, you know, like they can do it. So they take it as too much of a challenge.*
>
> ***(Shona, Biology, T3)***

Other dilemmas are rooted in uncertainties over where and when to incorporate inquiry, and having the requisite knowledge to support inquiry (especially problematic for primary teachers) but these issues are addressed through increasing familiarity with the curriculum generally as well as individual topics (*Curriculum & Courses; Subject Knowledge*).

Time management was another dilemma, both in and out of class (as distinct from the limited time available for content coverage which was a constraint). To begin with one of the main challenges was workload and its interaction with participants' life outside school. Due to the amount of paperwork (planning, reporting, etc) and pressure to over-commit (eg. curricular development or extra-curricular activities) many were forced to take work home just to keep up to speed; preparation and planning often took place outwith school hours. As the year progressed, participants talked of improvement in time management, and behaviours becoming a bit more ‘automatic’.

> *You're always up against it no matter what you're doing. Time is always an issue; you just have to kind of manage it really.* ***(Jill, Primary, T2)***
>
> *I'm obviously learning what to plan and better time constraints to make sure what I'm planning, I can do that in the time that I'm saying I can do it in, as opposed to giving them and activity saying, oh, that will take them five minutes but actually it takes them half an hour. You get better at gauging how quickly things ... or how slowly certain kids will do things.* ***(Dee, Chemistry, T1)***

Thus, although in the rhetoric of inquiry we discuss ‘barriers’, many are in fact internal dilemmas, or at most constraints, rather than external obstacles, and largely these dilemmas are due to limited teaching experience and pedagogical content knowledge. For instance, familiarity with the curriculum and courses allows identification of opportunities for inquiry – where it might fit; knowledge of pupils and development of rapport with class will determine style of interaction and elucidate pedagogical possibilities – what they are capable of, how much autonomy they can cope with, pitching language, level of challenge, social groupings. All aid decisions regarding planning and organisation and lead to an operational understanding of inquiry and how to implement it in one’s own class, hence the variation described in practice.

Curriculum and School Culture

The participants in this study were entering the profession at a time of arguably major transition in Scottish Education. Curriculum for Excellence is regarded by many as a re-conceptualisation of classroom practice; it constitutes a shift towards more learner-centred practices, with greater emphasis on skills development and a more ‘holistic’ approach to assessment. Pupils’ learning is framed in terms of Experiences and Outcomes (rather than Learning Objectives) and these are deliberately written in such a way as to allow individual teachers flexibility in what is pursued and what strategies are employed depending on pupils’ interests and abilities, with scope for bringing in real life events - personal, local or global. Although CfE has been gathering momentum in Scotland since its inception in 2004, participants' induction year (academic year 2010-2011) coincided with its official introduction and implementation in schools. This means that participants experienced not only the 'lead up' to CfE during ITE, but also its early impact on schools in terms of both culture and practice.

These new teachers were introduced to CfE early on in their career, during ITE, and this underpinned much of their subsequent learning on campus. They became conversant with the aims and philosophies of the new curriculum which, in many ways, provided a rationale for their initial pedagogy. However, going into the field, their understanding of education was often challenged by the prevailing school/departmental culture. CfE was making its presence felt in schools, but it was not universally welcome, nor well understood. Participants experienced a great deal of negativity towards CfE during student placements - from departmental colleagues, sometimes management, and even parents on occasion - which was generally linked to a perceived lack of guidelines and consequent uncertainty about expectations based on typical classrooms. They were acutely aware of tensions within and across departments in respect of CfE (with the potential to start 'a huge screaming match in the middle of the staffroom' at the mere mention of Curriculum for Excellence). Although armed with ideas (based on discussion and the experience of others), and encouraged by tutors to try different CfE approaches, many co-operating teachers were not ready to accept ideas and suggestions from student teachers with virtually no classroom experience and so many participants felt a pressure to conform to extant practices rather than experiment with something new.

Despite findings of the recent *Donaldson Report* (Donaldson, 2011) that ITE institutions were taking adequate measures to ensure new teachers were prepared for CfE, many participants felt far from prepared to work under the new CfE regime and were concerned about meeting expectations which were far from explicit. For many, 'nervous anticipation' summed up the feeling of beginning teaching under this new regime with its myriad of uncertainties, particularly with respect to assessment and accountability, and some were sceptical about its manifestation based on variable states of preparedness and attitudes in the field. However, at the end of ITE, participants were generally positive about the aims and philosophies of CfE; they were optimistic that it would ease some of the existing pressures, improve the teaching and learning experience, and provide scope of inquiry and other pupil-centred pedagogies. Most participants embarked upon their induction year with a positive outlook, or at least an open mind, in relation to CfE.

By the time participants took up their induction posts CfE was very much in evidence, although the level of engagement and approach to implementation varied between schools. In-house and external CfE-based CPD was prevalent; most teachers (including NQTs) were involved in CfE development work; ideas, exemplars and resources were shared at school, local authority and national level; and CfE-related pedagogies began to permeate classroom practice, including cross curricular themes, active learning, collaborative working, formative assessment ... and inquiry. Many participants perceived a positive shift in colleagues' attitudes towards CfE going from student placement to induction. This trend continued as the year progressed and teachers became more familiar with the experiences and outcomes and, presumably, more confident about meeting expectations for delivery of the new curriculum, which was generally seen as a teaching approach or set of strategies (eg. establish current knowledge and understanding; encourage pursuit of questions and interests; promote independence and responsibility for learning; provide opportunities for discussion, inquiry and collaborative work).

Most of the primary schools represented in the study were making an earnest attempt to embrace CfE as evidenced by participants' many references to 'new' planners, materials and practices. Pupil-centred pedagogies were certainly encouraged, but, generally speaking these were more prevalent in the Social Sciences. Although participants agreed that CfE should support inquiry in science, the continuing low priority given to science (not within the curriculum itself, but within the primary sector generally), and the consequent lack of resources and support, made it more difficult to implement.

In the secondary sector, this 'approach' was adopted almost exclusively with the lower school (S1, and sometimes S2 depending on how progressed individual schools were in CfE uptake); another stance completely was taken with 'non-CfE' or certificated classes which was much more teacher-centred. Although some strategies associated with CfE were implemented in such classes, due to time constraints, pressure to cover content, and perceived accountability for examination results, the main mode of instruction was 'delivery' - traditional lecture, note-taking, demonstrations, verification labs, question-answer sessions, practice exam questions and individual assessment. Authentic inquiry was rarely a possibility within this format. This suggests that changes in practice must coincide with, and be compatible with, changes in procedures for assessment and expectations for achievement – which were, at the time, still uncertain.

For the small number of participants in whose schools the transition to CfE was more troublesome, inquiry was very difficult. In one case resistance to CfE seemed to be school wide; although it 'had arrived' and was apparent in discussion and on walls, this constituted little more than 'lip service' as there was no perceptible change in accountability or flexibility. In another case, although the Science Department had adopted the organising themes of CfE (Science) in the development of the new courses, all experiences and outcomes were crammed into S1 - and assessed - in order that pupils could select subjects for further study from S2 onwards, thereby ignoring the principle of a 'broad general education in S1-S3' and creating a real pressure to cover content. Further, CPD training which may have supported pupil-centred pedagogies was not prioritised for probationers. In yet another case resistance to CfE seemed to reside with the Head of Department, the participant's immediate superior. It was posited that some of the principles of CfE (pupil personalisation and choice; teacher freedom and flexibility) were incompatible with her obsessive compulsive personality; consequently she had interpreted the documentation in such a way as to maintain control over teacher practice and pupil learning. In this small number of schools, whether ignored, misunderstood or simply paid 'lip service', in any case, inquiry was not supported or encouraged, and at times, actively discouraged.

Although some intrinsic and extrinsic constraints persist (pedagogical confidence; time constraints; department politics and personalities), generally speaking there seems to be more scope for inquiry within the CfE format, and evidence of a changing teaching and learning culture in schools which embraces the opportunities inherent in CfE. When asked about their hopes for next year with regard to curriculum, courses, teaching and learning, most participants' affinity for CfE was quite apparent. All participants believed it held the potential to support reform efforts for science education. Even those individuals who were very sceptical of CfE to begin with (based on student placement experience) came to appreciate its potential to impact positively on pupils' learning and the teaching profession generally. The following illustrations demonstrate a reconciliation of conflicting attitudes towards CfE and Inquiry which were apparent at the start.

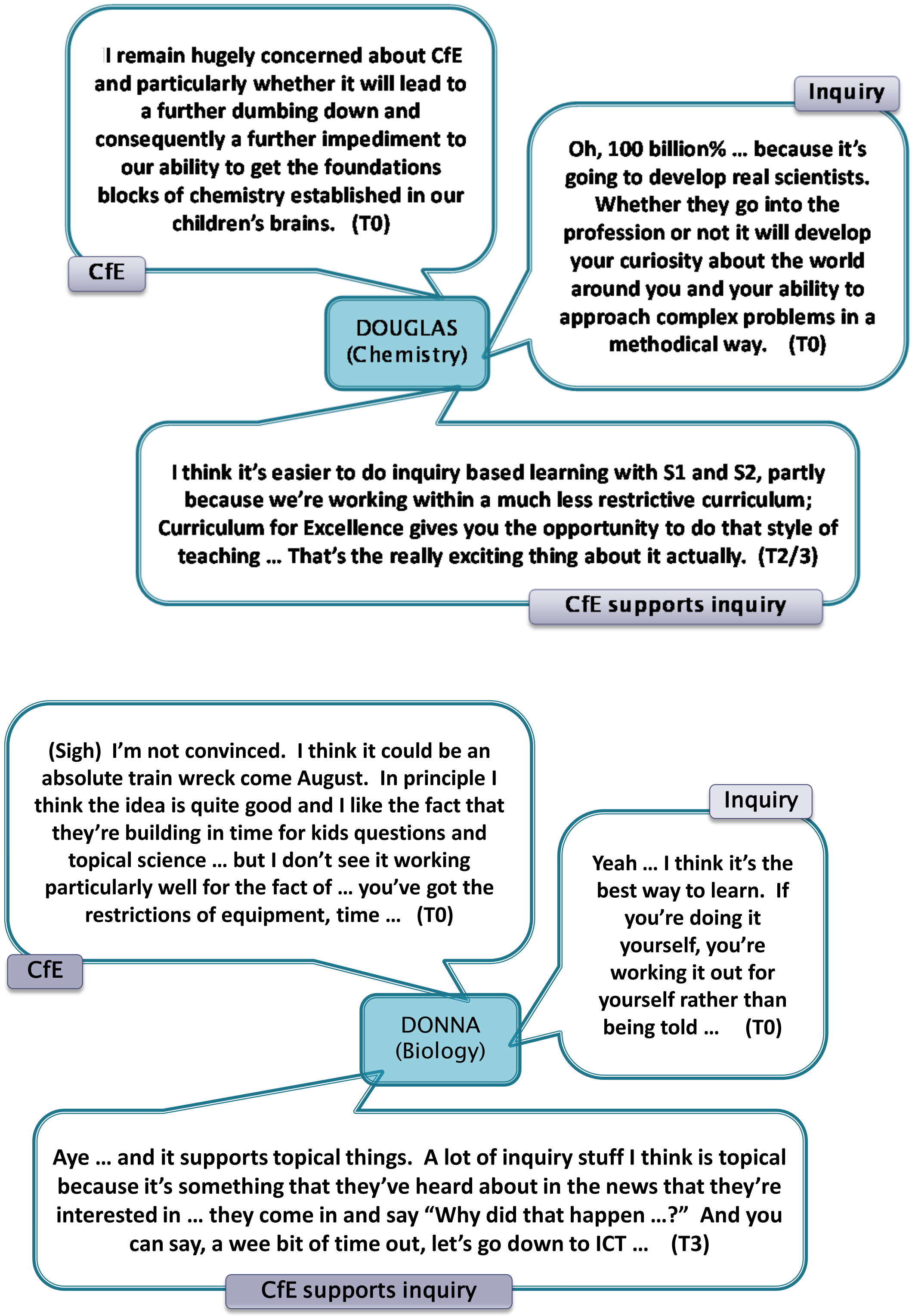

Figure 6 – Conciliation of views on Curriculum for Excellence and Inquiry – Donna and Douglas

Teacher Disposition and 'Fit'

Before leaving the discussion of professional learning in context, it is important to acknowledge participants' contribution in terms of disposition and developmental needs. How school context is experienced and what outcomes are possible is not merely a function of the school itself but rather a function of the participants' interaction with the context they find themselves in.

For instance, the following excerpts give a flavour of Douglas and Joanne's perceptions of the professional autonomy afforded to them by their school context.

> *Em ... a very prescriptive way of working in here. Oh, incredible. No deviation off the course what so ever. I mean, micromanager to the extreme, which is not the right boss for me. I find that quite hard actually... But we find a way of working together, you know. But inquiry based science teaching doesn't happen at all.*
>
> ***(Douglas, Chemistry, T1)***

> *Complete freedom, you can go and do whatever... Like, it must be the opinion they have of us as a probationer, an NQT, and I think a lot of it comes from when they were NQTs... 'right there you go, away you go'...close the door and then leave you. 'That's what we had to do, we had to go and learn for ourselves, [now] you go and do it for yourself'... especially because we've came through the Curriculum for Excellence they go, 'well you've came through that, you know more about it than we do'.*
>
> ***(Joanne, Chemistry, T2)***

Douglas felt stifled and compromised, Joanne felt isolated and unsupported. One has to wonder if their experience would not have been much more positive had they ended up in each others' department/school. Douglas, who was mature and confident and had a well developed teacher identity and clear aspirations for teaching, commented that his PT was 'not the right boss' for him. Perhaps Joanne, whose teacher identity was more tenuous at the start of her induction year, may have welcomed the support inherent in that style of management and level of organisation.

In Rose's case, her line manager (who was also her appointed mentor) was also responsible for two other probationers, and both of these individuals seemed to fit more comfortably within their school context than Rose, which may be down to differences in disposition.

> *I think the other two probationers probably are even more successful. I know that my mentor's very, very hands-on and like in my class a lot and talks to me a lot, which is maybe too much for me, whereas [other probationer] can't get her supporter to look at anything that she's done. They're both doing fine. My mentor teacher really likes both of them and uses them as an example of what I should be like, so ... and I like them too. (laughs)*
>
> ***(Rose, Primary, T1)***

Rose acknowledged the possible mismatch between herself and the school in which she was placed but accepted that, given her wilful nature, she may have faced similar problems (to a greater or lesser extent) wherever she ended up teaching. Interestingly, Rose was also the only primary participant to identify Politics as a prospective issue at T0.

> *I think that a lot of the problems that I've had probably just have to do with my attitude towards being managed. I don't like it very much. (laughs) And probably no matter what they did I would probably be like... I probably wouldn't love it. You know what, any different head teacher or line manager is going to have different priorities and probably I would agree with some of them and not agree with some of them, and chafe against the ones I don't agree with.*
>
> ***(Rose, Primary, T2)***

Dee and Lisa worked in the same department and much of their experience of their context was similar: they had the same line manager and close colleagues, attended meetings together and sat on the same committees. They also taught the same S1/S2 courses for which there were teacher guides, lesson plans, PowerPoints, and other supporting resources. However, whereas Dee felt obliged to follow these as 'intended', Lisa felt able to incorporate her own ideas and make pedagogical decisions appropriate to her own classes.

> *What they've done... what they've come up with is amazing. So they get these booklets and everything's in there and all they need to do is just write in the answers, and you've got a prep ... That's the file there that's got all the work cards*

in it, the lessons plans ... everything! And it's just you do this and that's the way you do it, because the lesson plans follow the workbook, so you can't go, well, I don't really want to do it that way, I'll just do it a different way. You've got to do it that way because that's the way it falls ... There's no scope for ... In S1/S2 at least there's no scope for kind of veering off and doing something else, which is what we are trying to change now I think. It's not what I ... no. Definitely not. There's just no [flexibility].

(Dee, Chemistry, T1)

There's teacher guides of lessons ... So there's one of these for every first and second year topic, so basically a big folder and the lessons are numbered. It's good because it tells you what you need to order from the technicians... it tells you the aim, the outcome, the resources. And they also put on a PowerPoint as well... but you want to have your own stuff in the PowerPoint too. So if I'm reading this and I think they'd be better off knowing something else first, I'll just do it. I'll try and cover everything, or I tried at the start, but to be honest I think ... I do try and bring in other things as well.

(Lisa, Biology, T1)

Thus, an individual's personality and disposition, for instance, their willingness to conform or how predisposed are they to risk-taking, putting themselves forward and initiating change are likely to influence the 'fit' with their context and shape their overall experience. Further, as Hodkinson and Hodkinson (2004) point out, they may be oriented towards different learning opportunities or respond to the same opportunities in different ways by virtue of their differing dispositions and biographies.

Summary 2

The current study points to the interaction of personal and institutional factors for novices' developing pedagogy and teacher identity. As discussed, most teacher candidates see teaching as a vocation and enter the professional with a general confidence and lofty aspirations. Although, initial university learning has the potential to fuel pedagogical aspirations and support a teacher identity which is pupil-centred and inquiry-oriented, for many beginning teachers school placements challenge that persona, even undermining self-confidence for some. Student teachers are 'dropped in' and consequently classroom experience is very fragmented in the sense of disparate lessons linked neither to what has gone before or what has still to come. Pedagogical aspirations often have to be deferred because passing the year (in order to be 'allowed' to teach) is contingent upon aligning with school politics and conforming to existing practices, which may not accommodate an inquiry approach. Satisfactory completion involves 'jumping through hoops' and meeting expectations which often are not clearly defined. Any mistakes are public mistakes and weakness perceived as failure (even if only by the beginners themselves). The student teaching experience, therefore, has major implications for developing confidence, teacher identity and classroom practice.

As they take up their induction post, in many ways unprepared for the teacher role, confidence in many arenas is lacking. Although beginners may recognise the merits of inquiry in terms of engagement and learning, they quickly come appreciate the institutional constraints of teaching, not only inquiry, but classroom practice in general. Their primary agenda, once again, is meeting the expectations of significant other(s) (principally PT and/or mentor) in order to pass probation and gain full registration with the General Teaching Council. This involves gaining and maintaining credibility as a teacher, both in the class (in terms of control, preparation and pedagogy) and outwith the class (meeting deadlines and targets for achievement). Implementing investigative pedagogy, it seems, poses a risk to that credibility. For all but a small percentage of beginners for whom investigative structures form a natural part of their repertoire (and whose educational context supports such pedagogy), inquiry is problematic and risky. The nature of risk perceived in many ways reflects the contextual barriers in play at that time - for example, health and safety (particularly if behaviour is problematic), political, time demands, subject knowledge - and these barriers are likely to change over time and with experience as practical knowledge, and consequently confidence, in the various arenas increases.

The data gathered in this study point to certain main aspects of knowledge influencing beginners' capacity to implement an inquiry approach in their classroom: politics and proprietal knowledge (aims and values, rules and expectations); general pedagogical knowledge (lesson planning and managing behaviour); subject/curricular knowledge (familiarity with topics and identifying opportunities for inquiry); knowledge of pupils (individual interests and abilities and how they work together); understanding of inquiry (what constitutes inquiry and 'how to make it happen'). Further, in the absence of any intervention during initial teacher education (instruction or even discussion centred on inquiry), it is suggested that, for inquiry to become a pedagogical possibility, these aspects of professional learning have to be satisfied in the order indicated.

With regard to inquiry, however, knowledge is only one component of confidence. The beginner must feel that they have the time to do it ('because it does take longer') and not fear that other things will suffer as a consequence of time spent on inquiry based activities (namely exam results). The beginner must also have the support of colleagues and superiors in terms of pedagogy (ideas), behavioural support (advice and following up on disciplinary issues) and professional development, as well as support in the form of course structure and materials. The overall perception of support seems to underpin beginners' autonomy and capacity for initiative and innovation. As Eraut and colleagues (2000) report, confidence is gained from successfully undertaking challenges, but confidence needed to undertake challenge in the first place depends on the level of support perceived. Proprietal knowledge, although not directly related to inquiry–based pedagogy, may turn out to be critical, not only in a practical sense (getting the job done) but also in terms of being accepted and building confidence (relational/emotional dimensions). Failure to pick up on (implicit) things like staffroom etiquette, departmental dynamics, permissions and protocols can leave beginners feeling foolish, or worse, vulnerable, especially if someone perceived to hold a position of power or influence is involved.

Thus, even when beginners' visions and aspirations are largely congruent with the underlying philosophy of the intended curriculum, school culture and classroom reality tend to govern pedagogical decisions; complexity may lead to modification of personal beliefs and changes in practice, but not necessarily in the direction of reform (Haser & Star, 2009; Sing Chai et al., 2009). As Anderson (2002) points out, preparing for an inquiry approach requires much more than just technical input, the political and cultural context of schools must also be addressed.

The introduction of CfE seems to have addressed many of the issues which make inquiry problematic: understanding of inquiry is developing through engagement with curricular documents and collegiate discussion; it provides scope for pursuing pupils' interest which is likely to impact on engagement and behaviour; opportunities for inquiry are being 'built into' the new courses being developed; appropriate material resources are being developed to support the delivery of courses; and it addresses the cultural barriers, to some extent changing the educational priorities and school agendas. Undoubtedly, content coverage will continue to be high on the agenda of many secondary science teachers, and numeracy and literacy will dominate the primary curriculum for many years to come, at least until teachers gain knowledge of the new assessment criteria and expectations for achievement, as well as confidence in their ability to deliver. The culture of assessment is pervasive and stubborn and hampers innovation, however, that the new teachers in this study found it easier to implement inquiry within the CfE format rather than the higher level certificated courses and, further, noticed a positive shift in attitude towards CfE amongst colleagues, suggests that a curricular initiative of this type, with its flexible, learner-centred philosophy, may go a long way to promoting inquiry in schools, thereby answering the call of science education reform.

Recommendations

Based on evidence gathered in this study, against a background of research in the respective areas, the recommendations set out below are pertaining to: teacher candidates; ITE (both on campus and in school); Induction (in-school support and FE involvement); and curriculum implementation. Where relevant, a connection is made to the recently published 'Donaldson Report' (*Teaching Scotland's Future; Report of a review of teacher education in Scotland*, Donaldson, 2011).

Recommendation 1: Recruitment to the Profession

Selection procedures should provide opportunities to explore candidates' personal histories and belief sets in the hope of recruiting teachers with science epistemologies, educational ideologies and visions of teaching which are compatible with the philosophies of inquiry, and CfE generally. This recommendation is based on a wealth of research which points to the influence of individuals' belief sets on adopted teaching approaches and styles of interaction (Eick & Reed, 2002; Wallace & Kang, 2004), but is also supported by evidence herein. Two cases, Charlie and Sean (see Chapter 6), serve to illustrate this point.

Charlie espoused the belief that science education was for developing scientific thought and critical understanding of world issues. He purported to advocate inquiry – 'when pupils have more control over what they pursue... more responsibility' – yet was unable to relinquish any control to the pupils in his classes and there were many instances which revealed a preoccupation with examinable content and a need to be regarded by pupils as an expert or authority in the subject. Although there is no data on Charlie's experience as a learner, interview data point to a science epistemology centred on knowledge, commitment to an examination agenda, and a vision of teaching which places the teacher and pupil in quite traditional roles. Of course, that he was placed in a school which he perceived to have very traditional values and practices, would not have helped (although one may intuit that he was placed there due to a perceived 'fit'). Nevertheless there is room to argue that a different individual with a more pupil-centred teacher identity may have exploited more opportunities for inquiry.

A case in point is Sean. Sean, too, perceived a strong examination agenda and the pressure of accountability, however, because of his experience as a learner (both at school and university), as well as a metacognitive appreciation of how that learning was best fostered, he was able to justify his pupil-centred approaches (an argument supported by improved engagement and behaviour in the class) to the satisfaction of school management.

Donaldson, too, advocates 'more rigorous selection' for entry to initial teacher education programmes, 'drawing on existing best practice and using a wider set of selection criteria' (p. 85; Recommendation 4).

Recommendation 2: ITE – University Learning

Having recruited individuals with the aspiration to realise reform visions, it is important to nurture that potential by helping to develop the knowledge and skills needed to facilitate classroom inquiry. This would necessarily begin with an understanding of inquiry as a pedagogical approach: what practices might constitute inquiry; how, where in the curriculum, with whom to incorporate it; and how best to support investigative activities.

With reference to CfE documentation, and perhaps modelling an inquiry approach in student teaching sessions, there should be explicit discussion of the terms *Inquiry* and *Investigative Pedagogy*, including some consideration of the 'essential features of inquiry' as set out in NSES (NRC, 1996, p. 29). However, lest these be seen as the definitive and defining parameters of inquiry, it is important to present and discuss the various ways in which inquiry finds expression in real classrooms (for example, the 13 variations described in the previous chapter) depending on, for instance, class ability and dynamic, institutional constraints, teacher confidence and the topic in question. With regard to the latter, concrete examples in the context of specific topics would provide useful PCK for beginners, and in terms of primary teachers specifically, a stronger science component would help build subject confidence. This accords with Donaldson's vision, that "increased emphasis should be given to ensuring that primary students have sufficient understanding of the areas they are expected to teach" (p. 89; Recommendation 12). Also, acknowledging the idiosyncratic nature of schools and classes, as well as the uncertainty and risk inherent in inquiry, may help to alleviate individuals' feelings of personal inadequacy should inquiry efforts fail to achieve the desired results.

ITE constitutes the ideal forum to begin dialogue on inquiry; after individuals disperse to their respective schools it becomes much more difficult to ensure any sort of consistent and coherent learning which leads to a shared understanding. In developing such understanding in collaboration with peers and tutors, beginners can go into school with a conception of inquiry that they can have some confidence in, which may help them to recognise opportunities and respond to pupil questions.

Recommendation 3: ITE – Student Teacher Experience

In order to bridge the gap between pedagogical theory on inquiry and teaching practice it is important to build inquiry experiences into student placements. Depending on particular circumstances it may well be appropriate to encourage beginning teachers to dabble with inquiry during student placements whilst they have someone in the class with them to help with organisation and discipline. However, given the difficult time that many student teachers experience on placement - an unacceptable situation acknowledged by Donaldson (2011) - this is probably not the best time to experiment with inquiry. Even where pupil-centred practices are the norm and inquiry encouraged, for the beginner whose knowledge of the class, the topic and general pedagogy is limited, pursuing any lines of inquiry (particularly in a practical sense) risks failure, which may undermine authority and confidence. As Wallace and Kang (2004) suggest, "...the most powerful component of lasting reform may be the opportunity to experience success with inquiry-based teaching" (p. 941). Based on evidence gathered herein, this is unlikely if they don't know the class!

However, as Crawford (2007) argues, it is important that beginners see that student-centred inquiry approaches can work. Other than 'learning through doing' beginners often cite learning from others, including observation, as a valuable medium for learning, so having the opportunity to observe (and possibly assist) would be useful. This would provide some experience of posing questions, structuring the activity (including groupings), and strategic questioning, including perhaps eliciting pupils' questions. It may also highlight some of the benefits cited by those participants lucky enough to observe such practice – 'nice atmosphere', engagement, motivation, enjoyment, ownership, deeper learning. Such experiences may serve not only to modify their own conception of inquiry in line with emerging theoretical models, but may strengthen their commitment to this type of approach, especially if it allows them to see it as a potential solution to difficult behaviour rather than something to be avoided for the sake of managing behaviour.

The provision of such school experiences will depend on strong HE-school partnerships, where dialogue between partners is central. Indeed Donaldson (2011) calls for a more consistent and positive experience for beginners generally, with the possibility of 'hub schools' (a partnership model currently being developed by Glasgow and Aberdeen Universities, analogous to teaching hospitals) being considered. Whether this arrangement would adequately prepare beginners to teach in 'regular' schools is a debate for another day; nevertheless, the idea of 'hand picked' inquiry-oriented student mentors is very appealing.

Recommendation 4: Induction Programme

Promoting inquiry in the beginner's classroom is the central agenda of this research. However, because beginners' general comfort level is very relevant to their classroom practice and, in particular, their capacity for risk taking and innovation, it seems appropriate to consider the wider school context; specifically the curriculum and culture (the focus for Recommendation 6) and the quality of the induction programme. The New Teacher Induction Scheme was established in recognition of new teachers as 'learners' and designed to support beginners through their first year of teaching by incrementally building local and professional knowledge, skills and confidence. It is generally seen as a major success, and without doubt has improved the induction experience of many new teachers, however, that not all beginners perceive a supportive environment and receive adequate training means there is room for improvement, again acknowledged by Donaldson (2011).

Findings of this research suggest that orientation, training and mentoring are critical aspects of induction; inadequacy in any of these areas has the potential to seriously undermine professional development. As such, a more systematic and consistent approach is needed, for example:

- Basic orientation should include a tour of the school, introduction to significant personnel, access to policies and other important information (rules and procedures), signposts to administrative, practical and professional support, and information on curricular materials and teaching resources available.

- A structured programme of CPD should include common 'core' sessions appropriate to all beginning teachers, but also respond to individuals' professional development needs. It should incorporate in-house CPD to allow interaction with colleagues and 'sharing good practice', and external (LA) CPD to promote wider dialogue. Where possible NQTs should have the same opportunities to attend CPD on local and educational initiatives as their colleagues in school as this may help alleviate feelings of inadequacy, in terms of both status and worth, and acquired knowledge and skills.
- Mentors should be selected on suitability; suitable criteria suggested by this research include availability, approachability and experience. A more widespread and consistent mentor training scheme should be instituted in order that mentors hold a common notion of what the role entails, including the tone of the relationship, the type of support expected, and the frequency and focus of support meetings (which, of course, must be accommodated within school timetabling!) This mirrors Donaldson's recommendation that 'mentors should be selected carefully and undertake training based on a recognition of the skills and capacities required for this role' (p. 94, Recommendation 28).

If schools are to be allowed to fill a post using a probationer (especially where it affords economic benefit, such as rationalising staff) then measures must be taken to ensure that school is equipped and prepared to support that probationer.

Another aspect of induction thrown into question by this research is the utility of the SFR. The process of completing their professional profile added significantly to an already overwhelming workload and ate into valuable 'developmental time', yet for most participants the SFR was seen as a time-consuming formality which contributed little to their professional development. Indeed, many participants were more positive about their involvement in the research project and its impact on their development (see following section). This would suggest that another focus, such as research activity, may be more beneficial for their developing teaching practice.

Recommendation 5: Continued involvement of HE

At around the time the New Teacher Induction Scheme was introduced, McNally (2002) argued for the ongoing involvement of HE; this did not happen. Now, a decade later, the issue has resurfaced. Donaldson (2011) reports that although only 4% of probationers retained links to their university, significantly, 45% would have chosen to do so if the opportunity had been offered. Thus he recommends that 'in order to improve continuity and coherence for new teachers, university-based teacher educators should have a role in the development and delivery of induction schemes' (p. 93, Recommendation 25).

Without prior intention, this study strengthens the argument for ongoing input by HE[16] beyond ITE. When asked if they had gained from being involved in the study (T3; final interview), all participants responded positively, and a range of perceived benefits was apparent. For most, the opportunity for reflection was acknowledged and appreciated. This reflection (and verbalisation) had led to greater understanding of their own practice, and of inquiry, and in many cases had encouraged a wider pedagogical repertoire (Shona, Charlie, Lisa, Rebecca, Courtney, Douglas, Dee, p. 218). Indeed, three individuals felt their teaching had benefited more from their involvement in the study than from the formal process of completing their professional profile (Ruth, Carol, Joanne, p. 219).

Some primary participants, having felt let down by the quantity and quality of science content in the ITE course, embarked on the study to improve their knowledge and confidence in teaching science, and on reflection felt it had (eg. Jill, p. 91).

Three participants (Donna, Douglas and Sean) espoused the importance of educational research and, as the following quote suggests, its potential to influence practice.

> *It's made me kind of think a little bit more and I think it would be good to get the outcome of your... the whole thing, and find out what you're kind of reasoning is and what you've found out.* ***(Donna)***

Finally, for some, my visits had a general support function; participants valued the continuity and 'support in the form of rapport' (Obersky, 1999; cited in McNally, 2002).

> *Yeah, I think the main thing is it's been really nice having a familiar face coming up. It's almost like a link to being a student, the student days, and you're getting to discuss... It's quite good to reflect and just say it out loud.* ***(Courtney)***

[16] Although at no time had I tutored anyone in the group, I believe I was, nevertheless, conferred an HE role by association (I was a familiar face around the STEM building, my collegiate relationship with the science tutors was apparent, and I was involved in education research).

Yeah, it's been nice. It's been interesting certainly. I like talking to you. ***(Rose)***

The preceding two quotes (Rose and Courtney) suggest that what was valued was support in the form of one-to-one school visits. This has obvious institutional, practical and economical implications, however, if 'partnership' is to mean anything then it must surely be that Teacher Educators, schools and beginning teachers work together for the benefit of the profession, and ultimately pupils.

Recommendation 6: Promote Inquiry through CfE

The following is not so much a recommendation as an acknowledgment of positive change (in terms of reform-oriented pedagogies) brought about by the introduction of CfE, and an appeal to drive CfE forward through continued CPD, working groups, LA networking and online resource banks (eg. Education Scotland / Glow). As intimated, CfE seems to address many of the oft-cited barriers to inquiry: it challenges traditional pupil-teacher roles, puts responsibility for learning in the hands of pupils, encourages collaboration - all of which lay solid foundations for inquiry-based pedagogy. Participants' experience as students suggests that CfE was not a popular initiative, however, initial resistance seemed to have uncertainty at its roots. Subsequent data suggest that, even one year after its introduction, much of the tension surrounding CfE had dissipated as many teachers began to embrace the increased professional autonomy inherent in the new curricular regimen and appreciate the opportunity to make learning relevant and meaningful.

Paradoxically, even in those schools which were wholeheartedly embracing CfE, inquiry was still difficult to fit in because of the time demands of writing new courses. This suggests that more time needs to be set aside for such development work. On a cautionary note, however, it is important that schools avoid the temptation to 'over-develop' courses for the purpose of supporting teachers' delivery of the experiences and outcomes, thereby producing yet another 'prescribed' curriculum.

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The recommendations set out above are based on a study involving a number of volunteers, a self-selected sample as it were. This may be argued to be a limitation of the study on the basis that it may have attracted a certain type of individual, perhaps with a pre-existing interest in inquiry and predisposed to teach in this way. As such, it may be further argued that the assumption that the interventions suggested may be effective for student teachers generally is flawed. As previously stated, there was no attempt at representation, however neither was there anything to suggest that the research participants were atypical students (if there is such a thing as 'the typical student'). They gave a variety of reasons for becoming involved, including general research interest, improving teaching, CV enhancement, having the opportunity to learn more about science... and just wanting to help. Further, at the outset, many conceded a very tentative understanding of inquiry; some thought it was something different altogether (something to facilitate teacher development rather than classroom pedagogy). Indeed the study itself may be regarded as a form of intervention (although this was not intended), as it oriented NQTs towards inquiry-based pedagogies, informing thinking and, perhaps, shaping practice.

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Clearly the propagation of reform oriented pedagogy will rely heavily on changes within schools in terms of structures and attitudes of management and classroom teachers. However, recognising the potential for new teachers entering the profession to influence the existing culture and practice within schools, it would be prudent for teacher educators to maximise the opportunity afforded by ITE to develop an understanding of, and support for, an inquiry approach. Simple measures such as explicit use of terms, exploring existing notions and building ideas through discussion may provide new teachers with an initial conceptualisation of inquiry that they can have at least some confidence in, in the sense that it was perceived to be jointly constructed. Further, opportunities to observe, discuss and evaluate lessons from an inquiry perspective may provide ideas for introducing and structuring inquiry activities and help to elucidate possible pitfalls, thereby providing a good starting point for practice. Thereafter, a strong induction programme with ongoing HE input to encourage critical reflection, and a science curriculum which affords a degree of teacher flexibility and encourages pupil contribution, will support new teachers' growing pedagogy and teacher identity. Such interventions may just be enough to help beginners recognise opportunities for inquiry and encourage them to experiment with something which, for many, is perceived as a risky but worthwhile approach.

In terms of further research, in the context of CfE, and especially in light of The Donaldson Report, it is important to investigate the current state of play in terms of what measures have been instituted in ITE to promote inquiry, including how this impacts on beginners' understanding and confidence to implement inquiry approaches. However, because beginners' practice is largely dependent on their school context, it is also important to investigate how inquiry is being accommodated within schools' teaching culture and adopted curriculum. From this research it is clear that many schools have responded to the introduction of CfE by re-writing courses. It would be prudent at this stage to conduct an audit of these 'new' courses (in consultation with authors) to identify opportunities for inquiry; for example, flexibility in terms of teaching approaches and topics pursued, or indeed, explicit authentic inquiry activities. Ensuring schools are interpreting curriculum policy as intended at this early stage may contribute to the overall success and longevity of this initiative and thereby promote classroom inquiry in the long term.

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APPENDICES

Appendix 1: Interview Schedules

Time 0 – End of ITE, Summer 2010

Time 1 – End of Term 1, Christmas 2010

Time 2 – End of Term 2, Easter 2011

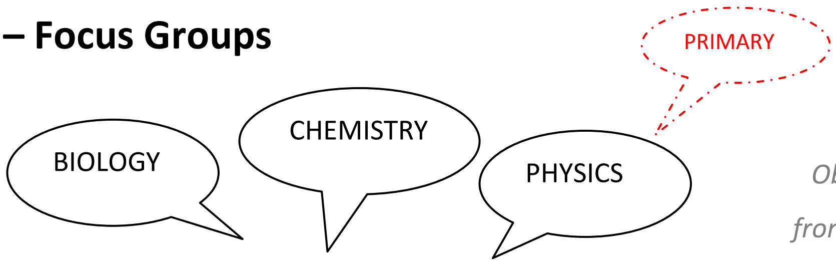
Term 3 – End of Term 3, Summer 2011

Acquiring Investigative Pedagogy

I am interested in how we, as beginners, conceptualise an inquiry or investigative approach and what conditions and learning are needed to *'insider'*

a) facilitate implementation of inquiry in science, and
b) strengthen our commitment to this approach.

Time 0 – Focus Groups



Obtain perspective from 4 distinct groups

Thinking back on your placements …

Q1 What are your priorities for learning when starting in your new school?

Exploration of relationship between knowledge gained and confidence/relationship issues which dominate early on.

Q2 What do you understand by the term 'investigative pedagogy' or 'inquiry-approach'?

Are they the same? or do they have different connotations? Attempt to arrive at a consensus or collective operational definition of what it is and how it differs from a more traditional approach.

Q3 What sorts of issues affect your ability or willingness to incorporate this approach? A list …?

Eg. knowledge, confidence, time, experience, pupil behaviour.......

Q4 What are your thoughts about CfE in this regard?

Does CfE alleviate any of these concerns?

Time 0 – Individual Interviews

For you, what is the purpose or goal of science education – why do we teach science in school? What are we trying to achieve through science education?
Eg. knowledge transmission, generation of knowledge, development of skills...

Do you feel that what happens in science classrooms reflects authentic science?

Do you agree in principle with an inquiry approach to science education? ***Elaborate.*** *Do student teachers advocate this approach generally and if so, why? Eg. more engaging or more accurate portrayal of science?)*

Thinking back over your teaching practice, I'd like you to describe a lesson (either observed or taught) which employed an inquiry approach, with as much structural detail as you can remember. Could you comment on the atmosphere, the children, the learning ... What was most significant to you?

Consider these issues; choose 5 and attempt to order them in terms of their potential impact on the likelihood of you incorporating an inquiry approach.
Derived from focus group data - individual cards so easily ordered.

What have you learned this year (PGDE) which might help you to adopt this approach in your teaching – in uni and in school?
Reflect on utility of past learning and the relative value of different aspects.

What future learning would be needed, or at least beneficial?
Consider their professional development needs in terms of inquiry teaching.

What particular knowledge have you acquired, or failed to acquire, which has impacted on your confidence?
Any experiences which have had a positive or negative impact on confidence.

How confident do you feel at the moment – at the prospect of 'flying solo' in your new school? Do you have any specific worries?

With which year group are you most likely to experiment with an investigative approach?
Perhaps S1 novices with few expectations or S5/6 for control/behaviour reasons?

What are your personal feelings about CfE?

Time 1 – Individual Interviews

Tell me about your experience of settling in.

Open...

Anything that has not met expectations or exceeded expectations?

...perhaps based on student experience?

Is there anything about your situation / placement you've found particularly supportive?

Learning: **What did you strive to learn at first?**

What are your learning goals now?

How prescribed are the science courses?

How much autonomy do you have with respect to your pedagogy?

Describe an inquiry oriented lesson. Difficulties?

Barriers to inquiry task

Would you say ITE prepared you in any way for inquiry?

How is CfE being embraced/implemented?

Time 2 – Individual Interviews

How are you feeling? Are you enjoying your induction year? How do you think it compares to being on placement as a student?

Based on a variety of comments last time about it being so different from placement

Have there been any major incidents which have impacted on your confidence – positive or negative?

What are your main challenges? And your main strategies for getting through this year?

Do you feel you are well enough supported? Who, or what, is the main source of support? What additional support would be helpful?

Is there a structured induction programme in place for you? Do you get to attend organised CPD sessions?

How important would you say your relationship with your mentor/supporter is for getting through this year? Could you characterise that relationship?

Based on the centrality of the mentor/supporter in discussions last time...

In general, what would you say are the main elements of an inquiry-based lesson? What does it mean for your practice and pupil activity?

Given that ITE contributed little to your understanding of inquiry, where are your ideas of inquiry-based teaching coming from; what are the main sources of learning?

Based on consensus last time that ITE did not prepare them for inquiry...

What would help you at this stage to develop inquiry in the classroom?

CPD, observations...?

Barriers to Inquiry Task

Other than these issues, is there anything that's impeding inquiry in your classroom?

Time 3 – Individual Interviews

Thinking about what you've learned this year, what will you do next year to quickly establish your place in the school/department/classroom? What will you do differently, or the same?!

What are your hopes for the school?
- **culture, ethos, relationships, support**
- **curriculum, courses, teaching and learning**

Was there an induction programme in place, with orientation phase, structured CPD and centralised information, eg. policies and procedures; explicit rules and expectations, etc?
How important was this? How different would things have been with/without it?
What type of support have you valued most?
- **moral/emotional/social**
- **support with behaviour**
- **classroom support**
- **pedagogical/professional discussion (courses, T&L)**
- **administrative and procedural**

How useful was the SFR/Profile for your learning & development? Guidance or formality?

Think of a pedagogy you would describe as risky. Why?
Would you describe inquiry as risky? What makes it a risky pursuit?

Do you still advocate inquiry as a worthwhile pursuit?
Do you feel you've achieved a degree of inquiry in your classroom?
With which year groups?
Would you agree that CfE supports inquiry?
What form does inquiry normally take?
- **pre-planned and teacher structured investigative (or research) activities**
- **organic, spontaneous pupil-centred inquiry moments, arising in the course of lessons**

How do you intend to incorporate inquiry next year?
What will you need to know, learn or suss out?
What have you learned this year that will help you incorporate inquiry (more) successfully?
With which year groups do you envisage experimenting with inquiry?

Barriers to Inquiry task
Before, we focused on barriers, BUT what would encourage you to do inquiry?
(Do these mirror the barriers?!)

The 2 main barriers last time in both Primary and Secondary sectors were Understanding & Implementation and Pupils & Behaviour.

In terms of 'understanding', I asked last time what would help.

In terms of Pupils & Behaviour...
What knowledge aids classroom management (discipline); what have you learned?

And finally...

Did you manage to blog at all this year? If not, why not?

What was your main reason or motivation for getting involved in this study? Has it been of benefit?

Appendix 2: Barriers to Inquiry Quantitative Data

- Detailed analysis by time point.
- For each time point, combined primary/secondary data is followed by extracted primary and secondary data.
- In each table, data are sorted in order of frequency of selection.

Combined - T0

Implementation Issues	Frequency	Weight of Response																		Ave	Overall
		C	C	C	C	D	D	D	G	J	J	J	J	L	R	R	R	S	S		
Classroom Management	12	2	4	3	3	3	3		4			4		4	5		5	4		3.7	44
Time Constraints	11			5	5	1	5	3		5			4	3	2	4	3			3.6	40
Availability of Resources	11		2		4	5	2	4	3	4	1	2				1			5	3.0	33
Curriculum Structure & Course Content	10	4			1	4	4	5	1		2			2		3		3		2.9	29
School / Department Politics	10	3		1	2			1		2		3	5	1		2		1		2.1	21
Knowledge of Pupils	7						1		5			5	2	5			4	5		3.9	27
Subject Knowledge	6		5	2						3	5				3				4	3.7	22
Confidence	6	1	3	4							3						1	2		2.3	14
Practical Support Available	6		1						2	1		1			4				2	1.8	11
Learning Intentions	5	5				2							3				2		3	3.0	15
Understanding & Belief in Approach	2										4					5				4.5	9
Assessment / Achievement Implications	2							2											1	1.5	3
Personal Commitment	1												1							1.0	1
School Location (external resources)	1														1					1.0	1
	90																				

Secondary - T0

Implementation Issues	Frequency	Weight of Response													Average	Overall
		C	C	C	D	D	D	G	J	J	J	L	S	S		
Classroom Management	9	2	3	3	3	3		4		4		4	4		3.3	30
Time Constraints	8		5	5	1	5	3		5		4	3			3.9	31
Availability of Resources	8			4	5	2	4	3	4	2				5	3.6	29
Curriculum Structure & Course Content	8	4		1	4	4	5	1				2	3		3.0	24
School / Department Politics	9	3	1	2			1		2	3	5	1	1		2.1	19
Knowledge of Pupils	6					1		5		5	2	5	5		3.8	23
Subject Knowledge	3		2						3					4	3.0	9
Confidence	3	1	4										2		2.3	7
Practical Support Available	4							2	1	1				2	1.5	6
Learning Intentions	4	5			2						3			3	3.3	13
Understanding & Belief in Approach	0														#DIV/0!	0
Assessment / Achievement Implications	2						2							1	1.5	3
Personal Commitment	1										1				1.0	1
School Location (external resources)	0														#DIV/0!	0
	65															

Primary - T0

Implementation Issues	Frequency	W of R					Average	Overall
		C	J	R	R	R		
Classroom Management	3	4		5		5	4.7	14
Time Constraints	3			2	4	3	3.0	9
Availability of Resources	3	2	1		1		1.3	4
Curriculum Structure & Course Content	2		2		3		2.5	5
School / Department Politics	1				2		2.0	2
Knowledge of Pupils	1					4	4.0	4
Subject Knowledge	3	5	5	3			4.3	13
Confidence	3	3	3			1	2.3	7
Practical Support Available	2	1		4			2.5	5
Learning Intentions	1					2	2.0	2
Understanding & Belief in Approach	2		4		5		4.5	9
Assessment / Achievement Implications	0						#DIV/0!	0
Personal Commitment	0						#DIV/0!	0
School Location (external resources)	1			1			1.0	1
	25							

Combined - T1

Implementation Issues	Frequency	C	C	C	D	D	D	J	J	J	L	R	R	R	S	S	Ave	Overall
Classroom Management	7		2	5		3			4		5				4	5	4.0	28
Time Constraints	12	1	4	4	4	5	2	1		5	2	5		5		4	3.5	42
Availability of Resources	9	2	3	2	5				1	2		2		4		2	2.6	23
Curriculum Structure & Course Content	8		5	1	2	4	4			4			5		2		3.4	27
School / Department Politics	5						5					1	4	1	5		3.2	16
Knowledge of Pupils	6			3	3	2				1	4			2			2.5	15
Subject Knowledge	6	4	1					5	3			4	2				3.2	19
Confidence	7	5						2	5		1	3	1			3	2.9	20
Practical Support Available	2				1				2								1.5	3
Learning Intentions	2						1	3									2.0	4
Understanding & Belief in Approach	6	3						4			3		3	3		1	2.8	17
Assessment / Achievement Implications	3						3			3					3		3.0	9
Personal Commitment	1					1											1.0	1
School Location (external resources)	1														1		1.0	1
	75																	

Secondary - T1

Implementation Issues	Frequency	Weight of Response										Average	Overall
		C	C	D	D	D	J	J	L	S	S		
Classroom Management	7	2	5		3		4		5	4	5	4.0	28
Time Constraints	8	4	4	4	5	2		5	2		4	3.8	30
Availability of Resources	6	3	2	5			1	2			2	2.5	15
Curriculum Structure & Course Content	7	5	1	2	4	4		4		2		3.1	22
School / Department Politics	2					5				5		5.0	10
Knowledge of Pupils	5		3	3	2			1	4			2.6	13
Subject Knowledge	2	1					3					2.0	4
Confidence	3						5		1		3	3.0	9
Practical Support Available	2			1			2					1.5	3
Learning Intentions	1					1						1.0	1
Understanding & Belief in Approach	2								3		1	2.0	4
Assessment / Achievement Implications	3					3		3		3		3.0	9
Personal Commitment	1				1							1.0	1
School Location (external resources)	1									1		1.0	1
	50												

Primary - T1

Implementation Issues	Frequency	W of R					Average	Overall
		C	J	R	R	R		
Classroom Management	0						#DIV/0!	0
Time Constraints	4	1	1	5		5	3.0	12
Availability of Resources	3	2		2		4	2.7	8
Curriculum Structure & Course Content	1				5		5.0	5
School / Department Politics	3			1	4	1	2.0	6
Knowledge of Pupils	1					2	2.0	2
Subject Knowledge	4	4	5	4	2		3.8	15
Confidence	4	5	2	3	1		2.8	11
Practical Support Available	0						#DIV/0!	0
Learning Intentions	1		3				3.0	3
Understanding & Belief in Approach	4	3	4		3	3	3.3	13
Assessment / Achievement Implications	0						#DIV/0!	0
Personal Commitment	0						#DIV/0!	0
School Location (external resources)	0						#DIV/0!	0
	25							

Combined - T2

Implementation Issues	Frequency	Weight of Response															Ave	Overall
		C	C	C	D	D	D	J	J	J	L	R	R	R	S	S		
Understanding / Implementation	11	4	5	1	5			5	5		2		5	1	4	3	3.6	40
Pupils & Behaviour	10		2	3		3		1			1	4	3	5	2	4	2.8	28
Resources & Funding	9	5		5	1			2	2	3	3	3				5	3.2	29
Curriculum Structure & Course Content	8		1		3	4			4	2	5		2		1		2.8	22
Time	7	3	3	2		5				4		5		3			3.6	25
Planning & Organisation	7	1			4	2		3			4		4	4			3.1	22
Assessment / Achievement Implications	6			4	2	1				1					5	1	2.3	14
Politics	4						5			5			1		3		3.5	14
Subject Knowledge	4	2	4					4				2					3.0	12
Technical/Classroom Support	2								3			1					2.0	4
Confidence	2								1							2	1.5	3
Learning Intentions	1													2			2.0	2
Classroom Layout	0																####	0
	71																	215

Secondary - T2

Implementation Issues	Frequency	Weight of Response										Average	Overall
		C	C	D	D	D	J	J	L	S	S		
Understanding / Implementation	7	5	1	5			5		2	4	3	3.6	25
Pupils & Behaviour	6	2	3		3				1	2	4	2.5	15
Resources & Funding	6		5	1			2	3	3		5	3.2	19
Curriculum Structure & Course Content	7	1		3	4		4	2	5	1		2.9	20
Time	4	3	2		5			4				3.5	14
Planning & Organisation	3			4	2				4			3.3	10
Assessment / Achievement Implications	6		4	2	1			1		5	1	2.3	14
Politics	3					5		5		3		4.3	13
Subject Knowledge	1	4										4.0	4
Technical/Classroom Support	1						3					3.0	3
Confidence	2						1				2	1.5	3
Learning Intentions	0											#DIV/0!	0
Classroom Layout	0											#DIV/0!	0
	46												140

Primary - T2

Implementation Issues	Frequency	W of R					Average	Overall
		C	J	R	R	R		
Understanding / Implementation	4	4	5		5	1	3.8	15
Pupils & Behaviour	4		1	4	3	5	3.3	13
Resources & Funding	3	5	2	3			3.3	10
Curriculum Structure & Course Content	1				2		2.0	2
Time	3	3		5		3	3.7	11
Planning & Organisation	4	1	3		4	4	3.0	12
Assessment / Achievement Implications	0						#DIV/0!	0
Politics	1				1		1.0	1
Subject Knowledge	3	2	4	2			2.7	8
Technical/Classroom Support	1			1			1.0	1
Confidence	0						#DIV/0!	0
Learning Intentions	1					2	2.0	2
Classroom Layout	0						#DIV/0!	0
	25							75

Combined - T3

Implementation Issues	Frequency	Weight of Response															Ave	Overall
		C	C	C	D	D	D	J	J	J	L	R	R	R	S	S		
Time	11		5	2		5	2		1		4	4	3	4	2	1	3.0	33
Pupils & Behaviour	8		3			1		1	2			5		3	1	4	2.5	20
Resources & Funding	8	1		5	2			4	4		1				3	5	3.1	25
Planning & Organisation	7	2		1	1				5			1	2	5			2.4	17
Politics	7		1	4			5				3	3	4		5		3.6	25
Curriculum Structure & Course Content	6		4		4	3	4	5			5						4.2	25
Understanding / Implementation	5	3		3				2					5	2			3.0	15
Confidence	5	4			5				3				1	1			2.8	14
Assessment / Achievement Implications	4		2			4	3								4		3.3	13
Subject Knowledge	4	5			3			3								3	3.5	14
Technical/Classroom Support	3						1					2				2	1.7	5
Learning Intentions	1										2						2.0	2
Classroom Layout	1					2											2.0	2
	70																	210

Secondary - T3

Implementation Issues	Frequency	Weight of Response										Average	Overall
		C	C	D	D	D	J	J	L	S	S		
Time	8	5	2		5	2	1		4	2	1	2.8	22
Resources & Funding	6		5	2			4		1	3	5	3.3	20
Pupils & Behaviour	5	3			1		2			1	4	2.2	11
Curriculum Structure & Course Content	5	4		4	3	4			5			4.0	20
Politics	5	1	4			5			3	5		3.6	18
Assessment / Achievement Implications	4	2			4	3				4		3.3	13
Planning & Organisation	3		1	1			5					2.3	7
Subject Knowledge	2			3							3	3.0	6
Technical/Classroom Support	2					1					2	1.5	3
Confidence	2			5			3					4.0	8
Understanding / Implementation	1		3									3.0	3
Learning Intentions	1								2			2.0	2
Classroom Layout	1				2							2.0	2
	45												135

Primary - T3

Implementation Issues	Frequency	W of R					Average	Overall
		C	J	R	R	R		
Understanding / Implementation	4	3	2		5	2	3.0	12
Planning & Organisation	4	2		1	2	5	2.5	10
Pupils & Behaviour	3		1	5		3	3.0	9
Time	3			4	3	4	3.7	11
Confidence	3	4			1	1	2.0	6
Resources & Funding	2	1	4				2.5	5
Politics	2			3	4		3.5	7
Subject Knowledge	2	5	3				4.0	8
Curriculum Structure & Course Content	1		5				5.0	5
Technical/Classroom Support	1			2			2.0	2
Assessment / Achievement Implications	0						#DIV/0!	0
Learning Intentions	0						#DIV/0!	0
Classroom Layout	0						#DIV/0!	0
	25							75