The Development of a Model of Continuing Professional Development for Teachers of Primary Science

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Thesis submitted for a Ph.D. degree

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December 2013

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Abstract

A new science curriculum was introduced to primary schools in the Republic of Ireland in 2003. This curriculum, broader in scope than its 1971 predecessor (Curaclam na Bunscoile, 1971), requires teachers at all levels of primary school to teach science. A review carried out in 2008 of children's experiences of this curriculum found that its implementation throughout the country was uneven. This finding, together with the increasing numbers of teachers who were requesting support to implement this curriculum, suggested the need for a review of Irish primary teachers' needs in the area of science.

The research study described in this thesis was undertaken to establish the extent of Irish primary teachers' needs in the area of science by conducting a national survey. The data from this survey, together with data from international studies, were used to develop a theoretical framework for a model of Continuing Professional Development (CPD). This theoretical framework was used to design the *Whole-School, In-School* (WSIS) CPD model which was trialled in two case-study schools. The participants in these 'action-research' case-studies acted as co-researchers, who contributed to the development and evolution of the CPD model in each school. Analysis of the data gathered as part of the evaluation of the *Whole-School, In-School* (WSIS) model of CPD found an improved experience of science for children and improved confidence for teachers teaching at all levels of the primary school. In addition, a template for the establishment of a culture of collaborative CPD in schools has been developed from an analysis of the data.

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I wish to express my sincere thanks to my supervisor, Dr. Declan Kennedy, whose inspirational teaching sparked a love of science and education in me as a young chemistry student. His unfailing belief in me, together with his wisdom, kindness, patience, professionalism and unerring good judgement combined to provide the support I needed to complete this project.

I also wish to thank Professor Kathy Hall who co-supervised this thesis. Her insightful comments and high standards refined my thought processes and honed my writing skills.

I wish to acknowledge the financial assistance I received from the Irish Research Council for Science, Engineering and Technology (IRCSET) to carry out this research.

I am very grateful to the many teachers I encountered throughout this project. I thank those who assisted with piloting questionnaires, providing feedback and those who invested thought and time in responding to the National Needs Analysis. I am especially grateful to all staff members (teaching and non-teaching) of the two schools in which I trialled the CPD model for their dedication and professionalism. Their contribution to this study is immeasurable. I thank sincerely the parents and children of both trial schools, whose enthusiasm was infectious.

I thank my dear friends, Christine, Lorna, Florence, Eibhlín, Maureen, Anne and their 'significant others' who believe in me and inspire me to follow my dreams.
I remember with love my god-parents, Bill and Betty Savage, who first suggested to me that I should become a student of University College Cork, at the age of four!

To my late parents, Kathleen Sylvester-Mulcahy and Timothy Mulcahy and my late brother, Liam Mulcahy, who would have been so proud, I extend my love and gratitude for sharing with me their love of learning.

Heartfelt thanks to my proofreader, Sinéad Reilly, who laboured so intensively with me to bring this thesis to a successful conclusion and to my friend, Rory Geoghegan, whose support made all the difference.

This work would not have been possible without the unwavering love and support of my family to whom I dedicate this work. I will be forever in debt to my extraordinary husband, Brendan and my wonderful sons Jonathan, Timothy and Nicholas with whom I am privileged to share the adventure of life.

Nunci Mulcahy-O'Mahony
December 2013

Author's Declaration

This is to declare that this work is an original study, carried out by the undersigned, which is being presented to a university for the first time as the requirement for the award of a PhD degree.

Signed by the author

Abbreviations

CPD – Continuing Professional Development

DES - Department of Education and Science (Ireland) (1997-2010)

DES - Department of Education and Skills (Ireland) 2010-present

EPV – Extra Personal Vacation

M – Participant in Trial Site 1

NNA – National Needs Analysis

NQT – Newly Qualified Teacher

NPC – National Parents' Council

OECD – The Organisation for Economic Co-operation and Development

P1 – Principal of Trial Site 1

P2 – Principal of Trial Site 2

R – Participant in Trial Site 2

Res NNA – Respondent to National Needs Analysis

SPSS – Software package to analyse the quantitative data

SNA – Special Needs Assistants

TIMSS – Trends in International Mathematics and Science Study

TS1 – Trial Site 1, first school in which WSIS CPD model piloted

TS2 – Trial Site 2, second school which trialled the WSIS CPD model

WinMax – Software package used to analyse the qualitative data

WSIS CPD – Whole-School, In-School model of Continuing Professional Development

CHAPTER 1

INTRODUCTION

1.1 Why Was There a Need For This Research?

My personal interest in science for primary pupils began with a desire to empower primary school children to become life-long learners. In my 1989 thesis I attempted to describe how the skills of science might "develop intellectual potential, to lay the foundation for subsequent learning" (Shulman and Tamir, 1973, in Mulcahy 1989, p.36). The Irish primary science curriculum suggests that "science encompasses knowledge and understanding of the biological and physical aspects of the world, and the processes through which such knowledge and understanding are developed". It also suggests that "science education equips children to live in a world that is increasingly scientifically and technologically oriented" (Department of Education and Science 1999(b), p.6). Since the 1800s, rationales to include science at primary level have included the perceived interdependence of society, science and technology (Beggan, 1988; Eivers and Kennedy, 2006; Directorate General for Research, European Commission, 2007; Department of an Taoiseach, 2008; OECD, 2007 (a), 2009; Varley, Murphy and Veale, 2008(a); Royal Irish Academy, 2009; McKinsey and Company, 2007, 2011; Expert Group on Future Skills Network, 2008, 2011); the perceived contribution of science to children's intellectual development (Bruner, 1960; Shulman, 1968; Driver, 1980; Cresham, 1983); children's innate tendency to construct explanations of natural phenomena (Harlen, 1987; Driver and Easley, 1978; Osborne, 1980; Osborne and Gilbert, 1980; Stead and Osborne, 1981; Osborne and Freyberg, 1985; Driver, Guesne and Tiberghien, 1985) and the need to develop positive attitude formation towards science and technology, particularly among girls (Reidy, 1987; Schollum and Osborne, 1985). The 1999 Irish primary curriculum echoes many of these sentiments, presenting science as necessary within the context of a ‘child-centred’ curriculum and the desirability of developing a sense of responsibility for the environment (Department of Education and Science (DES) 1999(b), p.2-5).

Prior to 1999, while science was an element of the 1971 curriculum (Department of Education and Science, 1971) it was only taught in the senior classes and there is evidence to suggest that it was often neglected (Mulcahy, 1989). The 1999 curriculum, on the other hand, includes primary science as a mandatory subject for all classes. This decision to make science obligatory for all children throughout the compulsory period of their education in Ireland may have been influenced by the findings of Osborne and Freyberg (1985), which support the need to introduce scientific concepts at an earlier age than heretofore. They found that the older the pupil is, the more resistant their self-constructed ideas are to change.

> While we may frequently attempt to teach ideas too early in terms of the intellectual development of our pupils, we must also consider the possibility that we may at present be introducing new ideas at a stage when children are no longer interested or do not want to be interested.
> (Osborne and Freyberg, 1985 in Mulcahy, 1989, p.66)

The traditionally late introduction to science at post-primary level in Ireland (Mulcahy, 1989) may explain why many children in the 12-15 age group have been found to reject science, especially the physical sciences (Task Force on Physical Sciences, 2002). This situation has been compounded by recent cutbacks to the education budget in Ireland (Royal Irish Academy, 2010) with some science subjects no longer being offered in some schools. Physics has been particularly affected.

The introduction of the new national science curriculum into Irish primary schools in 2003 might foster enthusiasm for the subject by introducing science at an earlier stage than heretofore. However, the Primary Science Curriculum (Department of Education and Science, 1999(b)) places considerable demands on primary teachers as it is broader in its remit than the previous curriculum which dated back to 1971.

> There are notable changes between these two curricula including an increased emphasis on the development of scientific skills from junior infants to sixth class. In addition, the 1999 curriculum encourages the development of pupils' scientific knowledge within physical and biological areas at all class levels.
> (Varley et al 2008(a), p.17)

My earlier research into Irish primary science (Mulcahy 1989, p.445) concluded that Irish primary teachers at the time (1980s) felt ill-prepared to teach science and, 78% of those surveyed, considered the teaching of science in Irish primary schools to be "practically non-existent" (Mulcahy, 1989, p.425). This suggests that, prior to the introduction of the 1999 primary science curriculum; science did not enjoy the same status as other subjects. The absence of a culture of science teaching in Irish primary schools suggests that Irish primary teachers would have needed much more support to implement the new curriculum for science, than they did for other subjects.

In 2006, three years after the introduction of the science curriculum, calls from teachers for more support suggest that the in-service provided was, of itself, insufficient (Lawlor, R. 2006). This finding is supported by evidence from the research conducted by Varley, Murphy and Veale (2008 (b)) on behalf of the NCCA which confirms that there are "challenges with the implementation of the primary curriculum" (p.142). Their findings indicate that there is very uneven implementation of the primary science curriculum and that:

> ...post-primary students from different feeder schools could therefore potentially be entering the same post-primary school with widely varying experiences, skill levels and levels of attainment in scientific subject knowledge.
> (Varley et al. 2008 (b), p. 142)

In an effort to address these issues, the 2008 NCCA report recommends continuing professional development for primary teachers, ring-fenced funding for the primary sector and more liaison between the primary and post-primary sectors.

The remit of this research is, therefore, to assess teachers' needs in order to develop an appropriate model of Continuing Professional Development (CPD) in the area of science which would provide the necessary support. In order to assess the teachers' needs, it is important to understand the nature of Irish primary teachers' relationship with science.

1.2 Irish Primary Teachers' Relationship with Science

Even though science is still not a compulsory subject at any level of Irish education science is now studied at Junior Certificate level (the first state examination undertaken by students in Ireland), by about 85% of Irish post-primary students. This has led to a change in the science profile of primary teachers since my 1989 research (Mulcahy, 1989).

> Science is not a compulsory subject despite it being a requirement for the Junior Certificate School Programme. This means that although science must be taught in every school, students can choose whether they wish to study the subject.
> (The Social Science and Politics Research Team, Oireachtas Library and Research Service 2009, p.3)

The majority of schools, however, have opted to make science mandatory for all Junior Certificate students. The choices exercised for the years 2006 to 2008 are summarised in Table 1.1 below.

Year	**% of Candidates Participating in Junior Certificate Science**
2006: N=56,471	89
2007: N=56,031	89.4
2008: N=57,287	85.4

Table 1.1 Participation in Junior Certificate Science, 2006-2008

(adapted from: The Social Science and Politics Research Team, Oireachtas Library and Research Service (2009)

Research by Waldron et al (2007) into the level of science qualification at entry level to Colleges of Education shows that 70% of students entering college in autumn 2004 had a qualification at Leaving Certificate level (final state examination at post primary level), in at least one science subject. While this gives hope that pre-service teachers' subject knowledge in the area of science is on the increase, the evidence shows that the females surveyed for their 2004 study were less likely to have studied physics than their male counterparts. The choice of Leaving Certificate Chemistry in 2004 by 56% of females indicates an increase of about 9% since 1984 (See Table 1.2 below). This may possibly be accounted for by the proliferation of co-educational schools in the intervening years and their concomitant wider provision of subject choice. (In 2002-2003, 50% of girls were still being taught in single sex schools (Department of Education and Science, 2005).

Candidates by Subject in the Leaving Certificate According to Gender				
	1984		2004	
	Male	Female	Male	Female
Total Candidates	76,059	84,729	63,746	71,839
	%	%	%	%
Physics	75.3	24.7	75.7	24.3
Chemistry	52.9	47.1	44	56
Biology	33.5	66.5	31.8	68.2

Table 1.2 Gender of Students Studying Science Subjects in 2004 Leaving Certificate (DES, 2005)

The predominance of females among primary teachers (DES statistics, 2007) suggests that, for those who entered Colleges of Education in 2004 or afterwards, scientific expertise is likely to be predominantly in the biological sciences and to a lesser degree in the area of Chemistry. While the respondents to Waldron's 2004 survey expressed broadly positive attitudes to science as a subject (Waldron et al., 2007) "many… [primary school teachers] have found their own education in science uninspiring and uninteresting and approach the teaching of it with apprehension" (Asoko, 2000, p.80). There is evidence that negative attitudes to science are not confined to primary teachers. Evidence from PISA 2006 (OECD, 2007(a)) indicates that "Students in Ireland reported low levels of involvement in the activities contributing to the engagement in science-related activities" (Kennedy 2008, p.25).

There is also evidence to show that negative attitudes to science tend to become exacerbated with age, and also by perceptions of the physical sciences being more difficult than other subjects (Kelly, 1986; Hendley et al. 1996; Ramsden, 1997; Osborne and Collins, 1999; Cheng et al. 1995; Fitzgibbon and Vincent, 1994 in Kennedy 2008, p.26). It has been found that unless teachers are exposed during their pre-service years to the 'products' of science, the scientific way of working and the real-life applications of science, they may not have the requisite attitudes to cultivate a positive attitude towards science and its relevance in their students (Kennedy 2008, p.26).

> Research in science education suggests that student teachers' prior experiences influence attitudes towards and conceptions of science and science teaching and that this, in turn, can influence practice. (Gooday & Wilson, 1996; Parker & Spink, 1997; Tosun, 2000; Skamp & Mueller, 2001a, b; Thomas & Pedersen, 2003 in Waldron et al. 2007, p.178)

Students from the Republic of Ireland, while ostensibly better prepared in the area of science, expressed less confidence in teaching primary science than similar students from Northern Ireland. (Waldron et al. 2007, p.189). This may indicate a need to review how Irish students experience science at post primary level. Traditional teaching of science subjects has been found to be lacking in addressing the affective issues which currently impact negatively on confidence levels among student primary teachers.

> It is arguable that providing student teachers with more opportunities to acquire a higher level of formal knowledge, for example through the provision of subject knowledge/academic courses, is unlikely to have a positive impact on their classroom practice unless the affective dimension is addressed and their subject-matter knowledge is successfully integrated with their pedagogical knowledge in a way that is consistent with the constructivist view of knowledge that underpins teacher education and child education in Ireland. (Waldron et al. 2007, p.188)

The predominance of females in the profession (DES, 2007) suggests that Irish primary teachers may lack a background in the physical sciences due to their tendency to study biology and to a lesser degree chemistry (See Table 1.2). A lack of subject knowledge in the physical sciences may account for the finding that "Children's experiences of science within the strand units of forces, and properties and characteristics of materials, appear to be rather limited" (Varley, Murphy and Veale 2008(a) p.8). This conclusion is justified in the light of Harlen and Holroyd's finding that "significant differences in confidence were found in favour of ...those with some science in their background compared with those with none" (Harlen and Holroyd, 1997, p.102). It suggests that lack of confidence among primary teachers teaching science is not simply a product of inadequate subject knowledge but may also be attributed to a myriad of other factors such as inability to manage the equipment necessary, inexperience using scientific investigative skills, lack of familiarity with the required pedagogy etc.

Regardless of the underlying reasons, lack of confidence, coupled with the absence of a strong culture of teaching science at primary level (Mulcahy, 1989) and the requests by experienced teachers for assistance (Lawlor, 2006) justify the development of a needs-based programme of science CPD for Irish primary teachers. My research question therefore is **"Which CPD model would best empower Irish teachers to effectively implement the 1999 science curriculum?"**

In order to develop a needs-responsive model, I hope to identify the areas of science (subject knowledge, pedagogy, classroom management etc.) which present as problematic for Irish primary teachers, as well as the type of CPD which they feel would best address their needs. I hope to marry that information with evidence from the literature about the type of CPD accepted internationally as most effective, in order to develop a model of science CPD which is both effective and accessible. In order to maximise the transferability of the resulting model it is my intention to trial it in two schools which mirror the real-life circumstances of an average Irish primary school.

Section 1.3 now outlines the contents of each chapter in this thesis.

1.3 Contents of Each Chapter

Chapter 2 presents a review of the literature with regard to teacher change and development. The chapter gives a brief review of what is known about Irish primary teachers' relationship with science and discusses the impact of that relationship on their engagement with the 1999 science curriculum. It also seeks to summarise the findings in the literature about what constitutes effective CPD.

Chapter 3 attempts to isolate the effective factors of some international models of science CPD. These factors, together with those identified in Chapter 2, are used to support the claim that effective CPD is under-pinned by constructivist principles, and also to construct a theoretical framework for this research.

Chapter 4 describes the design of the research strategy. The chapter provides a rationale for the research methods selected. The research tools used, which included questionnaires, school and classroom observation, journals and interviews are described. A description of the data analysis methodology is also provided. An account is also given of the steps taken to maximise the validity and reliability of the data collection tools and the data analysis.

Chapter 5 reports and discusses the analysis of some of the quantitative data generated by the postal questionnaire, named the National Needs Analysis (NNA). Based on the results of this analysis, a profile of the individual respondents and their schools emerges, and a science profile of Irish primary teachers is constructed which is used to deduce their CPD needs in the area of science.

Chapter 6 reports and discusses the quantitative data generated by the National Needs Analysis pertaining to Irish primary teachers' perceptions of CPD. An effort is made to extract from the data the kind of CPD Irish primary teachers believe would best support their efforts to change. From this analysis of the data, a matrix was constructed which summarises the teacher, school and external factors which ought to be taken into consideration when designing a model of CPD.

Chapter 7 describes the Whole-School, In-School (WSIS) model of CPD as it was first proposed, and how it eventually evolved and adapted to the local conditions in each of the two schools in which it was trialled.

Chapters 8, 9 and 10 outline what the participants considered to be the more successful aspects of the WSIS CPD model.

Chapter 11 deals with the factors which the participants found to be more challenging. It also describes how I dealt with the challenges of these inhibiting factors.

Chapter 12 summarises the main findings of the study and considers how this study has contributed to our knowledge. It also considers some of the limitations of the study which are discussed.

CHAPTER 2

TOWARDS A DEFINITION OF CONTINUING PROFESSIONAL DEVELOPMENT

2.1 Introduction

This chapter seeks to review the literature, official, theoretical and empirical on Continuing Professional Development (CPD) and attempts to synthesise the evidence, in order to identify principles which would underpin a model of CPD for Irish primary teachers of science.

Difficulties with curriculum implementation leading to cries for intervention is a familiar scenario that situates the teacher as a passive consumer of research, a recipient of remedial training and the essential interface between curriculum providers and pupils. The demand is for change - change in our teachers, the assumption being that such change will lead to better learning outcomes for our pupils. Many in bureaucracy see such change as:

> …problematic, with respect to the time taken to bring about change, the low proportion of teachers who engage with the requested changes, the funding implications of universal teacher development, the failure to effect discernible change in learning outcomes, and the lack of career incentives to entice change.
> (Bell and Gilbert 1996, p.8)

Teacher development is increasingly regarded as the means whereby such change can be secured. This chapter seeks to consider what is understood in the literature by the 'development' of teachers. Two anchor studies are used to provide a framework for this chapter. The first study is that of Richardson and Placier (2001) taken from the peer-reviewed journal of the American Educational Research Association (AERA), Handbook of Research on Teaching. Their review of the literature on teacher change spans the decades from 1969 to the beginning of this millennium, and so provides a longitudinal perspective on the literature. Richardson and Placier's (2001) study was chosen because of the breadth of the literature reviewed within it and the historical perspective it provides on the topic of teacher change. It also provides a broader international dimension to this study. The second anchor study chosen to support many of my conclusions is that of Bolam and Weindling (2006). This study synthesised the evidence from twenty research studies of CPD for teachers in England. I chose it because the overall strategy and conclusions were objectively overseen by such bodies as the British Educational Research Association (BERA) and the Evidence for Policy and Practice Information (EPPI) and Co-ordinating Centre (EPPI-Centre) http://eppi.ioe.ac.uk/cms/. Bolam and Weindling used the EPPI-Centre's 'weight of evidence' approach to evaluate the studies and qualified the strength of the evidence according to the three categories 'strong, fairly strong and weak'. I refer only to the results which were deemed to present strong or fairly strong evidence. The two anchor studies cumulatively span the four decades immediately preceding this research.

2.2 Change and Development

The words *change* and *development* are closely linked in the literature on curriculum development and implementation concerns, revealing a tacit presumption that securing one will guarantee the other (Bell and Gilbert 1996, p.8, p.154). Is a teacher who changes also considered to be developing, or must teachers develop in order to change? 'Teacher change' is described in terms of:

> … learning, development, socialisation, growth, improvement, implementation of something new or different, cognitive and affective change and self-study.
> (Richardson and Placier 2001, p.905)

Richardson and Placier (2001, p.907) identify at least three uses of the term 'development' in the literature on teacher change. At times it refers to what might be termed the pathway along which teachers are perceived to move from their personal school days through to their experience as practising teachers, i.e. 'a more naturalistic concept of learning and movement towards becoming an experienced and, sometimes an expert teacher'. Development is also perceived as consisting of 'Piagetian-like stages of development' (Piaget, 1970; Nias, 1989; Goldsmith and Schifter, 1994; Hollingsworth 1989 and Leithwood, 1992). The third use of the term is:

> …increasingly used to describe what used to be more commonly known as 'in-service education'.
> (Richardson and Placier 2001, p.907)

This is commonly understood to be 'training' or induction into either a new way of thinking or some other innovation. In all meanings, the word 'development' has invariably been linked to efforts to secure 'teacher change'.

From Richardson and Placier's (2001) overview of the research into change from the 1970s to the 1990s, a picture emerges of teachers being viewed as recalcitrant and uncooperative with the designs of curriculum developers. Change is viewed as the goal of curriculum developers, where the change is quantified in terms of the degree of implementation of the intended innovation. Change is therefore observable and quantifiable in terms of the degree of implementation and, teachers have traditionally been viewed as not amenable to 'arbitrary or at least sudden change at the behest of central government" (Bell and Gilbert 1996, p.154).

This approach to teacher development arose from the realisation that merely providing teachers with new curriculum materials, teachers' guides or even new pedagogical ideas was insufficient stimulus to change (Shaver1987, p.112).

> Experience of curriculum materials development shows that, however sound in theory such materials are, the resources put into developing them are not well used unless teacher education adequately prepares teachers for using them.
> (Harlen 1983, p.198)

Similar sentiments were expressed by the Irish National Teachers' Organisation in 1992.

> The transmission of new science programmes will have only minimal impact unless they are accompanied by a genuine commitment to provide in-service education for all teachers.
> (INTO, 1992, p.46 in Varley et al. 2008(a), p.15)

Hopes of increasing the incorporation of science into primary education from the 1960s onwards revolved exclusively around the development of curriculum materials. These materials variously included both teacher guides and student materials but still proved, of themselves, insufficient.

> …in spite of all the curriculum reform, widespread implementation has not occurred…the evidence points strongly to the need for pre-service and in-service training to provide for teachers what they so frequently lack at present-experience with inquiry skills, a basic understanding of science concepts and, above all, confidence.
> (Martin (1983) in Harlen 1983, p.66-67)

The surge in research in the 1980s into science teachers' thoughts, subject matter knowledge and their conceptions of teaching and learning science has been related to reports from the inspectorate in the 1970s and early 1980s on the poor quality of teachers' content knowledge of science, particularly in the case of primary and lower secondary teachers (Vonk, 1991; De Jong et al., 1998).

The manner in which the most recent Irish primary science curriculum (1999) was introduced could be described as an 'Empirical-rational' strategy, which believes that change in practice is possible through appropriate and timely interventions (Richardson and Placier, 2001). However Bell and Gilbert (1996) would claim that this concept of 'change without innovation' is "simplistic in the extreme, with a focus on becoming familiar with the new requirements in detail and turning them into schemes of work, making as few changes to existing practice as possible" Bell and Gilbert (1996, p.154-155). This research seeks to find out if practice has changed in response to the introduction of the 1999 science curriculum and if not, why not.

2.3 Irish Primary Teachers and Science

The low status of scientific knowledge amongst primary teachers internationally (Wragg et al., 1989; Alexander et al., 1992; Summers, 1992; Ofsted 1994 and Harlen et al.1995) justifies the expectation that Irish primary teachers might be poorly prepared to teach science, given the uneven provision for science at pre-service level in Ireland. Up to 2012 there was no standardised provision for curriculum science among the Colleges of Education, with the number of hours varying from 12 to 44 over a three year degree as seen from Table 2.1 below.

Number of Hours per Year Dedicated to Curriculum Science					
Year of Degree	Church of Ireland College of Education, Dublin	Coláiste Mhuire Marino, Dublin	Froebel College, Dublin	Mary Immaculate College, Limerick	St. Patrick's College Dublin
1st year	14	14		6	0
2nd year	14	14		6	44
3rd year	7	14		0	0
Total	35	42	35 in total	12	44

Table 2.1 Compulsory Curriculum Science Hours for Pre-Service Teachers in the Three Year Bachelor of Education Degree
(Varley, Murphy and Veale 2008(a), p. 24)

Students attending St. Patrick's College up to 2012, had the option of studying Bioscience in first year, but none of the other Colleges of Education in the Republic of Ireland ever offered any 'academic' science subject. See Table 2.2 below.

College	Academic Science	Education Subjects
Mary Immaculate College, Limerick	None	Social, Environmental and Scientific Education
St. Patrick's College, Drumcondra, Dublin	Bioscience (First year only)	Curriculum History, Curriculum Geography, Curriculum Science
Coláiste Mhuire, Marino, Dublin	None	Social, Environmental and Scientific Education
Froebel College, Dublin	None	Social, Environmental and Scientific Education
Church of Ireland College of Education, Dublin	None	Social, Environmental and Scientific Education

Table 2.2 Provision for Science in Irish B. Ed Programmes (Extracted from Waldron et al. 2007, p.187 and College websites, December, 2011)

A recent study suggests that for pre-service Irish primary teachers:

> ….insufficient scientific content knowledge was a concern for many of them, as were concerns over various teaching methodologies and classroom management issues in teaching science. The findings of this study are worrying, as it is likely that high percentages of these students will enter the teaching profession with similar inaccurate conceptions of science as the students they will be teaching.
> (Murphy and Smith 2012, p.3)

This view of pre-service primary teachers' scientific knowledge has been corroborated internationally by Harty, Samuel and Andersen (1991); Scharmann (1988a, 1988b), Wenner (1993), De Boo and Randal (2001); Goodrum, Hackling, and Rennie (2000); Jarvis and Pell (2004); Murphy, Neil, and Beggs (2007); Osborne and Simon (1996); Varley, Murphy, and Veale (2008(a) and (b)); Waldron et al. (2007) and Murphy, Beggs, Russell and Melton (2005). Deficient scientific knowledge is not confined to pre-service teachers but has also been found among qualified primary teachers by Kruger, Summers and Palacio (1990); Harlen et al. (1995); Carré (1997) and Shulman (1987). Murphy et al (2005) found that primary teachers themselves strongly support such views.

The evidence from research into early post-primary education (Kennedy, 2008) through to pre-service education (Varley et al.,2008(b)) in Ireland suggests that primary teachers´ experiences of science have not promoted an enthusiasm for the subject, culminating in poorly developed subject knowledge and poor confidence.

Section 2.3.1 now considers what efforts have been made to support primary teachers to implement the 1999 science curriculum.

2.3.1 Supports provided to Irish primary teachers 2002 to the present date

In the academic year 2002-2003 the Primary Curriculum Support Programme (PCSP) provided in-service courses to support teachers implementing the 1999 science curriculum (Varley et al. 2008(a), p.23). The Regional Curriculum Support Service (RCSS) provided support to schools after the initial in-service through the system of 'Cuiditheoirí', which provided in-school visits and workshops (Varley et al. 2008(a), p.23). Schools also received money with which to purchase materials and equipment. On-going support for implementation has, however, been limited. Varley et al (2008(a), p.25-27) outline three projects which provide support for teachers - Discover Primary Science, the K'NEX challenge and the Eureka weekly science supplement with the publication 'The Irish Independent'. The most popular of these among teachers is the Discover Primary Science programme which provides in-service education and materials to one teacher from each school. The system of in-school support which was very popular has now been discontinued. This mirrors a similar pattern of withdrawal of support by government as witnessed in the UK and New Zealand, where it is reported that "teachers feel thrown back on their own resources" (Bell and Gilbert 1996, p.9).

It has been argued that "a teacher can help children to inquire without being a science specialist" (Martin, 1983, in Harlen 1983, p.58). This argument is considered in section 2.3.2.

2.3.2 Does an inadequate science education matter?

Floden (2001, p.13) suggests it is mere ‘common sense’ to argue that teachers who know more about their subject will produce better results with students, and refers to studies which have empirically connected teacher knowledge to student learning e.g. Cobb et al., (1991); Carpenter et al. (1989); Cohen and Hill (1998). Garet et al. (2001) concur with Cohen and Hill’s conclusions.

> Our results also indicate that professional development that focuses on academic subject matter (content), gives teachers opportunities for “hands –on” work (active learning), and is integrated into the daily life of the school (coherence), is more likely to produce enhanced knowledge and skills.
> (Garet et al. 2001, p.935)

The evidence is clear that without adequate teacher preparation to teach science, confidence is compromised among teachers:

> …with half of all respondents pointing towards lack of knowledge, expertise, confidence and training as their main concerns in teaching science.
> (Murphy et al. 2005, p.3)

Teachers preparing for exams appear to withdraw to the comfort zone of teacher-controlled, rote learning by the pupils wherein the teachers’ conceptual understanding is not challenged. This type of teaching has been linked to a decline in children’s interest in science (Murphy et al. 2005, p.7)

This highlights the danger of expecting poorly prepared and inadequately supported teachers to implement a curriculum in which they have little or no background. Pupils far from becoming enthused about science may well have an experience of science, based on ‘knowledge acquisition’ (Field 2011, p.171) that would further alienate them from the subject.

Murphy and Beggs (2005) found that the primary influence on teachers’ levels of confidence teaching science:

> ...was their experience of professional development in science; those who had carried out CPD in science were more confident in nearly all aspects of science teaching from developing children's investigative skills, to developing their understanding of topics deemed difficult and addressing how science might affect children's lives.
> (Murphy et al. 2005, p.15)

However, many teachers who have undertaken such CPD in their own time and at their own expense feel frustrated as, without support, they fail to implement innovative practice.

> …unable to use the new teaching activities, curriculum materials or content knowledge to improve the learning of their students [they]… find themselves teaching in the same way they always have.
> (Bell and Gilbert 1996, p.9)

In section 2.4 I consider how professional development might provide the kind of support teachers need to change their practice, and thus increase their confidence.

2.4 Implications for Irish Primary Teachers of Science

Irish Primary teachers, aware of their needs in the area of science, expressed their desire to change. To this end they sought support from the Education Support Centres in Cork, West Cork and Limerick; in University College Cork (UCC) and other similar institutions around Ireland. UCC set up the Diploma in the Teaching of Primary Science in response to these requests for assistance (Lawlor, 2006). Wenner (1993) also found high levels of motivation among pre-service teachers to improve their knowledge for teaching science.

However, the pursuit of a programme of CPD in Ireland requires a very high degree of motivation because the full costs, both personal and financial, with limited opportunity for specific needs-oriented development must be borne by individuals. Section 2.4.1 considers this motivation.

2.4.1 Why do teachers voluntarily pursue CPD?

Research has found that the greatest motivator for teachers to participate in CPD is the belief that it will impact on their students' learning.

> Research evidence … shows that professional development is most likely to lead to successful changes in teachers' practice where teachers want to change, particularly because they believe it will help their pupils' learning.
> (DfEE 2001, paragraph 20)

Evidence from the UK and the USA indicate that such belief is justified. CPD programmes:

> …were linked with improvements in both teaching and student learning; many of these improvements were substantial. Seven studies reported increases in student performance, eight reported demonstrable changes in student behaviour, or both.
> (Bolam and Weindling 2006, p.20-21)

The more cynical might suggest that it is teachers' *belief* in the impact of CPD programmes, rather than the programmes themselves, which make the difference to perceived learning outcomes. This may be plausible as participation alone is likely to lead to increased class time on a topic, increased confidence around the topic of the development and more familiarity with the reform topic. However, of the twenty studies reviewed by Bolam and Weindling (2006), eight were considered to provide strong evidence of the link between participation in CPD and student outcomes.

The evidence, therefore, justifies the provision of professional development programmes but does not indicate the type of programme which should be provided. Section 2.5 attempts to identify what the literature claims to constitute effective CPD.

2.5 Effective CPD

Bolam and Weindling (2006, p.4) claim that professional development:

> ...consists of all natural learning experiences and those conscious and planned activities which are intended to be of direct or indirect

> benefit to the individual, group or school. It is the process by which, alone and with others, teachers review, renew and extend their commitment as change agents to the moral purposes of teaching; and by which they acquire and develop critically the knowledge, skills, and emotional intelligence essential to professional thinking, planning and practice with children, young people and colleagues through each phase of their teaching lives.
> (Day (1999) in Bolam and Weindling 2006, p.4)

This definition incorporates the three categories of 'development' identified by Richardson and Placier (2001, p.907). It is clear from Day´s definition that any programme of planned professional development needs to take into consideration the voluntary or naturalistic changes which cannot be planned for, as well as the stages of development of the participants. Section 2.5.1 considers these idiosyncratic aspects of change.

2.5.1 Due attention to individual beliefs and attitudes

It would appear that teachers are very resistant to change unless their tacitly–held theories of teaching, learning, knowledge and classroom activities are made explicit and found by the teachers *themselves* to be wanting. Unfortunately the "mismatch between goals of the reforms and the objectives of …the school" (Borman et al. 2005, p.43) can alienate individuals and schools. Marks and Gersten (1998) found that low engagement and low impact were the results when "teachers' philosophies contradicted the assumptions underlying the practice being encouraged." Research into 'naturalistic change' (Richardson and Placier, 2001) revealed that professional development programmes which did not take into account teachers' prior experience, philosophies or beliefs would be ineffectual. Fullan claims that:

> …**personal purpose** is the route to organizational change. When it is diminished, we see in its place group-think and a continual stream of fragmented, surface-changes acquired uncritically and easily discarded.
> (1993, p.13)

CPD which takes into account teachers' existing knowledge (Krajcik and Layman, 1989; Clermont et al., 1993; Smith and Neale,1989; Borko and Putnam,1997) reflects a view of professional growth:

> …which recognises teaching as a complex activity that is highly demanding, both cognitively and affectively, and is a process of continuous development in which teachers themselves have a high personal as well as a professional investment.
> (Calderhead and Gates 1993, p.9)

Hunzicker (2011, p.177) also claims that teachers are motivated by "opportunities to address problems - and create solutions - that relate directly to their lives".

It would seem from the evidence that professional development must originate in individuals' perceived needs. In order to be aware of their needs, teachers must have the opportunity to reflect on their practice, both alone and with others.

2.5.2 Reflection

Ryan (2005) agrees that teachers need to become aware of their beliefs through reflection.

> The comprehensive teasing out of these tensions through reflection was found to be fundamental to the professional development of those who participated in the study as a whole. Seeking to attain a sense of individually meaningful equilibrium in their work, these teachers could, as a consequence of their reflection, readily determine the need for, and as appropriate, initiate a reconstruction of their images, and hence explicate any necessary improvements in their professional practices.
> (Ryan, 2005, p.195)

Support for this personal dimension of CPD is found in Fullan (1991) and Bell and Gilbert (1996).

> Educational reform will never amount to anything until teachers become simultaneously and seamlessly inquiry oriented, skilled, *reflective* and collaborative professionals.
> (Fullan 1991, p.326)

Fullan continues by saying that the use of such a reflective technique "might well promote sustained professional development of teachers as an essential basis for educational change". The 'normative-re-educative' change mechanisms in Richardson and Placier (2001), suggest that individuals act on the basis of socio-cultural norms to which they have become committed through a process of collaborative reflection.

> Within this normative-re-educative change approach, the assumption is made that change is enhanced through deep reflection on beliefs and practices. Because the change process entails understanding one's beliefs and knowledge and determining whether or not to change them dialogue has been used as a critical element of this process.
> (Richardson and Placier 2001, p.906)

Field (2011, p.171) agrees that reflection is at the heart of effective CPD and suggests that, unless teachers are given the opportunity to reflect, "the wider impact of professional learning is not achieved".

> The emulation of ideas and the use of materials developed without reflection do not empower the teacher, but can make them over-reliant on the use of products of others' learning.
> (Field 2011, p.171)

Fullan (1988) would concur with Richardson and Placier (2001) that reflection is best done collaboratively in an on-going, interactive way which allows 'sufficient time' for it. This raises the issue of the appropriate length of time needed for CPD to be effective.

2.5.3 Appropriate time for CPD

The need for sufficient time is found in the research of Summers and Kruger (1994), Blumenfeld et al. (1994) and Dillon et al. (2000) which points to a needs-based model of change programme offering extended support to teachers trying to change. Bell and Gilbert (1996, p.4) explain the need for longer support by claiming that, teachers' experiences of conceptual change reflects that observed in students which occurs over a longer period than traditionally allowed for. Courses which acknowledge this are thought more likely to be effective than the traditional short 'delivery' model described by Hunzicker (2011) as "one shot, sit and get" programmes (Blumenfeld et al., 1994; Anders and Richardson, 1991; Placier and Hamilton, 1994; Richardson and Hamilton, 1994 and Bos and Anders, 1994). Garet et al (2001, p.935) provide empirical evidence for the effectiveness of "sustained and intensive professional development which is more likely to have an impact, as reported by teachers, than is shorter professional development."

> The evidence is relatively clear about the main characteristics of CPD that appear effective in improving teachers' performance and in raising standards of pupil achievement…it promotes continuous inquiry and problem-solving embedded in the daily life of schools.
> (Bolam and Weindling 2006, p.66)

It has been found that the 'empirical–rational' view of teachers, evident in the introduction of the 1999 science curriculum, where they are expected to deliver unchanged mandated reform, does not take into account teachers' tendencies to amend policy to fit their own belief systems.

> [They]…interpret and enact the precarious facets of policy and in so doing, invariably influence and modify them through their practice. In consequence, practitioners' decisions can and do significantly affect policy, producing outcomes that were unintended as intended by the original policy makers.
> (Bolam and Weindling 2006, p.58)

What leads teachers to accept the need for reform and then change their practice to incorporate it? It would appear from the literature that teachers are driven by their personally identified need to change (Section 2.5.1).

> The most effective transfer processes are those that are demand driven (the pull to learn and change comes from the person or unit that has a problem or need) rather than push or laissez-faire approaches.

(O’Dell and Grayson (1998) p.173 in Bolam and Weindling 2006, p.115)

But how do we meet the needs of the system while also addressing individual needs? Bolam and Weindling (2006, p.3) suggest that this might be achieved by...”making teachers’ professional development more systematic and systemic”.

2.5.4 Systemic Reform - Changing the culture of teaching

Susan Moore Johnson (1990) gives an uncompromising portrayal of the culture of teaching.

> In the ideal world of schooling teachers would be true colleagues working together, debating about goals, purposes, coordinating lessons, observing and critiquing each other’s work, sharing successes and offering solace, with the triumphs of their collective efforts far exceeding the summed accomplishments of their solitary struggles. The real world of schools is usually depicted very differently with teachers sequestered in classrooms, encountering peers only on entering or leaving the building. Engaged in parallel piecework, they devise curricula on their own, ignoring the plans of their counterparts in other classrooms or grades……….Although such portrayals are often exaggerated, they contain more truth than most of us would like to believe.
> (Moore Johnson 1990, p.148)

If this portrayal accurately reflects reality in schools, the difficult task of changing the prevailing culture from insularity to collaboration must be examined. Richardson and Placier (2001, p.922) contend that school and teacher changes are “long-term, interdependent, micro-level processes that entail changes in beliefs and interactions.” Similarly, Bolam and Weindling (2006, p.23) found that collaborative CPD was linked with an improved disposition to work and reflect collaboratively with colleagues on an ongoing process as well as “observable and self-reported enhancement in... motivation; teacher confidence; attitudes and beliefs.”

There is evidence that “the transfer rate of training into classroom practice approaches 100 percent” (Joyce and Showers, 1995), and that improved attitudes towards professional development result (Bolam and Weindling, 2006), when the entire staff participates in CPD.

> All the studies found links between the CPD and changes in teacher practice, attitudes or beliefs….there was evidence that changes in teachers' classroom behaviour were accompanied by positive changes in attitude to their professional development.
> (Bolam and Weindling 2006, p.22)

This provides strong evidence for moving the focus of change away from individual teachers or schools to more collaborative ways of working where such:

> …a supportive approach does not neglect criticality. Criticality helps to diagnose and eliminate errors. Interaction with colleagues and peers promotes collaboration and teachers respect the opinion of those with real experience and empathy. Emotional well being is at the core of effective CPD, but not in the form of constant positive stroking. Challenge and critique is how reflection is encouraged.
> (Field 2011, p.172)

This type of interaction pre-supposes strong relationships of trust among staff.

> A strong trust level is important within the community since it is important for the participants to discuss with others their practices that don't seem to work, and to accept responsibility for their own practices. Thus the development of a discourse community is productive in beginning this process of change.
> (Richardson and Placier, 2001, p.921)

To effect the "transfer of practice is more intrusive" than merely affirming colleagues … "and therefore more demanding on the quality of the relationships between those involved in the process" (Bolam and Weindling 2006, p.29) but:

> …the majority of teacher respondents saw healthy development and challenge as an outcome not a casualty of long term relationships of trust.
> (Bolam and Weindling 2006, p.29)

From the evidence above, it is possible that peer affirmation of good practice could provide the impetus to continue one's professional development. If this is so, is it possible that teachers could be inhibited from participation in CPD or implementation of innovative practice by the nature of their relationships with colleagues? Section 2.5.5 addresses the issue of school culture and both its positive and negative effects on change efforts.

2.5.5 School culture

Bolam and Weindling (2006, p.24) were unequivocal that a supportive ethos in the workplace and support from senior managers were necessary for the implementation of change arising from CPD.

> Certain kinds of trusting relationships were fundamental to the transfer of good practice. They were not an extra or a pleasant accompaniment, but the necessary foundation of the complex, demanding and potentially rewarding process of professional learning across professional boundaries.
> (Bolam and Weindling 2006, p.29)

In total they found that eight of nine projects provided strong evidence for the importance of a supportive school culture for CPD. Sharp et al. (2005) found that “culture was critical to the success of a research–engaged school”, while Bolam et al. (2005) found that “culture was fundamental to the success of a professional learning community involving all staff, teachers and support staff.” School culture was also found to provide strong support in “promoting a research orientation and professional learning community” (Bolam and Weindling 2006, p.84). The corollary of this is that there is also evidence to show that the school culture can *inhibit* innovative practice, if that culture does not endorse the new practice.

> Cultures of individual teacher autonomy, lack of tradition, the structure of the Irish school day and views of CPD as an optional add-on are among the factors frequently put forward as inhibiting such developments.
> (Callan, 1997; Sugrue et al., 2001)

Studies tracking young teachers in their early years of teaching found that the prevailing attitudes of the existing staff could have a negative impact on the teaching methods employed by them, and these new teachers were even found to adopt the negative stance of the dominant group. "…they [new teachers] become socialized to entrenched ineffective practices" (Anderson and Mitchener, 1994). The negative effect of school culture is identified in the International Review of Finnish Teacher Education carried out in 2000, which found that the effect of teacher education versus the dominating school culture is weak. The study discusses the negative 'reinforcing culture' which could possibly militate against innovation in schools. This 'Reinforcing Process' tends to keep existing practice dominant (Jussila and Saari, 2000) and, encourages teachers who find the process of change stressful, "to develop a variety of psychological defence strategies to avoid learning that challenges their identity and personal ways of thinking" (Illeris, 2003).

Changing the dominant culture of a school is, however, a difficult under-taking. Bolam and Weindling (2006, p.115) categorise this difficulty as an 'enduring issue', and highlight the dilemma of securing "agreed understandings of …CPD as reflective learning-in-practice by teachers" when "the majority of teachers still see professional development largely in terms of short courses and INSET days." An unintended effect of participation in collaborative CPD, however, has been found to be "a disposition to work and reflect collaboratively with colleagues on an ongoing process" Bolam and Weindling (2006, p.23), and increased participation in CPD. This was true even where it was not a specific aim of the CPD undertaken.

It would appear, therefore, that experience of collaboration promotes the development of a collaborative culture. Section 2.5.5 now looks at the potential of CPD which is pursued individually to impact on practice.

2.5.6 The power of one?

Isolation has been found to negatively affect teacher learning and development in a number of ways. Firstly, an individual seeking to challenge existing practice may encounter:

> ...resistance from those who understand their professional competence to be a positive and direct outcome of the social reality that is confined to the classroom but cut off from the wider social and political contexts.
> (Hutchinson and Whitehouse 1986, p.93)

Secondly, teachers have idiosyncratic needs which may or may not reflect the needs of the school (Hustler et al., 2003, in Bolam and Weindling, 2006). Bolam and Weindling (2006) found that ten of the eleven projects dealing with ‘needs identification’ offered strong evidence that this should be part of CPD policy. If, however, we rely on teachers choosing courses that address only their individual needs to simultaneously address the CPD needs of a whole school, the success rate is likely to be at best piecemeal. Dillon (2000) supports this argument and says that “the key issue is the importance of individual teachers’ relationships with individual institutions.” The need for balance between individual and institutional needs is reiterated by Hustler et al. (2003) and Goodall et al. (2005) (in Bolam and Weindling and Weindling 2006, p.7-8)

While many mission statements of schools contain aspirations to a culture of learning, few contain any commitment to the development of individuals within that school. This type of commitment is already a feature of some schools in the UK.

> I get to visit some schools where they think very hard about the whole staff and the way they manage their performance and their development. They have individual plans for every member of staff. I see that as a basic requirement for a school and for every individual. They talk to people about how they can contribute more to the school, how they can build up their skills and do things to help them develop in their own careers. They follow that discussion up with

> giving people lots of opportunities and offering very pro-active support, coaching, mentoring, and that drives into support for change management programmes. Also they evaluate the impact although that's always the hardest bit.
> (Earley and Handscomb (2005) in Budd and Earley, 2006, p.4)

When teachers are committed not alone to their personal development, but also to that of their colleagues, a different perspective on needs emerges. In this way a symbiotic relationship will obtain between the development of the school and the development of the individual.

> While high quality instruction depends on the competence and aptitudes of individual teachers, individual knowledge, skills and dispositions when put to use collectively within a school can create a strong professional community.
> (King and Newman, 2000 in Borman et al. 2005, p.8)

Harnessing the experiences and development of individuals to contribute to a professional learning community requires leadership, if that individual expertise is not to devolve into disparate, competitive practices. Section 2.5.7 considers the type of leadership necessary to drive a culture of collaboration which successfully incorporates individual professional development.

2.5.7 Leadership

Floden (2001) found that teachers experiencing most success in implementing innovative practice were:

> …supported by communities in their schools in which teachers shared a commitment to examining and improving their practice. These communities, in turn, were fostered by subject-matter departments and by *principals who shared this commitment.*
> (Floden 2001, p.12)

Borman et al. (2005) quote Supovitz and Turner (2000) who claim that teachers who felt supported by their principal reported significantly greater use of reform approaches than those who did not. The most compelling evidence for the pivotal role of the principal is Bolam and Weindling's (2006, p.29) finding that not only could principals 'enable' CPD, they also played a key role in obstructing 'collaborative working arrangements in ways that did not appear to be justified'. The Education Act, 1998 (Government of Ireland, 1998 Section 23, 2.c) considers the principal as central to cultivating a culture of collaborative enquiry in his/her school but neglects to acknowledge the complexity of the issue. It has been seen that such a culture is not the product of just one generation of teachers or indeed principal. Teachers in a school are themselves subject to the vagaries of the dominant culture and may not be in a position to challenge that culture. The 2011 policy document of the Teaching Council not only suggests that principals should be supportive of CPD by creating the right 'school environment', but actually has changed the definition of what it means to be a principal, by assigning responsibility for provision of CPD to them.

> Effective school leadership, within a collaborative school culture, is essential for the continuing professional development of teachers. In particular, the instructional leadership aspect of the principal's role should be the central and core element of his/her work and should also include provision for CPD for the school.
> (The Teaching Council June 2011, p.20)

This declaration recognises that responsibility for professional development must be allocated, and indicates that the perception of CPD as an optional extra is on the wane. However, making professional development 'the central and core element' of a principal's work neglects the research evidence about the ownership of CPD, highlighted as a factor which has been confirmed as:

> ...likely to contribute powerfully to effective CPD….the more influence teachers have over their own CPD, the more likely they are to judge it effective.
> (Bolam and Weindling 2006, p.7)

It also contradicts the Teaching Council’s own assertion that:

> ..the current administrative workload of principals, and particularly teaching principals, should be addressed so that they can be facilitated in developing the school as a learning community. The move to a model of more distributed leadership within schools would facilitate this.
> (The Teaching Council June 2011, p.20)

In light of the current embargo (2011-2013) on middle management appointments, re-defining the role of principal to make it a primarily ‘instructional’ one, while simultaneously withdrawing the means to realistically provide for the ‘administrative workload’, suggests that the provision of leadership for CPD has not been thought through sufficiently. The research of Bubb and Earley (2006, p.2) supports the notion that the CPD coordinator would ideally come from within the ranks of middle management.

A culture supportive of collaborative CPD, simultaneously committed to the professional development of individual teachers and their school, led by a dedicated CPD coordinator, are some of the hallmarks of effective CPD. What other considerations are necessary to improve the effectiveness of a CPD programme?

2.5.8 Context

The characteristic which unifies the research into theories of change is that change is personal and quite unique to individuals. Change is also context-specific and tends to be more likely to be sustainable if the change takes into account the context in which the practice takes place. Bolam and Weindling (2006 (a), p.7) conclude from their review of the research on the topic that effective CPD should…“use collaborative, collegial and generally school-based learning environments”.

It has been seen in Section 2.5.6 that individual change can only hope to be effective if it takes place within a supportive context. The most supportive context must be the school itself 'because it is real'.

> Effective professional development is job-embedded, making it relevant and authentic. Professional development becomes relevant when it connects to teachers' daily responsibilities and becomes authentic when it is seamlessly integrated into each school day, engaging teachers in activities such as coaching, mentoring and study groups.... Teachers take job-embedded professional development seriously because it is real.
> (Hunzicker 2011, p.178)

Efforts to reconceptualise the school as a centre of research can be traced back to the 1960s in such books as Schaefer's 1967 *The School as a Center of Inquiry*. Similar themes are explored in *Tomorrow's Schools* by the Holmes Group (1990). The qualities required for this type of programme to succeed have been summarised in research on staff development by Fullan, 1990; Griffin, 1986; Loucks-Horsley et al, 1987; McLaughlin, 1991 and Ward, 1985.

The following characteristics have been proposed:

- The programme should be school-wide and context-specific;
- Schools' principals should be supportive of the process and encouraging of change;
- The programme should be long-term with adequate support and follow-up;
- The process should encourage collegiality;
- The programme should incorporate current knowledge obtained through well-designed research;
- The programme should include adequate funds for materials, outside speakers and substitute teachers so that teachers can observe each other.

(Richardson and Placier 2001, p.917-918)

Having established that teachers need to identify their own needs, the needs of their schools and have autonomy in addressing these needs within the school context, why should teachers bother aligning their needs with reform initiated by outside agencies? Section 2.5.9 explores the relationship of practising teachers with the research community and the products of their work.

2.5.9 Research

It is necessary that teachers should have a clear understanding of the rationale underpinning reform initiatives if they are to accept them as a valid part of their own development. To be effective teachers, teachers must also be learners.

> Lifelong learning is *de rigueur* in many fields of employment – surely if any vocation should embrace the concept it is the teaching profession.
> (Murphy et al. 2005)

Millar, Leach, Osborne, Ratcliffe, Hames, Hind, Bartholomew, Collins, Lewis, Scott, and Duschl (2002) similarly use the analogy of the medical profession to support their call for teachers to remain current in research and apply evidence-based practice in science education. The nature of science as a subject places even more demands on a teacher's need to keep up to date as the knowledge base is constantly changing.

> The pace of scientific discovery continues to accelerate, developments in ICT open up new opportunities in learning environments and social and ethical context is becoming an ever more significant aspect of science and science teaching.
> (Murphy et al, 2005)

The dual goals of a healthy economy and an informed electorate are expressed in the goals of science education described by Harlen (2006) as:

> ...preparing future scientists and technologists and... providing all children with sufficient knowledge and understanding of the world around them to enable them to become informed citizens, able to

> operate effectively and make sensible decisions about science-related issues that affect all our lives.
> (Harlen 2006, p.6)

The balance between understanding science "as a firm and developing body of human understanding and as a powerful but provisional framework that must remain open to challenge" (Goodwin, 2005) can only be accomplished if teachers of science are themselves familiar with the nature of research.

It could be argued that a facility in generating data and its analysis should form part of the pre-service and on-going training of teachers who are ultimately expected to teach these aspects of science.

The desirability of training teachers as researchers is recognised in Finland where all teachers, both primary and secondary, are required to undertake a Masters degree with a strong research orientation at pre-service level (Jusilla and Saari, 2000), and is echoed by Sahlberg, Munn and Furlong (2012, p.14-15) with regard to Irish primary teachers. From the perspective of professional development as "...subject-specific...and... classroom-based" (Dillon et al., 2000), which requires that individuals take responsibility for addressing their own needs in the context most relevant to them, it appears clear that a research orientation among teachers would be highly valuable. Section 2.5.10 considers how such an orientation might be cultivated among teachers.

2.5.10 Coaching and mentoring

To conduct research into one's practice requires the ability to look critically at one's own practice and identify areas worthy of research. From what we have gleaned from the literature, it would appear that this type of analysis would be more likely to be effective if done with like-minded colleagues.

> For teachers to learn new ways of teaching we must construct settings that assist teachers to perform the new skills before they are fully

> competent….Teachers, like their students, have zones of proximal development; they too require assisted performance.
> (Tharp 1988, p.190)

It has been suggested that coaching might be a useful method by which to access such support (Lieberman and Miller, 1999; Field 2011, p.171) where coaching is defined as:

> A one-to-one conversation focused on the enhancement of learning and development through increasing self-awareness and a sense of personal responsibility where the coach facilitates the self-directed learning of the coachee through questioning, active listening and appropriate challenge in a supportive and encouraging climate.
> (Van Nieuwerburgh, 2012, p.17)

It is suggested that primary teachers, accustomed as they are to regular inspections throughout their careers and having the common bond of teaching the same pupils the same subjects, have a strong base from which to introduce mentoring or coaching into schools as a method of professional development. While a form of mentoring is a concept acceptable to teachers in terms of inducting the apprentice e.g. NQTs in Ireland, the concept of coaching as a means to encourage experienced practitioners to critically examine their practice and identify solutions to difficulties is not as familiar or widely used.

As a concept, however, it meets many of the identified requirements for effective professional development. Engagement with the coaching cycle would benefit the entire school as "…carefully planned mentoring and coaching processes can benefit organisations and organisational performance" (Field 2011, p.172). Joyce and Showers (1995) developed an effective model of teacher development which includes coaching. Their model consists of the following steps:

- Presentation of the new skills;
- Modelling the new skills;
- Practice in simulated settings;
- Feedback on performance in simulated or real settings;
- Coaching on the job.

The greatest inhibiting factor for the use of coaching, mentoring or indeed any model of job-embedded professional development, is time.

2.5.11 Time

Many primary teachers in Europe are currently allowed paid child-free time within the working year to pursue professional development activities.

> In Belgium, the Czech Republic, Finland, Italy, Lithuania, Luxembourg, Portugal, Romania, Slovenia and the United Kingdom teachers have the right to use a certain amount of paid working time for professional development activities.
> (Eurydice, 2008 in OECD, 2010)

The typical model of in-service education in Ireland currently tends to be off-site and out of term. These 'summer courses' organised by the Education Centres on behalf of the DES represent the typical professional development undertaken by the majority of Irish primary teachers. These generally involve one week 'face to face' courses, but there are a growing number of courses provided on-line. The other typical model of professional development involves the withdrawal of teachers from class duties for individual days. This model of professional development has been judged inadequate by the OECD (1991).

> In relation to in-service education we must point up the limitations of the school day model which in general totally ignores the professional development needs of the teachers themselves. As a consequence in-service education is normally viewed as something extra that has to be provided over and above the normal teaching day, week, or year.

> On this basis it will always be to a degree marginal for many teachers, and those participating in in-service programmes will do so very often at the inconvenience or with the forbearance of their colleagues.
> (OECD, 1991)

Irish primary teachers have been led to associate in-service education with a 'one week summer course' for which they receive three extra personal vacation (EPV) days. Teachers generally pay for these courses and the net result is that teachers give up two days of their holiday time freely to attend these courses. The benefit of these summer courses to teachers' professional development is questionable. They take place generally at the beginning of the summer holidays and there is generally no form of follow-up after the holidays to support implementation. Schools are not provided with substitute cover for EPV days and thus the whole system depends upon the goodwill of a teacher's colleagues, who absorb the extra children into classes which are already quite large. This method of providing development costs the Department of Education and Science very little, if anything. It represents a deficient model of professional development, consisting as it does of individuals pursuing a multitude of very diverse courses which, at best are based on the needs of the individual teacher without cognisance being given to the needs of the school. On a staff of thirty, it is possible that teachers could pursue thirty different themes! This reflects diverse views on the purpose of professional development. Is it undertaken to promote the goals of the school, to enhance promotional opportunities or merely to avail of extra personal leave?(O'Donovan 2013, p.124). This intense level of individualism has been supported by a deficient concept of professional development.

2.6 Summary

The synthesis of the literature on teacher change suggests a model of professional development which emphasises collegiality and collaboration rather than individualism and competition. Professional development seems more likely to be effective if there is a symbiotic relationship between the needs of individuals and the needs of institutions. CPD which is long-term and context-specific is more likely to be deemed satisfactory by teachers, and therefore should be an intrinsic part of daily practice. The pervading culture within schools can support or inhibit good practice. Strong leadership is necessary to establish a common vision of school goals and an acceptance of collaborative professional development as a means to achieving these. While the supportive role of the principal is essential to the success or failure of a CPD programme, a designated CPD coordinator from within the ranks of the staff would have more time and possibly be more effective in engaging staff with reform initiatives. Mentoring and coaching are effective tools which embody the best principles of CPD as derived from the literature.

If job-embedded CPD, which addresses the self-identified needs of teachers, is to become part of the culture of teaching in Irish schools, the issue of time for associated activities, such as mentoring and coaching, needs to be negotiated with the relevant authorities.

Chapter 3 will now review international practice in relation to teacher education and compare it with current Irish provision, in order to derive principles for a sustainable CPD model for Irish primary science.

<u>CHAPTER 3</u>

LESSONS FROM ABROAD

3.1 Introduction

Science in the 1971 curriculum (DES 1971) consisted predominantly of the biological sciences/environmental studies, with only fifth and sixth classes being exposed to the physical sciences. Evidence exists of uneven implementation of this curriculum (INTO 1987; Mulcahy, 1989). It was only in 1999 that science was included in the primary curriculum as "a subject in its own right" with all aspects of science, both biological and physical, being covered (Varley et al 2008(a), p.16). Science, therefore, does not have associated with it the same history or culture in Irish primary schools as other long-established subjects such as Irish, English or maths. It is therefore a relatively new subject for many Irish primary teachers and change is required of them to implement the 1999 science curriculum. One of the 'conditions for success' quoted in the report on the iTEC project, which is attempting to encourage increased use of ICT in classrooms, is "Positive attitudes at all levels towards change" (Lewin, Ellis, Haldane and McNicol 2013, p.20). This resonates with Fullan's (1993, p.3) contention that change should be seamlessly embedded into what it means to be a teacher. However, my review of the process of change in education in Chapter 2 reveals that change is problematic for teachers.

The OECD has stated that one of its goals is to promote "ongoing and lifelong professional learning embedded in schools as *a natural and expected component of teachers' professional activities*" (OECD 2010, p.32), implying that participation in professional development cannot currently be presumed among teachers. The "casual approach to courses" noted by O'Donovan (2013, p.124-125) "without any review of the contribution the courses make to primary school teachers' practice" suggests that change is not 'embedded' in Irish teachers' professional identity. Change in a subject well-established on the curriculum is difficult for teachers, as was seen in Chapter 2. Where a subject such as science has been treated rather ambiguously by curriculum developers, the effort required to change must be all the more challenging. When this is placed in the context of a population slow to embrace change, the challenge becomes evident.

> A recent report by the Irish Council for Science, Technology and Innovation (ICSTI, 2005) noted that *the professional development of primary teachers in a life-long learning context* was not as advanced in Ireland as in other countries, and it recommended training and support "before, during and *after* the introduction of new…[science] curricula" (p. 2; emphasis added). Studies in other countries have shown that, even after curriculum implementation, teachers lack confidence in teaching primary science (Murphy et al., 2007) and that further in-service support is a common request.
> (Goodrum et al., (2000) in Varley et al. 2008(a), p.159 emphases added)

Even in countries such as the UK, Northern Ireland and Australia where there is a longer history of science on the primary curriculum, there is evidence of less than satisfactory levels of implementation (Varley et al 2008(a), p. 11-16). The response by most countries wishing to improve implementation has focussed on "enhancement of in-service and pre-service education" (Varley et al 2008(a), p. 15). This chapter attempts to synthesise information from CPD models which have sought to improve implementation of the science curricula in New Zealand, Australia, the United States, the United Kingdom and Japan. This is done in an effort to isolate those factors deemed to have contributed to the success of those programmes. The factors thus extracted, together with those identified in the literature in Chapter 2, will be used to provide the theoretical framework of a science CPD model for Irish primary teachers.

3.2 Criteria for Selection of CPD Models to Review

To begin the process of designing a model of science CPD, I began by considering those countries achieving high scientific scores in comparative studies, for example, the 1995 'Third International Mathematics and Science Study' (TIMSS, 1997) conducted (Eivers and Clerkin, 2012). While limited inferences can be made from test results alone, they nonetheless can be indicative of relative strengths and shared problems.

Ireland's mean achievement in the 1995 test was considered significantly lower than that of Korea, Japan, USA, Austria, Australia, Netherlands and the Czech Republic. The top two countries in 1995 were Asian. The top 4 countries in the 2007 survey were Singapore, Chinese Taipei, Hong Kong SAR and Japan, again all Asian. Whilst conscious of varying "social, cultural, economic and familial factors in different countries….explaining performance" (Reynolds and Farrell, 1996), the dominance of Asian countries in science suggested the value of reviewing an Asian model of professional development for teachers. The model chosen for review was the Japanese system of *Jugyou Kenkyuu.*

3.3 What is *Jugyou Kenkyuu*?

Jugyou Kenkyuu is a school-based training system involving collaborative research:

> ...the shared feature of which is observation of live classroom lessons by a group of teachers who collect data on teaching and learning and collaboratively analyze it.
> (Lewis, 2002a, 2002b; Lewis & Tsuchida, 1997,1998; Wang-Iverson & Yoshida, 2005 in Lewis, Perry and Murata 2006, p.3)

It involves teachers regularly identifying where children are at in terms of the teachers' goals for them; selecting through collaboration a means of bridging any gaps that exist; trialling those lessons while being observed by personnel from across the educational spectrum and engaging in in-depth reflection and discussion with those people about how the lesson might be improved. This cycle is continued until a satisfactory ‘Research lesson’ is achieved which may then be used for a ‘Public Research’ lesson i.e. it is shown to a wider audience which could involve a cluster of schools or even a national audience. The lesson is not intended as a finished product to be imitated unchanged; rather it is the process which provides the learning opportunities. This process represents a means of “...sharing... knowledge and practice both within and across schools” as a means to support teachers’ efforts to change for which Bolam and Weindling, (2006, p.112) found strong evidence. *Jugyou Kenkyuu* has been found to have a very profound effect on developing teachers’ competencies; improving quality of teaching; promoting school change; enhancing student learning and giving teachers responsibility for the development of the profession (Lewis, 2002). “The Lesson Study Cycle” taken from Lewis, Perry and Murata (2006, p.4) and illustrated here as Figure 3.1 highlights that *Jugyou Kenkyuu* is a process rather than a product to be disseminated intact. Each stage of the cycle requires collaboration with colleagues and multiple viewpoints on children’s current thinking and learning strategies with reference to, or creation of, data.

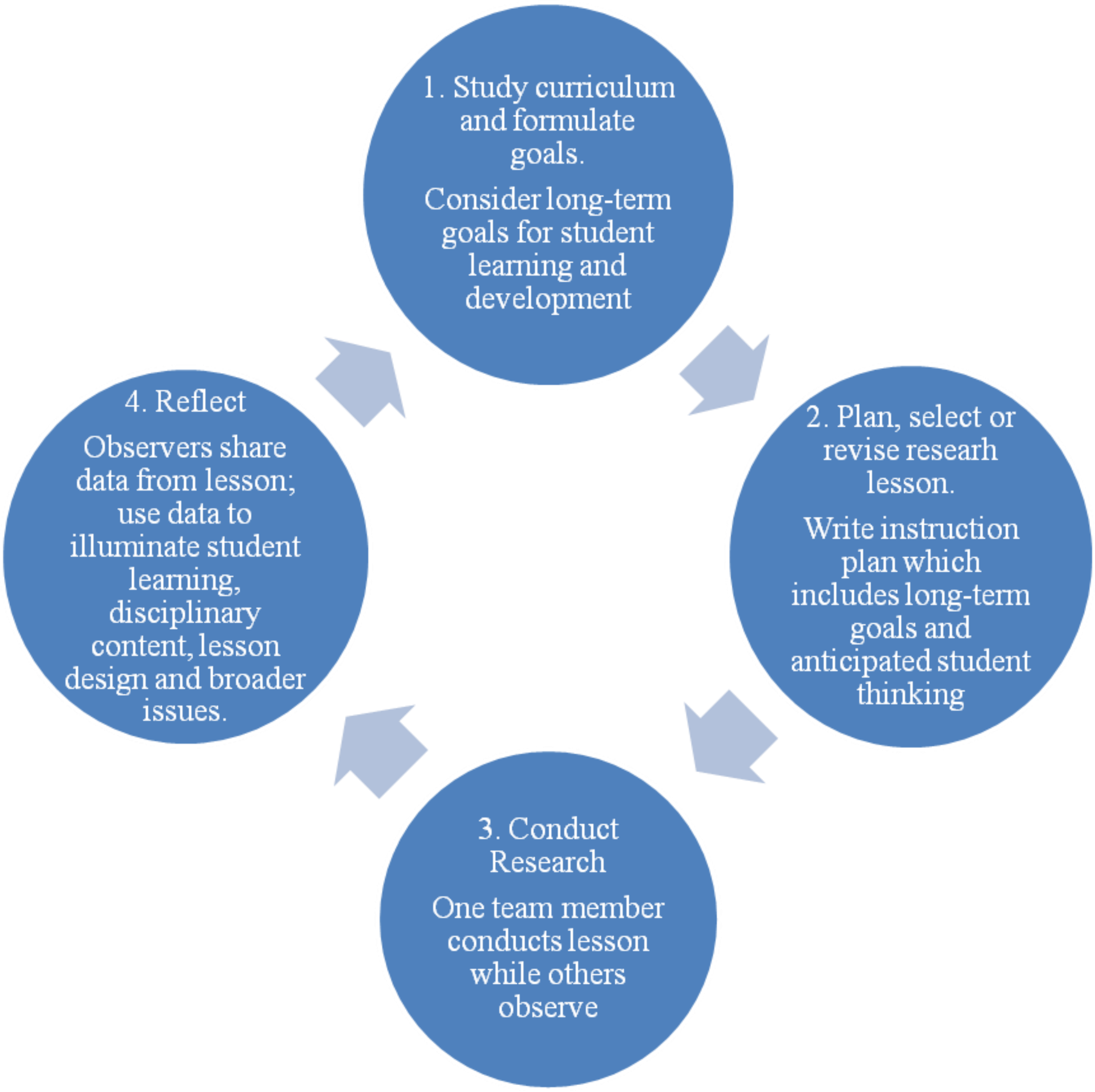


Figure 3.1 "Lesson Study Cycle" (Lewis, Perry and Murata, 2006)

Section 3.3.1 now considers whether or not an adaptation of *Jugyou Kenkyuu* would satisfy the professional development needs of Irish primary teachers of science.

3.3.1 Does *Jugyou Kenkyuu* satisfy criteria for CPD?

In an effort to establish the potential of *Jugyou Kenkyuu* as a model of CPD for Ireland, I sought to establish how it compares to "professional development" (GTCE, 2003, The Teaching Council 2011, pp.20-21) in supporting teachers' practice. See Table 3.1 below.

Characteristics of Professional Development (http://www.canterbury.ac.uk/education/protected/spss/docs/gtc-cpd.pdf accessed December 5th, 2013)	Corresponding Characteristic of Jugyou Kenkyuu (Taken from: Lewis, 2000; Lewis (2002); Lewis, Perry and Murata, 2006).
Reflecting on and enhancing practice.	Based on interviews and observations Lewis (2000) has documented nine ways in which research lessons might contribute to enhancing practice.
Identifying and addressing areas of pupil under-achievement.	When choosing a subject for research lessons, Japanese teachers often target a weakness in student learning and collaboratively plan a means of addressing this under-achievement.
Developing behaviour management strategies.	Children in Japan use self-management *Hansei* and have more responsibility for classroom management than western children. There is more emphasis on personal goal-setting rather than on adult-imposed rules and rewards. Personal goal-setting is recommended as part of the constructivist methodologies promoted in the Irish Science Curriculum (1999).
Career development	In Ireland, career development often means that exceptional teachers are lost to the system because advancement often means moving **'up'** to administration, third level or into the inspectorate. "We need a career structure for teachers which allows the best practitioners to get promotion while remaining in the classroom" (O'Mahony 2011, p.13). In Japan, however, because of the public nature of research lessons, teachers can become known nationally through their research lessons and subsequent publications. Research Lessons have been shown to increase demand for professional development.
Recognising improvements in their own practice	At a local level**,** a teacher can benefit from the positive affirmation of his/her colleagues when a research lesson or an aspect of it has gone well, particularly when he/she has adapted their practice in the light of earlier feedback.
Working with evidence to exercise their creativity and judgement.	In-depth data on student learning is collected and the data gathered is provided to all participants. Members of the research group and other faculty members often gather data on particular issues of interest and use the data to devise suitable interventions to address these issues.

Producing, interpreting and managing classroom and pupil data.	Lesson plans prepared by the research team give observers suggestions of what to look for in the lessons. All this evidence is analysed collaboratively in the colloquium following the lesson and used to decide the next steps in the Lesson Study Cycle.
Discovering, evaluating and embedding effective new approaches to teaching and learning, planning and assessment and the curriculum.	The advantage of *Jugyou Kenkyuu* from this perspective is that teachers actually observe other teachers (whom they may respect more than 'experts') using a different approach and benefit from listening to its analysis by a wide panel of expertise including the research community. They can also contribute to debate on new approaches in a constructive manner. This allows ample opportunity to 'discover and evaluate' new approaches. Harland and Kinder (1997) found that the most difficult outcomes of CPD to achieve are the "value congruence" outcomes. Teachers may not revert to adapting new approaches to their own "tried and trusted" philosophy if they have sufficient contact with those at the coalface of research who can personally present and defend their findings and if they can actually witness the implementation of the reform effort.
Exploiting all the opportunities to learn from other teachers.	The teachers surveyed by Yoshida (1999) observed a total of 10 research lessons per year and they engaged with other educators from all sectors to discuss the lessons observed.
Developing teamwork	Collaboration in Japanese schools is well established and enhanced by the fact that each teacher takes responsibility for attending professional meetings for a particular subject area and acts as a resource in that area for the rest of the staff. Teachers routinely use each others' ideas.(Lewis, 2000)
Promoting inclusion	Japanese staff rooms have teachers' desks arranged according to class level as teachers routinely consult each other on lessons. They also take care of each others' classes routinely as no provision is made for substitution when the absence is a short one (Bjork, 2000; Sato, 1996; Sato and Mc Laughlin, 1993; Rohlen and Le Tendre, 1996; Shimahara and Sakai, 1995 in Lewis, 2002). A lot of emphasis is placed on developing good working relationships within a staff.

Table 3.1 Juxtaposition of *Jugyou Kenkyuu* with Characteristics of Professional Development

Table 3.1 above illustrates how *Jugyou Kenkyuu* meets the objectives of CPD for Japanese teachers. How well would it serve the needs of Irish primary teachers of science?

3.4 Congruence of "Supporting Conditions" in Japan and Ireland

Using Lewis' (2002) "supporting conditions" for *Jugyou Kenkyuu,* I have attempted to identify which of these exist in Ireland and which need to be developed in order to gauge the potential transferability of this style of teacher education to Ireland.

3.4.1 National curriculum

Ireland, similar to Japan, has a national centralised curriculum. It is therefore possible to share research lessons which are relevant to a wider audience in Ireland as it is in Japan. Although there is not a national policy in Ireland regarding the amount of time a teacher spends teaching at a particular class level, most schools have some policy concerning the movement of teachers from level to level. In Japan, teachers typically teach the same class for two years and over time rotate to all levels. Because every teacher will eventually teach at all levels, the subject matter taught at research lessons is relevant to all. Even if this were not the case, all teachers benefit from a thorough knowledge of levels above and below the one where they teach, in order to provide continuity and progression to their students.

3.4.2 Stability of educational policy

The Japanese educational system acknowledges the length of time it takes to implement change and therefore major changes only take place every couple of decades (Lewis (2002). In this respect the Irish and Japanese systems are similar. In the last three decades the Irish Primary Curriculum has been changed only twice; in 1971 and most recently in 1999. The basic principles of child-centred education have been maintained throughout. The stability of Irish educational policy would support the time and effort required to establish and sustain a cycle of self-reflective professional development.

3.4.3 Focus on the whole child

The underlying philosophy of the Japanese education system is to promote children's social, ethical, emotional, aesthetic, physical and intellectual development. These are not too different from the child-centred aims of the Irish National Curriculum (DES, 1999(b)) which were adopted unchanged from the 1971 curriculum. The SESE (Social, Environmental and Scientific Education) curriculum of which science is a constituent subject also includes aspirations to develop "humane and responsible attitudes and an appreciation of the world in accordance with beliefs and values" (DES 1999(b), p.5). (Lewis (2002) sees this aspect of Japanese education as providing a strong unified approach to the development of each child and obliges all teachers to work together towards achieving these highly valued aspects of education. Theoretically, Irish teachers would share this vision, but the extent to which these goals are pursued collaboratively may not match Japanese practice.

3.5 Supports to be Further Developed in Irish Schools

Ireland does not have the same culture of research-based teaching as Japan. It is possible that the following aspects of professionalism might be developed through the adoption of a form of *Jugyou Kenkyuu* in Ireland.

3.5.1 Evidence-based instruction

Japanese text books are written by primary teachers and are based on their actual lessons. This means that primary teachers spend considerable time planning, observing, discussing and refining actual classroom lessons. Irish teachers on the other hand tend to be very reliant on materials produced by outside agencies, a practice which contradicts DES 1999 guidelines on the use of text books in science.

> There was also some evidence of negatively construed science experiences dominated by textbooks and worksheets: “We could probably have more fun if we actually got to do it ourselves, rather than just reading from books and stuff”;...Comments of this kind are of concern given that the Primary Science Curriculum Teacher Guidelines state that “science lessons should not be work card or textbook based”. (DES, 1999(b), p. 27; emphasis in the original) (Varley et al. 2008(a), p.152)

It would seem that internationally there is a need to link research results and materials used in classrooms. Fullan (1991) quoted in Millar and Hames (2003, p.22) indicate that there is a much greater interaction with research when it has been translated into something practical and useable. *Jugyou Kenkyuu* provides an opportunity for teachers and researchers to do this aspect of transforming research work into practical materials for classroom use together. There is currently limited opportunity for practising teachers in Ireland to influence the type of materials they subsequently implement in the classroom.

3.5.2 Reflection

Ireland does not have the same tradition of self-analysis or reflective practice (Jeffers 2006, p.26) as the Japanese. The practice of setting goals for self-improvement in Japan *(Hansei)* and the accompanying self-criticism is conducted in pursuit of personally-set objectives, a process which is viewed as an illustration of competence in Japan. Such openness around short-comings is not obvious in many Irish schools.

The proliferation of young teachers currently on temporary contracts in Irish primary schools eager to impress principals, in the hope of achieving permanent status, discourages open discussion of shortcomings. I feel the proposal that principals assume the role of probating NQTs in lieu of the inspectorate in a programme called "Droichead" (Teaching Council 2013-2014) could further inhibit open reflection (Irish Primary Principals' Network (IPPN), 2011).

The demands of a programme of professional development based on *Jugyou Kenkyuu* on school principals are now considered.

3.5.3 Leadership

The collective effort required to sustain research lessons in the Japanese fashion is, it is suggested, highly dependent on the style of leadership within schools (The Teaching Council 2011, p.20). This is echoed by the findings of Bolam and Weindling, 2006, p.111. Because of the diminishing middle management structure in Irish primary schools (Department of Education and Science (DES), 2009) leadership is very dependent on the individual leadership of the principal. In fact, the literature supports the futility of attempting any kind of reform without strong school-wide support.

> The development of all schools as learning organisations requires a deliberate process of building systems and supports.
> (Collinson and Cook, 2007; Earley and Bubb, 2004; Loxley et al. 2007 in Opfer and Pedder, 2011)

Ireland has some 'supports' for *Jugyou Kenkyuu*, namely a national curriculum, stability of educational policy and a focus on the whole child with its child-centred curriculum. However, there is limited, if any, "evidence-based practice" in Irish schools as the research ethic is not well developed (Jeffers, 2006; O'Donovan, 2013), nor is time for reflection planned for. Strong leadership which could create a culture conducive to identifying shortcomings would be needed.

What are the implications for an Irish adaptation of *Jugyou Kenkyuu*? Section 3.5.4 looks at the evidence for successful transfer of *Jugyou Kenkyuu* to a different culture.

3.5.4 'Transferability' of *Jugyou Kenkyuu*

Preliminary evidence (Lewis et al. 2006, p. 3) suggests that lesson study is proving an accessible form of professional development among teachers in the US, albeit still in its infancy relative to Japan where it has been used for a century (Lewis, Perry and Murata, 2006). Lewis et al. (2006) point out that lesson study by its very nature will not transfer unchanged to multiple sites, but consider that it can, and should, be adapted to local needs.

> Local adaptations are expected and studied as possible sources of potential improvement to innovation design and theory.
> (Lewis, Perry and Murata, 2006, p.7)

This dynamic of educational innovation is very different to the more traditional, centrally conceived model of reform where fidelity of implementation is a major concern at dissemination sites (Lewis, Perry and Murata 2006, p.7 and Borko, 2004). The essential components of *Jugyou Kenkyuu* that particularly recommend it to the Irish situation are the convincing findings arising from its use both in Japan and the US (http://www.tc.columbia.edu/lessonstudy/timeline.html). *Jugyou Kenkyuu* appears to satisfy the requirements of current policy documents (The Teaching Council, 2011; Government of Ireland 2006; Hyland, 2012; Sahlberg et al. 2012) to "professionalise" Irish teachers.

The Irish Teaching Council has an expectation that teachers would "actively shape their own professional development" by critically reflecting on their beliefs and practices (TTC, June 2011, p.20). This is a radical change considering teachers have, to date, been the objects of externally mandated, reform driven in-service. Section 3.5.5 attempts to illustrate how CPD premised on a *Jugyou Kenkyuu* model might support teachers to have more agency around their own professional development.

3.5.5 The potential contribution of Jugyou Kenkyuu as a CPD model

The Teaching Council's (2011) call for teachers to "critically reflect on their beliefs and practice" and to be more pro-active about their own development, suggests that it is important that teachers have opportunities to engage in research. If teachers are expected to assume responsibility for the development of their profession, they must be supported also to assume more ownership for the research and development aspect of education as "…there often remains a difference in purpose between researchers, policy makers and teachers" (Wong, 1995 in Hiebert et al 2002, p.12). The traditional role assigned to teachers in the western world as consumers, rather than producers of research, has been attributed to the succession of John Dewey by Charles Judd who sought to bestow on education a "higher research-oriented status" by applying methods borrowed from the physical sciences. This led to the creation of:

> …two professional communities - school practitioners and university researchers. Professional knowledge building became the province of researchers; applying the knowledge was left to the practitioners.
> (Hiebert et al 2002, p.11)

One consequence of this development is that teachers tend not to value research.

> Teachers rarely draw from a shared knowledge base to improve their practice. They do not routinely locate and translate research-based knowledge to inform their efforts.
> (Grimmett & MacKinnon, 1992; Huberman, 1989; Richardson & Placier, 2001 in Hiebert et al., 2002, p.3)

The absence of a research orientation among Irish teachers has been acknowledged and partly attributed to the nature of ITE they have experienced (Hyland, 2012; Sahlberg et al, 2012). Increased professionalization of teaching implies that the ideal model of teacher education is one which would make research and professional development integral to practice (Hiebert et al, 2002; Sahlberg et al. 2012, p.15). The evidence from Japan suggests that when control for professional development lies with practising members of the profession, reform is more likely to happen because the reform effort is sustained over longer periods of time. Japanese efforts to change science teaching from a didactic model to teaching for understanding took several decades, whereas the LISP programme in New Zealand found that even after nine years of work, the same reform objective had not become embedded in practice (Lewis, Perry and Murata, 2006; Bell and Gilbert, 1996). An adaptation of *Jugyou Kenkyuu* could potentially give Irish teachers an opportunity to develop a more critical attitude to their practice and encourage a research orientation among them. *Jugyou Kenkyuu* is particularly suitable for science CPD because the process is so well aligned to the scientific method with which Irish primary teachers seem to have particular difficulty.

> It is difficult to say how frequently children are being taught science through teacher-led, whole class methodologies. However, these kinds of approaches are not especially advocated in the primary curriculum or exemplar materials (DES, 1999a; b). It is therefore a concern that these images, especially of teacher demonstration, are clearly in evidence.
> (Varley et al. 2008(a), p.64)

For this reason, a familiarity with the scientific method of isolating variables and collecting and analysing data would increase their confidence levels in this particular aspect of science teaching. Currently accepted constructivist theories of conceptual development in science refer to the use of formative assessment to ascertain prior concepts before devising ‘learning trajectories’. While such methodology is espoused in the 1999 Irish Curriculum, such methodology was not much in evidence in the Irish primary science lessons reviewed by Varley et al. 2008(a), p.152. *Jugyou Kenkyuu* models this style of teaching, thus giving participants extensive practice in assessing children’s understanding and devising appropriate plans to bridge the gap between misconceptions and currently accepted scientific thinking.

Jugyou Kenkyuu, as a process with the potential to enhance both teachers’ professionalism and their proficiency in science teaching methodology, makes it an attractive option to adopt in some format for Irish teachers.

I now consider some western models of CPD in order to isolate those factors deemed to have contributed to their success.

3.6 Western Models of CPD

The non-Asian models reviewed were from New Zealand, Australia, the UK and the USA. These programmes of professional development had specific science-related goals e.g. to introduce a new pedagogy based on research findings into how children learn science; to develop a research orientation among teachers or to improve student outcomes in the area of science. The projects considered were the Learning in Science Project (LISP), New Zealand (Bell and Gilbert, 1996); The Project for Enhancing Effective Learning (PEEL), Australia (Baird and Mitchell, 1986); Harrow-King’s Local Education Authority science professional development

programme 1997-2001, United Kingdom (Dillon, Sissling, Watson and Duschl, 2002); Urban Systemic Initiatives (USI) USA (Borman et al., 2005).
These were chosen for review because they generally ran for considerably longer periods than was typical for the time, they involved teachers researching their own practice and were all focussed on improving the provision of science.

3.6.1 New Zealand and Australia

The focus of the New Zealand Learning in Science Project (LISP) - Teacher Development (1990-1993) (Bell and Gilbert, 1996; Hipkins, Bolstad, Baker, Jones, Barker, Bell, Coll, Cooper, Forret, Harlow, Taylor, France and Haigh, 2002) arose out of efforts to implement new knowledge about how children develop scientific concepts in the classroom. The main focus moved from looking at difficulties primary children have in learning science to looking at teachers, their training and pedagogy. The emphasis changed because it became clear that, without up-skilling teachers to teach in a different way, the new understanding of how children learn science would not impact on practice.

> As a consequence of the exploratory phase of the project, it was our view that the key problem of teaching and learning science in the primary school was centrally related to *teacher perceptions and teacher confidence*.
> (Osborne and Biddulph, 1985b, p.14 in Bell 2005, p.5)

Teacher education, therefore, was not initially a priority in the LISP project. This is reminiscent of the naïve assumption that educational change without teacher re-education is possible, as seen in the major projects of the 60s and 70s in the UK and USA, and as discussed in Chapter 2, Section 2.2. The LISP research sought to investigate the teacher development needed to enable teachers take into account the findings of the previous LISP projects into students' learning in science; related international research into children's learning in science, conceptual change and constructivist views of learning. LISP found that throughout the nine years of research, the findings had limited impact on practice in spite of (a) evaluations showing the efficacy of the new approaches; (b) the inclusion of the findings in new curriculum policy documents; (c) the publication of a range of teachers' guides and (d) a range of in-service courses for teachers (Bell and Gilbert, 1996). While a period of nine years seems long, experience in Japan indicates that change takes a lot longer than is commonly thought.

> …widely shared norms about teaching and learning may begin to change, as was the case in the shift from "teaching as telling" to "teaching for understanding" in Japanese elementary science instruction over *a period of several decades.*
> (Lewis and Tsuchida, 1997)

The analysis of comments from teachers participating in LISP indicated that, while the courses had increased their knowledge about the research findings, they had not addressed how teachers were supposed to implement them in their classrooms. This echoes the findings regarding the difficulties experienced by teachers in commuting research results into practice (Chapter 2, Section 2.5.8). The pre-service courses for student teachers at the time were found to be inadequate, as young teachers did not feel equipped to use the new constructivist methods in the classroom. This reflects the current situation in Ireland as highlighted by Varley et al. (2008(a)).

The methods employed to promote teacher development during the LISP programme included supportive sharing sessions with colleagues and third level personnel. Very little science was taught but, many participants reported being motivated to pursue further science education as a result of participation. The four factors that were found to help teacher development were:

> • a perception that better learning occurred with the new teaching activities compared to that with former teaching;
> • being more aware of and seeking more information in the classroom on learning;
> • focusing more on learning outcomes than learning conditions;
> • support, feedback, and reflection.
> (Hipkins et al., 2002, p.89)

The main finding of this research was that teacher development has three overlapping aspects: professional, personal and social (Bell and Gilbert, 1993). The professional element referred to the development of teachers' activities and roles in the classroom and their understanding of science education; the personal dimension referred to the emotional impact of change and the social dimension referred to learning to work collaboratively with colleagues. It is possible to question whether or not teachers' difficulties implementing the new methodologies could be linked to insufficient scientific content in the programme.

The Australian PEEL (Baird and Mitchell, 1986) programme differed from LISP in that, from the outset it focussed on teacher education and, teachers were more equal partners in the project. Research became an integral part of school life with the participants having total control over vital decisions about the direction and extent of change. The entire school was involved and teachers were allowed to adapt provision to their own needs. Northfield in Baird and Mitchell (1986) claims that PEEL provides compelling evidence that educational change is an outcome of individual change. Teachers became involved because of their self-identified needs. A major finding of the PEEL project was that change is a long term process.

Both LISP (Bell and Gilbert, 1996) and PEEL (Baird and Mitchell, 1986) were classroom-based and participants in both commented on the impact of the feedback they received, particularly from students. Both projects provided long-term support and involved collaboration with personnel from third level which included the sharing of teaching expertise and activities, theoretical ideas and experiences and developing collaborative ways of working. They differed from one another in that PEEL involved the whole school while LISP worked with just science teachers. However LISP was unique at the time in that primary and secondary teachers worked together. Outcomes common to both projects was the way teachers reconstructed their professional identities to include 'researcher' and also the evidence of the emotional trauma experienced when teachers were trying to change their practice.

3.6.2 A UK model of CPD

Another project which included extended support for teachers trying to implement change was the Harrow-King's LEA science professional development programme, Science Teachers as Researchers, based on developing a network of teachers interested in engaging with the university research community (Dillon, Sissling, Watson, and Duschl 2002, p.44). The programme is described by the authors as meeting "teachers' needs for long-term, classroom-focused, personal, professional development, based on a fair assessment of teachers' needs" (Dillon et al. 2002, p.43). The programme began in 1997 and ran for four years. It sought to support sustained improvement in focused aspects of science teaching and learning by enabling teachers to carry out supported classroom research and to engage teachers with current research and perspectives on science education over an extended period of time. The programme catered for both secondary and primary teachers. It was shorter, but more intense than other programmes reviewed, in that it ran for just three terms and consisted of a taught element as well as a practical research element where teachers were required to research an element of their own practice.

Ongoing support for this research was provided by third level personnel and support was provided for analysis and presentation of findings. In total there were thirty hours' of contact time between the teachers and the third level personnel. Teachers presented their findings on the final evening session to all interested parties, which included other teachers, principals, and members of the LEA advisory team. This research work was accredited as part of an MA programme.

The participants' gains in confidence were attributed to the intensity of the programme and the need to present their work to other participants and wider audiences. The programme provided opportunities to develop links with other schools (Dillon et al., 2002). This programme provides further evidence of a trend in international CPD programmes towards developing research skills for the purposes of researching teachers' own classrooms. While the long-term support of third level personnel was considered very beneficial to the teachers' development, it would seem that the pressure to present findings also honed the teachers' skills. In his case study, Halai (2006) suggests that support alone is insufficient to drive the process of integrating new practices, but that an element of pressure to prepare and present a lesson to colleagues is very helpful in clarifying ideas, removing confusions and improving the lesson planned. Halai (2006) believes that the requirement to actually teach and listen to a critique of the lesson should actually be undergone several times in order to support teachers. Both Halai (2006) and Dillon et al. (2002) acknowledge the value of presenting work for one's peers, as is integral to the practice of *Jugyou Kenkyuu*.

3.6.3 A US model of CPD

The National Science Foundation, USA attempted to reform science and mathematics education through "unremitting effort through the national system" and those efforts are reported in a book entitled "Meaningful Urban Education Reform" (Borman et al., 2005). The report is relevant to the Irish situation as it details efforts to achieve systemic reform. This study warrants particular attention because the impact of professional development was assessed, not by reference to student performance, but rather by observation of indicators of what was termed "Authentic Instruction" and triangulated with an assessment of subsequent engagement of students in science and mathematics classes as well as various interviews and questionnaires. This provided a rigorous and reliable assessment of the interventions. The attributes of *high quality teacher development,* used to assess programmes was derived from a number of analysts and echoes the Characteristics of Professional Development as outlined in Table 3.1 in this Chapter.

The relative success of the most 'successful' of the efforts was attributed to the *long-term commitment* of participating teachers to professional development which included both site-based and off-site activities. These schools encouraged the involvement of all science and maths teachers as well as principals and other auxiliary staff, and provided professional development opportunities that included *in-depth study of subject matter and methods of teaching.* Schools which had a greater range of actively participating stakeholders were most likely to have positive student outcomes. They also had "relatively larger numbers of teachers participating in staff development" which was carried out at the classroom level and was sustained over the period of the reform. These schools were characterised as "fostering communities of learners and providing opportunities for enhancing teaching skills"

(Borman et al. 2005, p.218-219). It was found that in order to sustain systemic reform, professional development should:

> …ideally provide teachers with direct, hands-on, problem-solving, pedagogical strategies, and *content knowledg*e.
> (Borman et al., 2005, p.201)

Other significant findings included the need to take cognisance of teachers' prior beliefs. Where teachers' opinions about how students learn were unchallenged, the impact of the programme was correspondingly low. Teachers felt that professional development had more impact when it took place on site and involved the whole school.

A clear implication for Irish efforts to reform from the US programmes is that "teachers must be well grounded in ...science content to be effective in their delivery of classroom instruction" (Borman et al. 2005, p.218) and teachers need support from their colleagues, principal and policy makers for their efforts to change. A significant point that is evident in all the programmes reviewed and highlighted in the US systemic reform is the centrality of context to the reform effort.

> While teacher professional development is the primary vehicle used for improving classroom instruction, our research indicates that *individual schools create a context within which professional development facilitated teacher and student learning and that this makes or breaks professional development's ultimate impacts on both instruction and student advancement outcomes.*
> (Borman et al., 2005, p. 202 emphases added)

I now consider the evidence in the literature regarding the significance of the context of CPD programmes. I begin by considering which learning theories, if any, under-pin the more successful science CPD programmes.

3.7 Is Best Practice CPD Constructivist?

While reviewing some of the large scale professional development programmes it appeared that many of the elements of programmes widely considered to be meritorious were resonant of constructivist theories of learning. In order to establish whether or not this is a justified interpretation of the evidence, an effort was made to map these successful elements of CPD programmes onto the basic tenets of what is considered to be constructivist theories of learning in Table 3.2 below.

Successful elements of Professional Development Programmes as found in the literature e.g. Bell (2005); Borman and Associates (2005); Bolam and Weindling (2006); Sarkar and Matoba (2003); Chapter 2, Section 2.5	Constructivist Theories of Learning (Applefield, Huber and Moallem 2000/2001, p. 37-40)
The teacher as a person of vision who reflects on his/her own practice; Commitment to increase the level of 'mastery' of the area being reformed, i.e. science; Teacher-led.	Cognitive constructivism: This emphasises the individual construction of knowledge stimulated by conflict (Piaget, 1970, 1977). In this case the conflict is caused by an acknowledged lack of confidence with the subject area of science. Teachers will strive to restore 'equilibrium' by reflecting on their perceived inadequacies and by seeking to address them. This principle emphasises active rather than passive learning.
Collaboration among whole staffs and other stakeholders to achieve a common vision; Activities which provide opportunities for teachers to observe and be observed; Familiarity with up to date research; Longer and more intensive contact between the support team and staff with sustained support over the reform period; Feedback.	Social constructivism: Within this theory, knowledge is socially constructed and therefore the "social milieu of learning is centre stage" (Applefield et al., 2000/2001, p.38). The origin of knowledge is the "social interaction of people i.e. the interactions that involve sharing, comparing, debating among learners and mentors" (Brown, Collins and Duguid, 1989; Rogoff, 1990, in Applefield et al., 2000/2001, p.38).

Classrooms as a source of professional development; The teacher as a lifelong learner; Teacher education as a continuum; Non-transferable nature of knowledge acquired off-site; Due attention to individual beliefs and attitudes.	Contextualism: This is an extension of social constructivism and suggest that the context in which the learning is inseparable from emergent thought and therefore the impact of culture and historical context on learning must be taken into consideration in a programme of CPD.

Table 3.2 Comparison of Elements of CPD Programmes Endorsed by International Literature with Constructivist Theories of Learning

Each of the "central characteristics of constructivism" (Applefield et al., 2000/2001, p.35-53) can be identified in the methodologies used in the CPD programmes reviewed in this chapter:

- New learning depends on the learner's existing understanding;
- Social interaction plays a critical role in the construction of knowledge;
- Authentic learning tasks are essential for meaningful learning;
- Zone of Proximal Development.

If it is accepted that constructivist learning theories underpin successful professional development programmes then the context of professional development is all pervasive and as such must be considered together with all other elements of a CPD programme.

3.7.1 The centrality of context

Borko (2004) suggests that what she terms "Phase 1 research into CPD" focuses on studying the relationship between the teachers and the programme without any need to consider the context. This is illustrated in Figure 3.2 below.

Figure 3.2 Borko's (2004, p.5) Professional Development System

The suggestion that one can study CPD without considering the context has, it has been suggested, kept both education researchers and politicians from confronting "the dynamic socio-cultural nature" of school processes (Van den Berg 2002, p.613). I have, therefore, amended Borko's (2004) model in Figure 3.3 below to include the contextual factor as an omnipresent influence on the other three elements.

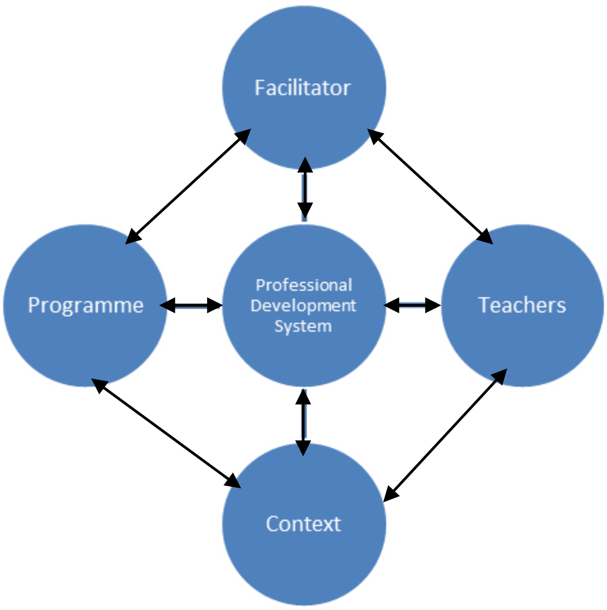


Figure 3.3 Amended model of Borko's (2004, p.5) 'Professional Development System'

Not only do I disagree with Borko's limited view of "Phase 1 research", excluding as it does any focus on the context of the Professional Development, I propose that it is the *Context* which defines not only how the programme is experienced but in fact determines the very nature of the programme and therefore ensures the integrity of the programme for the site it is intended.

I suggest that the context of any CPD programme is a combination of the personal, professional, social and physical contexts of an individual teacher's life and the "socio-cultural dynamics"(Van den Berg 2002, p.613) which connect them as illustrated in Figure 3.4.

Figure 3.4 The 'Ecology' of Professional Development

Each 'sub-context' which comprises the CPD context (Figure 3.4) is itself, embedded within a cultural and historical context, all of which impact on how a teacher interfaces with any professional development provision. Van den Berg (2002 p.612) from his review of various reform efforts notes that "... personal / professional growth does not occur in a vacuum but, rather, in interaction with the characteristics of the school organization" including the physical environment of the school (Best, 2012, p. 10-11). McGeown (1980) reiterates the central role played by socio-cultural dynamics in determining teachers' responses to change and innovation.

> Teachers' adoption of innovations and their innovative behaviour appear to be influenced significantly by their perception of the *school's organisational climate for change, its tolerance of and supportiveness of change, its functional flexibility and openness to new knowledge, its general motivational climate and the decision-making behaviour of the principal in the management of innovation.* (McGeown 1980, p.160, emphases added)

3.8 Summary

The New Zealand and Australian programmes, LISP (Bell and Gilbert, 1996) and PEEL (Baird and Mitchell, 1986) increased our understanding of the need for long-term support of teachers trying to change their practice. Support was required not only for their professional needs, but also for personal feelings associated with change, and with new ways of working collaboratively. The UK study (Dillon et al, 2002) highlighted the benefits of extended support from third level personnel; teachers researching their own practice and presenting their work to their peers. The US study (Borman et al., 2005) adds to our knowledge by highlighting the need to broaden the support base for teachers by involving as many stakeholders as possible. The emphasis on content knowledge in the more successful US programmes shows that for reform in the area of science, teachers' confidence is boosted by having strong content knowledge. This is supported by Garet et al. (2001, p.936) whose results indicate the centrality of subject matter content in professional development efforts.

> Our results give renewed emphasis to the profound importance of subject-matter focus in designing high quality professional development (p.936) …because ….enhanced knowledge and skills have a substantial positive influence on change in teaching practice. (Garet et al. 2001, p. 934; p.936)

Borman et al.'s (2005) study corroborates the findings of the New Zealand and Australian programmes, LISP and PEEL, which highlight the futility of programmes which do not directly address teachers' prior beliefs, feelings and convictions.

> Conversations …suggested that teachers' values and beliefs interfere with the goals of standards based reform efforts.
> (Borman et al. 2005, p.84)

The remit of this research is to determine how to improve the provision of science at primary level in Ireland. Figure3.5 synthesises the conclusions of the "Western" programmes of CPD, i.e. non-Asian, and compares them with *Jugyou Kenkyuu*, a Japanese tradition of teacher education, in order to identify the "success factors" common to both traditions.

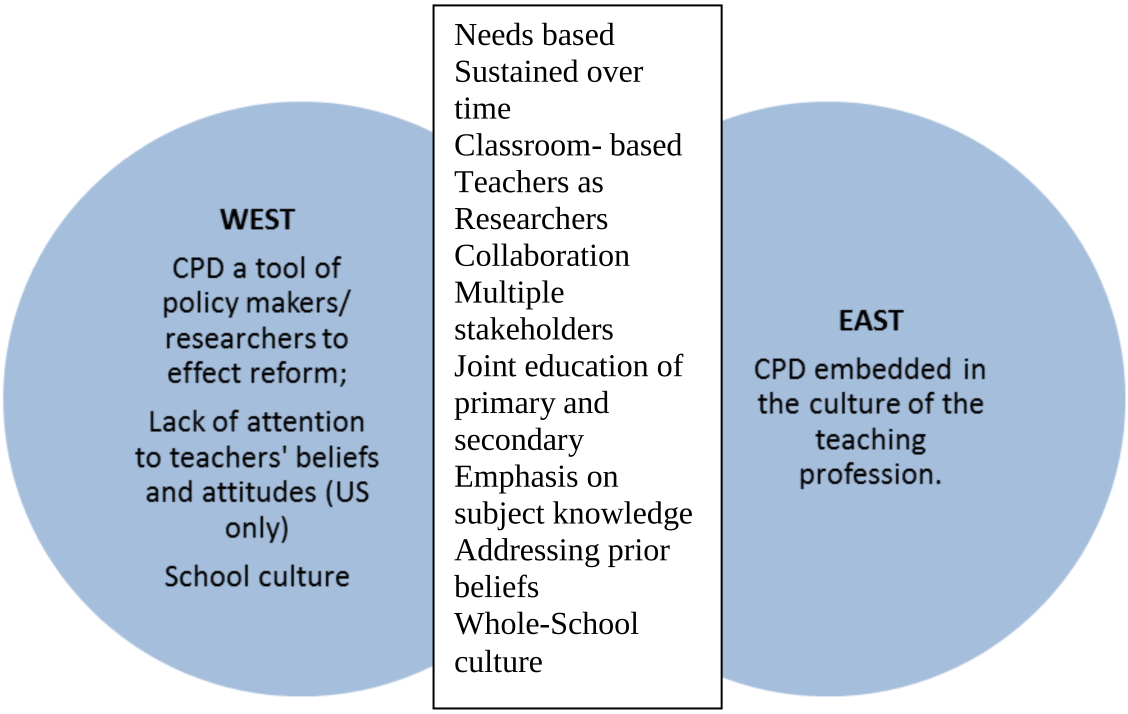


Figure 3.5 East Meets West

This comparison identifies the common features of the models reviewed. It also isolates "Teacher Agency" as the missing factor in the western models of CPD as well as "a strong, vital school culture supporting and sustaining teachers' professional development and student achievement" (Borman et al 2005, p.221).

If change is needed, the evidence suggests that the drivers of such change must be teachers themselves. Irish teachers, however, have been found to be more likely to await centrally mandated CPD than demonstrate agency about their own professional development (OECD 2010, p.73; Hyland, 2012; O'Donovan, 2013), reflecting a different construct of what it means to be 'professional' than is understood in "high performing education systems such as Canada, South Korea, Finland and Singapore", where:

> ...policy on teacher education is a national priority. Teachers are educated in academic universities where theory and practice are combined to form a foundation for teaching that is on a par with other academic professions. Teacher education is research-based and internationalisation is high on the agenda. Also, in these systems, teaching is perceived by young people as an attractive career choice which makes admission to teacher education highly competitive and intellectually demanding.
> (Sahlberg et al.2012, p.14-15)

The findings of the international review panel set up to review provision for ITE in Ireland intimate that one goal of the reforms is to address the development of "professionalism" by encouraging teachers to engage in research into their own practice (Sahlberg et al 2012, p.14-15).

Placing teachers at the centre of the change effort, therefore, I began my research by seeking to establish the needs of primary teachers in the area of science education from which point it is hoped to begin constructing a model of professional development. The theoretical framework for an experimental model of CPD, which will also be used for analysis of the data arising from the research, was derived from a combination of Bolam and Weindling's (2006) "underpinning factors in effective CPD" and from a synthesis of the "success factors" of the international models of CPD reviewed in this chapter. The research of Opfer and Pedder (2011) into the relationships between teacher learning and school achievement among the national population of English teachers (N=1126) is used to support this approach. The factors chosen as the basis for the theoretical framework of this research are summarised in Figure 3.6.

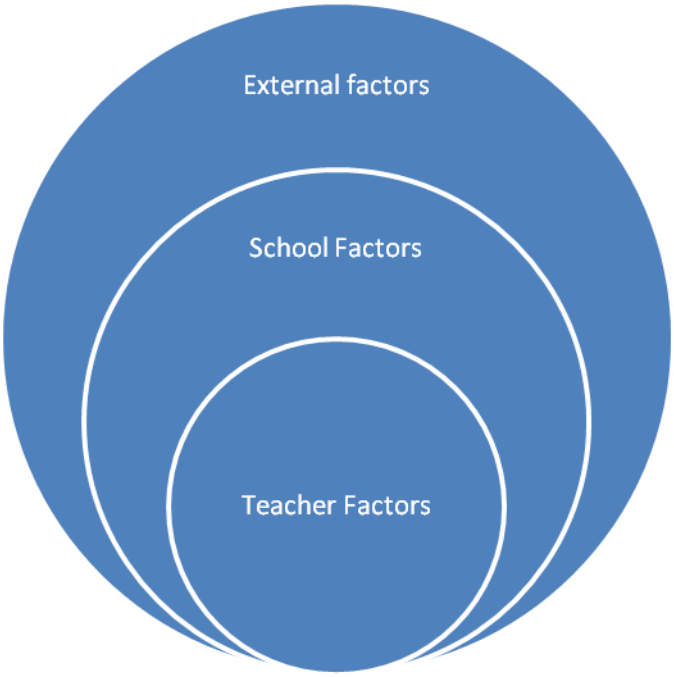


Figure 3.6 Outline of Theoretical Framework for CPD

The theoretical framework used to design a model of science CPD to meet the needs of Irish primary teachers is described in detail in Table 3.3. The framework justifies the factors chosen by reference to the extent to which they featured in the international CPD programmes referred to in this literature review.

Theoretical Framework

Underpinning Factors of CPD (Bolam and Weindling 2006 and Opfer and Pedder, 2011)	**New Zealand** LISP (Bell and Gilbert, 1996)	**Australia** PEEL (Baird and Mitchell, 1986)	**USA** Urban Education Reform (Borman et al. 2005)	**UK** Harrow-King's PD programme (Dillon et al. 2002)	**Japan** *Jugyou Kenkyuu* (Lewis, 2000; 2002)
Teacher Factors: Agency Needs Beliefs	 **X** √ √	 **X** √ √	 **X** √ **X**	 **X** √ **X**	 √ √ √
School Factors: Leadership Support culture	 √ √	 √ √	 √ √	 √ √	 √ √
External Factors: Networking between schools; Higher education expertise; Community-based stakeholders	√ √ **X**	**X** √ √	√ √ √	**X** √ **X**	√ √ √

Table 3.3 Theoretical Framework to Inform a Model of Science CPD for Irish Primary Teachers

CHAPTER 4

RESEARCH METHODOLOGY

4.1 Introduction

The purpose of this chapter is to describe the design of the research strategy and the research techniques employed to gather data. It also outlines how observations were "collected, evidence … marshalled, arguments … drawn, and opportunities … afforded for replication, verification and refutation" (Shulman 1981, p.5), so as to increase credibility in the data.

In selecting the appropriate methodologies, constant reference was made to the core research question: **Which model of CPD can best empower Irish primary teachers to improve their provision of the 1999 science curriculum?** In order to provide opportunity for 'replication, refutation and verification', both qualitative and quantitative data were collected and analysed, using a variety of research techniques with three different samples within the target population i.e. the national population of Irish primary teachers.

1. The National Needs Analysis (NNA) sought to identify the needs of a random sample of one thousand Irish primary teachers;
2. Two primary schools, whose staffs reflect the distribution of Irish primary teachers regarding age, experience and educational background, trialled a model of CPD grounded in the data collected from the NNA. The design of this research can be summarised by the cycle illustrated in Figure 4.1.

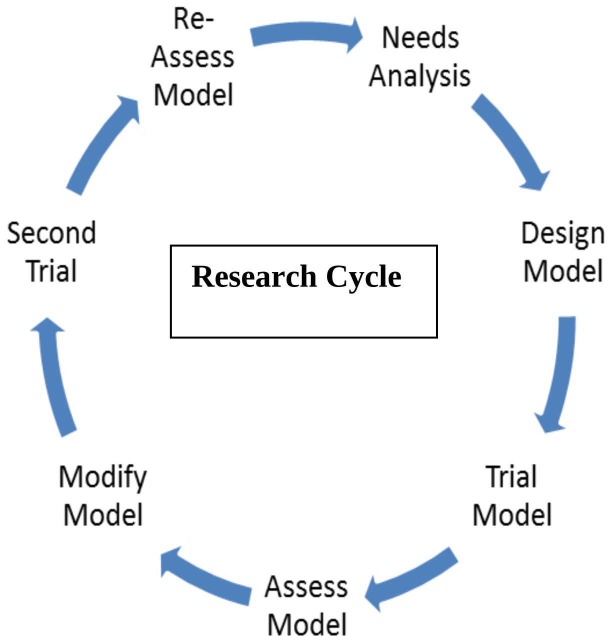


Fig. 4.1 Research Cycle

The techniques used to gather data included questionnaires, semi-structured interviews and observation techniques which included the use of journals and video recordings.

A brief overview of the research strategies employed is presented initially, followed by a discussion of the research techniques and data collection tools used. Each stage of the research project is then focussed upon, and discussed, in more specific detail. All data collected in this study are listed in Appendix I.

4.1.1 Research ethics

As this research was concerned with teachers, parents, children and communities, every effort was made to adhere to the principles of research ethics, i.e.

> The application of moral rules and professional codes of conduct to the collection, analysis, reporting, and publication of information

> about research subjects, in particular active acceptance of subjects' right to privacy, confidentiality and informed consent.
> (Marshall 1998, p.566 in Gallagher 2005)

The guidelines of Christians (2000, p.138-140) quoted in Gallagher (2005) were referred to when designing, using and interpreting each of the research strategies as follows:

- **Informed consent**: Subjects all agreed voluntarily to participate based on full and open information concerning the objectives of the research and what it would involve in terms of time and effort required as well as the methods to be employed;
- **Deception**: Misrepresentation of any kind was avoided by ensuring that all conclusions and interpretations were reviewed by the participants or their colleagues;
- **Privacy and confidentiality**: Permission was obtained from participants to use the data gathered but every effort has been made to 'safeguard against unwanted exposure'. Where potential existed for 'harm or embarrassment', it was necessary to make a value judgement about whether or not to exclude such data. Each school which responded to the NNA was assigned a numerical identity. All letters accompanying the responses which might identify NNA respondents were disposed of. I will provide feedback to all participants through the primary teachers' union magazine 'Intouch';
- **Accuracy**: I sought to present the data clearly in a manner which would accurately represent the true situation as regards primary science in Ireland (Christians 2000, p.138-140). I was able to discuss my interpretation of the NNA data with the teachers at both Trial

> Sites. As I used similar questions in all three samples, I am confident that the interpretations presented are reasonably accurate. The longitudinal nature of my engagement over twenty years with gathering information on primary teachers' relationship with science serves to support the findings in this research (Mulcahy, 1989).

I attended a course on *Ethics in Research* in the Education department of UCC prior to undertaking this research and was therefore very conscious of the issues which could potentially arise.

4.2 Overall Research Strategies

This research aimed to develop a model of CPD based upon a comprehensive assessment of the needs and values of individual teachers and the needs of the entire profession, as derived from the literature and the survey of the national population of Irish primary teachers aka the National Needs Analysis (NNA). The approach used was a combination of some of the main strategies used in educational research i.e. case study/ethnography, action-research and survey. I used multiple methodologies in an effort to provide…"sufficient descriptive data to make… similarity judgements possible" (Lincoln and Guba 1985, p.298). I felt that to rely on only one source of information would seriously limit the inferences possible and potentially undermine confidence in the data (Denzin 1970, p.315; Cohen et al. 2000 p.112; Wellington 2000, p.201). Each methodology provided specific types of data which, when taken together, cumulatively strengthened the inferences which could be made from each. Another reason for employing multiple means of collecting data was to address the "deficit view" of qualitative research (Miles & Huberman, 1984, p.15; Freeman et al. 2007, p.25).

A primary objective of this research was to place teachers at the heart of the research by engaging them in collaborative, critical analysis and reconstruction of their own practice. Action-research methodologies provided the participants with the opportunity to become actively contributing members to the research work, with a view to improving their own practice. By involving teachers in negotiating the manner in which they experienced their professional development, they were in a position to validate or repudiate my conclusions and interpretations continuously.

4.2.1 Survey - An inventory of needs

From the literature it is clear that a CPD priority for teachers is to have an opportunity to identify their needs (Dillon et al., 2002), so I decided to survey as large a sample of the national population as possible. The benefit of using a questionnaire was that it provided the opportunity to gather both quantitative and qualitative data from a large sample in a very objective manner. The information gathered was validated by reference to the questionnaires, semi-structured interviews and conversations with the case-study participants at both Trial Sites.

4.2.2 Action Research/Case-Studies: A re-evaluation of school as a setting for CPD

The choice of the case-study method allowed the combination of elements from the three approaches of survey, ethnography and action-research in each of the chosen sites. Since a goal of this research was to encourage teachers to re-evaluate the school as a setting for their own professional development, it was necessary to employ a research approach which offered teachers a chance … "to reproduce social action in its natural setting, i.e. classrooms and workplaces"…which could…"be used to develop new theory or improve and evaluate existing professional practice" (Hitchcock and Hughes 1995, p.323). In order to confirm the suitability of case-study techniques for this research, Kennedy's (2004) model was used to assess the match between case-study characteristics (Hitchcock and Hughes, 1995) and the characteristics of this research. The perceived alignment of the two is summarised in Appendix II.

To address the "situation-specific" flaw of case-study methodology (Nisbet and Watt, 1984) the CPD model was trialled in two different settings to increase the potential for inferences and transferability (Yin 2002, p.47). The case- studies, being "strong on reality" (Nisbet and Watt, 1984) provided confirmation of anecdotal evidence gleaned from the National Needs Analysis and "embraced and built in unanticipated events and uncontrolled variables" (Nisbet and Watt, 1984). Some of these 'unanticipated events' included non-compliant participants and difficult relationships. The case-studies therefore provided both breadth and depth of evidence.

The fact that a case-study could be undertaken by a single researcher made it an attractive option for me, in spite of the reported problems of observer bias (Nisbet and Watt, 1984). Multiple sources of data from multiple stake-holders at each site were gathered in an effort to counteract any bias on my part.

The term "action-research" was applied to the case studies and is defined as follows:

> Systematic inquiry that is collective, collaborative, self-reflective, critical and undertaken by the participants of the inquiry.
> (McCutcheon and Jung in Anderson et al. 2007, p.3)

The perceived alignment between this research and action-research methodology is outlined in Appendix III. As I was a fully contributing member of staff in TS2, it was possible to assess the potential for 'in-house' CPD leadership as it is unlikely that sufficient finances will be forthcoming to provide specialist CPD providers. I was "immersed in the culture of the case-study schools" (Patton, 1985, p.1) having taught full-time in a variety of Irish primary schools for twenty years. Aware of the potential for bias that this familiarity may have introduced (Wellington, 2000), I sought to retain the status of "objective outsider" through extensive "two-way interaction" (Huberman 1987; Leung 1992; Lomas 1997; Oh and Rich 1996 in Ke Yu, 2011, p.3) with participants who were encouraged to perceive themselves as co-researchers. The on-going reflection and "self-appraisal" by participants (Macintyre, 2000) served to reduce, if not eliminate, my bias.

I felt the benefits of being a practitioner-researcher outweighed the disadvantages and, that my "practitioner-insight" greatly facilitated the design of the intervention model, the ethical considerations for the project and the quality of the reporting. Because this action research was concerned with real practitioners and conducted within *actual* circumstances of practice, it is hoped that the results will have more resonance with other practitioners (Lincoln and Guba, 1985 p.298; Cohen et al.2000, p.79).

4.3 Overview of Research Methodology

Triangulation is considered by most writers on case-study methodology to be vital to internal validity. Hitchcock and Hughes (1995, p.324) quote Denzin's (1970) four types of triangulation: data; investigator; theory and methodological, each of which was used to ensure that the research tools are measuring or describing what it is they purport to measure or describe, i.e. have validity.

Data triangulation was attempted by collecting data from three distinct samples of the target population in different locations. Initially a random sample of 1000 schools was surveyed and the same information was sought from the staffs of the two case-study schools. *Investigator triangulation* was achieved by asking the participants in the case-study schools, along with my colleagues and supervisors, to review the conclusions of the research as they emerged (Merriam 1988, p.169-170). By maintaining an awareness of personal pre-conceptions and listening to perceptions of others, an effort was made to preserve a measure of objectivity at all times. I asked the participants of both trial sites to comment on my findings from the NNA. In an effort to enhance the validity of my conclusions from the case studies, the final month in TS2 was spent reviewing my initial conclusions with the participants of that site. Each participant was given a summary of these conclusions and asked to indicate the degree to which they agreed/disagreed with them. Opportunity was provided for participants to comment on the findings. These opinions and comments were used to refine the conclusions drawn. The instrument used for this purpose is presented as Appendix XXVI. *Methodological triangulation* was sought by utilising a wide variety of research tools in order to provide as complete and as balanced a report on the findings as possible to facilitate:

> …cross- checking the existence of certain phenomena and the veracity of individual accounts by gathering data from a number of different informants and a number of sources and subsequently comparing and contrasting one account with another to produce as full and balanced a study as possible.
> (Open University course E811, 1988 p.54)

Chapters 9, 10 and 11 present my conclusions as validated by the participants at both Trial Sites.

An overview of the research methodology together with the timeframe over which it was carried out is shown in Appendix V.

4.4 Questionnaire Data

The use of questionnaires had the advantage of anonymity. By using standardised questions it was hoped this would improve the reliability of the data generated. A total of nine questionnaires were administered during this research project and they are reproduced in Appendices V-XII (Appendix VI was used at both Trial Sites). The content and analysis of these questionnaires will be considered in more detail in Chapters 5, 6, 7, 8, 9, 10 and 11.

Questionnaires were used to assess not only the needs of the teachers at both case-study sites but also the needs of the profession as a whole. The first was a national survey called the National Needs Analysis (NNA, see). This was administered to one thousand teachers and provided the baseline data for the rest of the project, together with the information gleaned from the literature review. The objectives of this questionnaire included:

- establishing a profile of the population of Irish primary teachers with regard to their prior experience of science education, their attitudes to science and their perceived needs in the area of science;
- ascertaining the current levels of confidence of primary teachers in teaching the 1999 science curriculum (Government of Ireland, 1999);
- identifying the specific aspects of the science curriculum which present difficulties in terms of implementation;
- determining the type of CPD which teachers feel would best meet their needs in terms of access, relevance and efficacy;
- establishing teachers' attitudes towards professional development generally.

Every effort was made to ensure that the population surveyed was representative of the national population. At the time the survey was carried out there were approximately 3,300 practising teachers in the Republic of Ireland. I was aware of the poor response rate to such surveys from the literature. In an effort to secure a high response rate, I decided to target as high a percentage of the population as was feasible from both from an expense and labour point of view. Using *Excel* software, a random selection of 1,000 schools was selected.

4.4.1 Design of questionnaires

All questionnaires underwent many drafts in order to follow as closely as possible the advice given in the literature (Cohen et al., 2000; Munn and Drever, 1996; Wellington, 2000). The main issues were those of relevance to the research question: **Which model of CPD could best empower Irish primary teachers to improve their implementation of the 1999 science curriculum?** Other issues which were considered included: clarity of meaning; attractive presentation and brevity of completion time. In line with advice from the literature (Pallant, J. 2007, p.10), I sought to avoid long, complex or leading questions. In the case of the national survey the potential existed for the size of the sample to be very large, therefore it was decided that the majority of the questions would have to be closed and numerical to facilitate ease of analysis (Cohen et al., 2000 p.247). Ample opportunity was provided, however, for respondents to elaborate on answers in an optional, more open-ended manner.

A number of standalone, open-ended questions were also included to give depth to the information gleaned from the closed numerical type questions.

Every effort was made to eliminate bias and to render the questions unambiguous by using a rigorous procedure which took a few months to complete. It was hoped that the internal reliability would be borne out by reference to the data gathered from the questionnaires and interviews arising out of the two case-studies (Appendices VII-XIII and XV-XVIII).

Opinions were sought from a number of objective, experienced researchers, including my own head of department and supervisor, who read each draft and made recommendations where questions tended to be ambiguous or had potential to cause offence. A colleague from the Statistics Department of UCC also made comments regarding the layout and length of the questionnaire. It took a number of drafts to eliminate the many potential issues, in particular to achieve the balance between comprehensive coverage of the research questions and the length of the questionnaire.

In order to distract from the length of this questionnaire, it was considered prudent to follow the advice of the literature and to divide the questionnaire into sections. Advice was sought from the literature regarding the order of presentation of these sections. Wellington (2000, p.104) recommends placing the closed matter-of-fact questions first, followed by the questions which require opinions and judgements of the respondents.

As it was felt that the personal section of a questionnaire is generally regarded as a quick section to complete, it was tempting to put that section first. It was ultimately decided to let it follow the section on school-information as that is equally quick to complete, but has the advantage of being impersonal and less likely to evoke a negative initial response. This worked well and, it is believed, contributed to the high response rate and quality of the answers. In order to reduce the lengthy appearance of the questionnaire it was decided to reduce the line spacing between questions.

Having designed the questionnaire over several drafts, a pilot survey was conducted in order to detect any weaknesses in the structure of the questionnaire. The population for the pilot-run of the questionnaire consisted of twelve primary teachers in a local school. A letter containing the following questions accompanied each of the pilot questionnaires:

- Are the questions comprehensible?
- Are there any ambiguities in the questions?
- How long approximately did it take you to answer?
- Are there any other major issues around in-service that you feel I should have addressed and didn't?
- Is it too long/short?
- Is the layout attractive/congested?
- Are there any questions you find objectionable?

The term 'in-service' was used as it was felt that, at the time, the term 'CPD' would not resonate with all teachers.

A number of suggestions were made regarding the wording of some questions. Having re-drafted the questionnaire to address the issues highlighted, the questionnaire was administered by post on November 21st, 2007. It was hoped that this revision, in light of the pilot-phase, enhanced the reliability of the questionnaire. The return date was set for December 8th. The teachers had therefore just over two weeks to complete and return the questionnaire. From the literature (Cohen, 2000) it was felt this was sufficient time to galvanise those interested to reply, and not so long that they felt it was possible to delay. This timing, it is felt, was partly instrumental in the high response rate.

A letter to the principal of the target school, as well as a letter to the ultimate respondent, was included. These letters sought to assuage the annoyance which multiple surveys can induce in recipients. Even so, a number of principals replied, without having completed the survey, to say that no less than seven surveys had arrived on his/her desk that week. Their ire is completely understandable. These non-respondents expressed the opinion that schools are 'sitting- ducks' where researchers are concerned and that it was difficult to discriminate between worthy research topics and dross. It is hoped that the letters accompanying the survey expressed sufficient appreciation to respondents for the effort and time required to complete the questionnaires. They must have struck a chord as many personal letters accompanied the responses, expressing a perceived need for this type of research and also gratitude that the issues contained within were being addressed. This illustrates a bias issue that cannot be eliminated - those who are interested in the topic will respond and therefore the sample may not be quite as representative as one would wish for.

In each case-study, four questionnaires were administered in total. In each case the following format obtained:

- Initial needs-analysis of staff members;
- Post-intervention questionnaire to teachers;
- Post-intervention questionnaire to parents;
- Post-intervention questionnaire to children.

The needs-analysis questionnaires used in each trial school were based on the NNA questionnaire and a summary of the development of all questionnaires used in this research can be found in Appendix XIV.

4.4.2 Analysis of questionnaire data

I initially transcribed all quantitative data from the completed questionnaires into a spreadsheet package, *Excel,* as it was considered imperative to convert the data into electronic format as quickly as possible. All hard copies of the responses were numbered and filed in a metal filing cabinet so that any anomalies or ambiguities could be checked at a later date. As the data from the NNA were to provide the baseline data for the design of the model of CPD, it was imperative to conduct a preliminary analysis as quickly as possible in order to form an initial impression of the needs of teachers. *Excel* was used to calculate the frequencies for each question, however, no correlational analysis was carried out. It was decided, from reading the literature, that the best software available for this data analysis would be *SPSS*. I converted the data from *Excel* into the SPSS programme and this provided an excellent cross-checking facility to ensure that the number of items of data transferred tallied with the number of items on the hard copies of the completed questionnaires. A colleague was asked to cross check the data which had been input into *SPSS* with the hard copies of the completed questionnaires also. This strict process added to the reliability of the results. Electronic copies of the data were made and filed in two separate offices for safety. The process of naming the variables and assigning values to the codes also gave me an in-depth familiarity with the data. I felt that the use of *SPSS* to analyse the quantitative data increased the validity and reliability of the data analysis.

A large amount of qualitative data was generated by the NNA in particular. I transcribed all of this data into electronic form. This was extremely tedious work and also time consuming. Initially, I thought it would be possible to manually analyse this data without using a software package and transcribed the answers for each question into columns on *Excel*. Each answer was assigned a code according to the categories of answers identified. This was facilitated by my familiarity with the data, having read through so many and having done the transcription personally. The category labels were based on the headings that emerged from the theoretical framework. Coding involved going through each answer and assigning each one to a relevant category. This work proved gargantuan in the face of such a large response rate. Fortunately, my supervisor introduced me to a software package called *WinMax* which greatly facilitated the handling of the data.

Cohen et al., (2000) highlight the difficulties associated with the analysis of qualitative data:

> In qualitative data, the data analysis here is...more of a reflexive interaction between the researcher and the decontextualised data that are already interpretations of a social encounter.
> (Cohen et al., 2000 p.282)

In order to deal with the concern that incorrect interpretations might be made, an effort was made to read through the entire text of the questionnaires where any ambiguity was observed, to determine the tenor of the whole questionnaire. This follows advice from Cohen et al., (2000) that “the whole is greater than the sum of the parts”.

In order to ensure that the transfer of raw data to electronic format was reliable, a colleague worked with me to cross-check each of the questionnaires with the electronic format. Once the initial coding was completed, a frequency of the emerging themes was determined and compared with those isolated in the theoretical framework. A colleague was asked to go through each item of data and asked for his opinion on the appropriateness of the code allocated. While there were a small number about which we disagreed, the level of agreement was generally quite good. In the cases of disagreement, a new cluster was devised to accommodate the more ambiguous codes. This rigorous process facilitated the isolation of certain themes and generalisations became possible. This double-checking of the code allocations served to increase my confidence in the reliability of the inferences made from the data.

Each of the pre-intervention questionnaires carried out at the two Trial Sites were analysed under the same themes as those which emerged from the NNA and the

Theoretical Framework. This convergence of themes across all questionnaire data adds to the reliability and validity of any inferences drawn from the data.

4.5 Interview Data

Interviews were a vital element of this study. A large national survey, while having the benefit of providing empirical evidence, lacks the immediacy of personal accounts where ambiguity can be eliminated by the use of a probe. The NNA provided an indication of the factors which inhibit science teaching at primary level and attitudes towards CPD participation. Without the interview data it would have been difficult at times to determine the meaning intended in the NNA responses.

> …interviews are a good tool to use when....gaining a perspective on how others understand and interpret their reality.
> (Anderson et al., 2007 p.168-169)

I was also mindful of the need to place the data obtained from the NNA in context. For this reason it was necessary to obtain some ethnographic data which would provide the reader with "a comprehensive, holistic description of the cultural scene" (Spradley, 1979).

4.5.1 Selection of "Interview mode"

In line with the action-research principles adopted, it was felt necessary to provide teachers with a platform to air their thoughts and opinions unfettered by the structure of a questionnaire (Wellington 2000, p.72). It was also hoped that issues which they perceived as relevant to the research question, but not considered by me, would come to light using this technique.

Three interview "modes" were considered - structured; unstructured and semi-structured (Lechuga 2011, p.1). Structured interviews which allow no deviation from the wording, would not have added greatly to the information gleaned from the questionnaire data. The unstructured interview on the other hand, which has no set questions or even order of topic would, it was felt, prove too difficult to analyse. The compromise was to select the semi-structured interview.

Following the advice of my supervisor and looking at interview schedules in the literature (Cohen et al. 2000; Drever, 1995) I devised a general structure for the interviews. By reference to the questionnaire data gathered to date and my own journal and observations, an "interview schedule" (Patton, 1990) was drawn up. This was piloted with five practising teachers from the school in my own locality which had piloted the NNA questionnaire. It was modified in response to their comments and submitted to the Head of the Education Department in my university as well as to my supervisor for further objective comment. It was felt that this interview schedule needed to be rigorously reviewed before use, as it presented an excellent opportunity to give teachers a chance to clarify their responses to the Whole Scholl In School (WSIS) CPD model. The interview schedule used with the participants in both Trial Sites is reproduced as Appendices XV, XVI, XVII and XVIII.

4.5.2 The interview schedule

The overall aim of the interview schedule was to allow participants the opportunity to "make their perspectives known" (Wellington 2000, p.72) and therefore it was imperative that the teachers were relaxed and felt in a position to take what Wellington (2000) calls the "leading role." The main areas covered in the interview schedule were:

- Introductory questions which explored the teacher's background in teaching and their experience of teaching science. These questions came first, following the advice in the literature (Drever, 1995; Cohen at al 2000). Being of a personal/familiar nature, these questions did not require much introspection and sought to set the tenor of the interview as being informal and relaxed;

- Questions based around some of the main elements of CPD arising from the literature review and the preliminary results of the National Needs Analysis (NNA) in order to gauge participants' attitudes towards them. Participants' views on the potential contribution of each CPD element to a programme of CPD were appraised and opportunity was provided to suggest alternative elements of CPD;
- Questions of a retrospective nature based around their experience of the CPD model. Participants were asked to give their opinions on the effectiveness of the programme in developing their confidence with regard to their subject knowledge and scientific pedagogy. Teachers' views on the comparative merits of this model of CPD with more traditional models were also sought. They were also asked to suggest what they perceived as the benefits/drawbacks of this model;

The interview schedule provided a structure to the interviews which facilitated some level of consistency across all interviews. It also ensured that all topics were covered in each interview. The schedule provided a 'level of control', in that it kept the interviewees on topic, particularly for those who sought to use the interview as a platform to air their 'sometimes unrelated' grievances! As a researcher I found the interview schedule provided the freedom to allow the interviewee to lead the conversation, while being able to change the direction of it without causing offence. The interview schedule served as a reminder of the formality of the conversation. It was also useful in terms of analysis as all of the recorded responses were in the same order on each DVD.

As mentioned, probing was used judiciously to “obtain a response from an informant or a more extensive or explicit expression of it” but care was taken to make the probing questions “neutral” (Parsons, 1984, p.89) to “avoid directing the interviewees into certain responses” (Brenner et al. 1985; Kennedy 2004, p.177). An example of such a probe was “Can you elaborate on that please?” The possibility of such interaction between researcher and interviewee in a semi-structured interview made for a very flexible research instrument and helped to eliminate ambiguity.

4.5.3 The interview setting

All interviews in Trial Site 1 were carried out in a pre-fabricated building ordinarily used by one of the resource teachers. It was a medium-sized room with comfortable furnishings and pleasant décor. It was at some distance from the main building of the school and therefore was free from any disturbance. In Trial Site 2, interviews were carried out in my classroom. This was a small, intimate room, with comfortable furniture and good lighting. This room was at a remove from other classrooms and therefore was quiet and unlikely to be disturbed. The room had also been used for coaching, mentoring and planning sessions throughout the project and so was a familiar setting, unlikely to cause any unease. The principal at Trial Site 2 chose to be interviewed in her own office, where, it is presumed she felt more comfortable. This proved to be the most appropriate setting for this interview as it allowed her to retain some measure of control over the conversation.

Time allocation for interviews was not an issue at either school as both principals agreed for teachers to be interviewed during school hours while their classes were taught by the resource staff. This facility greatly enhanced the quality of the conversations as teachers were relaxed and free to concentrate on the interview topics.

All interviews were recorded with the permission of the interviewees. Recording was done using a high-quality camcorder bought specifically for the purpose. The camcorder had a large capacity hard-drive which meant that up to four hours of recording could be done without up-loading the recordings onto a PC or converting to DVDs. This enabled me to be flexible in accommodating teachers and it facilitated time management. Teachers had become very familiar with the apparatus which was used throughout the project to record lessons, mentoring, coaching and planning sessions. The camcorder was fitted with a wide angle lens and set up on a tripod. The use of the lens meant that the camera could be placed discreetly in the room at some distance from the interviewee and therefore did not intimidate them. The microphone of this recorder was very sensitive which meant that it did not need to be too near the interviewee in order to pick up the sound. Mains electricity was used at all times in order to avoid any problems with batteries. All recordings were transferred to hard copies (DVDs) on the day of the recording and multiple copies were made.

4.5.4 Interview techniques

Some teachers chose to sit with their backs to the camera but in all cases I sat opposite the interviewee. This enabled the use of the interview schedule, typed and held on a clip-board, without allowing the interviewee to see the questions. This gave me an element of control, as the interviewee could not anticipate the direction of the interview and prepare answers in advance (Drever, 1995). This ensured a natural flow to the conversation. Points were marked off as they were covered. Other than this, I did not write anything during the interview and so could maintain eye contact at all times. The use of the camera gave me great confidence that the conversation would be fully and accurately captured. One hour was allocated to each interview. This allowed time for settling down and any preliminary questions or informal conversation.

Other techniques derived from the literature (Drever, 1995; Cohen et al., 2000) and used to good effect were eye-contact, timing of interruptions, tone of voice, pace of speech and the use of stock phrases. Nodding and maintaining eye contact was found to be a useful way to encourage teachers to continue speaking. It was necessary to interrupt the flow of conversation from time to time in order to cover the full range of topics with each interviewee. This was usually done by using non-verbal signs such as breaking eye-contact and picking up the interview schedule. At times, raising a finger or a hand indicated my desire to add a probe or ask another question. Sitting back in the chair and/or folding my arms indicated that I was ready to listen again. The tone of voice and pace of speech were used to good effect to indicate the type of response required. The initial questions, some of which were closed, were asked in a more brisk tone of voice, indicating that only brief answers were required. The more searching questions were put slowly, in a more thoughtful manner, indicating that some reflection would be required before answering. The use of stock phrases such as “I see” and “I understand” encouraged the interviewees to continue talking and helped to maintain a natural flow to the conversation. Where the interviewee wandered off the point, the tactic of self-blame used to good effect by Kennedy (2004, p.180), was adopted. Phrases such as: “I apologise, I did not express that very well, did I? What I meant to ask was….” This facilitated directing the mind of the interviewee to the core-issue under discussion.

I found that my interview technique had improved considerably after the pilot phase and increased use was made of neutral phrases and probing questions such as “Can you elaborate on that more please?” These were written into the interview schedule as a reminder. These written prompts were invaluable and enabled me to avoid “loaded responses” which might indicate a pre-disposition on my part (Cohen at al. 2000, p.121).

It is hoped that the fact that the same interview schedule was used in two distinct settings, with two different groups of interviewees, has increased the reliability of it as a research instrument.

4.5.5 Analysis of interview data

The initial task undertaken was to transcribe fully all of the video-recorded interviews. This was an arduous task which I undertook myself. While it was very costly in terms of the time invested, I felt it greatly added to my understanding of the data, as it provided an opportunity to become fully “immersed” in it (Drever, 1995; Wellington, 2000). Full transcripts (Drever, 1995 and Cohen et al. 2000) were made including the informal conversation before and after the interview, which provided a picture of the personality of the interviewee, as well as indicators of their attitudes to both science and the intervention programme.

Having complete transcripts of each interview in electronic format allowed me to store the data safely on two external hard-drives which were kept in two metal filing cabinets in different offices at all times. This provided me with peace of mind that the data were very secure. Having the data in electronic format facilitated the use of the qualitative analysis package *WinMax* in order to process it. In addition, having the data so easily accessible in electronic format facilitated the easy retrieval of exact quotations.

Each transcript was checked for accuracy on two separate occasions by reading it while watching the interviews. Any errors observed were corrected. All hand-gestures, body-language and facial expressions were observed in order to assess the accuracy of interpretation of the language used (Cohen et al 2000, p. 282). In order to analyse the large amount of interview data and to address the difficulty of "decontextualised data", the advice from the literature was followed (Miles and Huberman, 1994; Cohen et al, 2000; Wellington, 2000) and the following stages were used in the data analysis.

- **Data immersion:** To begin the process of analysis I transcribed all the interviews onto an *Excel* spreadsheet, placing all the answers to individual questions in the same column. This process of transcribing and allocating answers to columns served to immerse me in the data. I then carried out a preliminary frequency count of occurrence of each theme that emerged for each answer. This method of transcription involved watching and listening to the interviews on multiple occasions while making notes and attempting, even at this early stage, to identify recurring themes. In this manner I became very *au fait* with the data.
- **Reflecting on Data:** Having spent considerable time reading the transcripts, I put them aside and reflected on what appeared to be emerging from the data. I spent considerable time discussing the interviews with my supervisor and with colleagues. This was an effort to distance myself from the data in order to gain an objective viewpoint on the emerging themes. This desire for objectivity was driven by advice from the literature which warns how easy it is for a qualitative researcher "to jump to hasty, partial, unfounded conclusions" (Miles and Huberman 1984, p. 21).

- **Data Analysis:**

1. Prior to using the software package *WinMax,* considerable time was spent uploading the written transcripts onto an *Excel* spreadsheet, counting the frequency of occurrence of themes and allocating them to various categories identified in the theoretical framework as described in Table 3.3. This was done in an effort to "reduce the data" (Miles and Huberman, 1984). This contributed to my immersion in the data and was used to cross-check the codes that eventually emerged from the work with *WinMax*. Time was then spent identifying and noting relationships between the themes identified.
2. A formal effort to code the responses was then undertaken. This was done using the software package *WinMax.* This package has a facility to indicate how many lines of data have been assigned to each code, thus indicating whether or not the theme elicited a strong or weak response from the interviewees. As the coding proceeded, it emerged that some responses could be categorised into more than one category. This necessitated the use of clusters i.e. more general coding categories which reduced the number of codes. In order to improve the reliability of the coding process, the coding was repeated after an interval of six weeks. A colleague, who was asked to check the coded data, noted some errors which were duly changed. The work of transcribing and coding the interview data was extremely demanding in terms of time and concentration. However, the fact that relevant quotations from the transcripts could be easily moved from *WinMax* to a word document meant that the information from the interviews was "in an immediately accessible, compact form" which allowed for great flexibility in the use of quotations to support conclusions drawn.

3. Once the first coding had been completed using *WinMax*, themes began to emerge which corresponded with those arising from the literature and used in the theoretical framework. This increased my confidence that the themes arising were not merely subjective choices on my part, but in fact, reflected international research on the topic. This adds to the reliability of conclusions drawn from the interview data. The second coding carried out after an interval of six weeks confirmed the initial themes. Some responses, which had been somewhat ambiguous during the initial coding and could have been assigned to a number of codes, were gathered together under broader clusters. This meant that valuable data were not lost. In order to validate this reassignment a colleague kindly agreed to carry out a third independent coding. This resulted in the correction of some minor errors which increased the validity and reliability of the data.

Having followed religiously the advice from the literature about the appropriate steps to follow in data analysis, and by subjecting the interview data to three separate assignment procedures, it is believed that the data analysis was reliable.

The conclusions drawn from the analysis are presented in Chapters 5, 6, 7, 8, 9, 10 and 11.

4.6 Complementary Data

In order to provide a rich description of the two Trial Sites it was felt important to gather data from all stakeholders at each of the sites. Data were collected from the children and parents of each of the schools through questionnaires. In an effort to present as complete a picture as possible of the milieu in which the two trials took place, I kept a detailed journal of life in those schools over the period of the trials, and some teachers also kept journals. These data are supported by a large collection of observational data obtained at both sites.

4.6.1 Data from teacher journals and parental and children questionnaires

While four of the teachers at the site of Trial Site 1 used the journals, none of the teachers in the second school chose to use the journals provided for the purposes of reflecting on their experience of the CPD model. The data garnered from the four journals used was not as rich as that gathered from the interviews. The teachers tended to use the journals predominantly for assessing the lessons taught and for deciding on their next steps in developing the children's scientific concepts. There were, however, some opinions about their experience of the CPD model, and these served to validate some of the themes deduced from the questionnaire and interview data.

The questionnaires completed by the parents and children at both sites were open-ended and did not require the use of any software package to analyse them, as the response rate was relatively small and each contained only a few questions. The responses to these questionnaires tended to be quite brief.

4.6.2 Observational data

Extensive use was made of the camcorder to record coaching and mentoring conversations with teachers; teachers and parents engaged in learning science; individual science lessons and Team-Teaching science lessons. A large collection of photographs of children engaged in science lessons was also gathered. This collection, together with the researcher's journal, provided a sense of the longitudinal development of the schools involved in trialling the CPD model. These data were used to cross-check inferences made from the questionnaire and interview data particularly when ambiguity arose. Taken together with the questionnaire and interview data, the observational data provided a detailed description of the cultural setting within which the research took place. A description of the two Trial Sites gathered through the personal and recorded observations of the researcher will be presented in Chapter 7.

4.7 How the Individual Data Sources Contribute to the Themes from the Theoretical Framework

The research question asked "Which model of CPD could best empower Irish primary teachers to become confident teachers of science?" In order to answer this question it was necessary to initially establish what teachers' attitudes to science in the primary curriculum are, and how confident they are teaching the 1999 science curriculum. These questions related to their perceived mastery of the subject. It was also necessary to establish which format of CPD they perceive as best meeting their needs in this area.

4.7.1 Identifying relevant themes in the baseline data

In order to establish the principles which should be used to design a model of CPD, data from the three pre-intervention sources of data were mapped onto the themes which emerged from the literature review and formed the basis for the Theoretical Framework. Appendix XXI shows the categories from the Theoretical Framework used to identify relevant themes in the baseline data reported in Chapters 5 and 6. An insight into the ***Teacher factors***, which impact on confidence teaching science and engagement with CPD, was gleaned from the NNA. The pre-intervention questionnaires administered at each of the two Trial Sites, together with the initial coaching conversations with the teachers, afforded the researcher an opportunity to further explore these factors with individual teachers. Data from the researcher's journal and teachers' journals provided an opportunity for the researcher to see how a teacher's level of confidence impacted on the type and amount of science being taught. Teachers' perceptions of themselves and their colleagues as professionals, along with their beliefs and attitudes towards CPD and CPD participation were explored.

Data from the NNA gave an insight into the role of various ***School Factors*** in supporting teachers' professional development e.g. the role of the principal in supporting CPD; time allocated for professional development activities etc.

Data from the questionnaires revealed teachers' perceptions of the influence and role of ***External Agencies*** such as the DES, third level institutions and other stake holders in providing support for professional development efforts.

Data from the questionnaires and initial coaching conversations yielded information about the ***CPD Processes*** teachers perceive as effective e.g. the degree of mastery of science subject-matter considered desirable; whether or not observation of colleagues was considered helpful etc.

Finally, the pre-intervention questionnaires and the personal reflections of the teachers provided an opportunity to collate data on how teachers view themselves as professionals and which ***CPD Processes*** they believe would empower them to bring about change in their practice.

4.7.2 Identifying themes in the post-intervention data

The same methodology was applied in identifying the relevant themes in the post-intervention data. The Theoretical Framework derived from the literature review, together with the Analysis Framework derived from the pre-intervention data, were used to isolate the emerging themes. The matrix employed to cross-tabulate data sources against themes used to report post-intervention data in Chapters 8, 9, 10 and 11 is shown in Appendix XXII.

The questionnaire data and interview data along with my own observations, provided information on teachers' identity as professionals, as derived from their sense of responsibility for bringing about change in their practice. This sense of identity was investigated as a possible indicator of teachers' responses to change.

My observations of the two case-study sites, the interview data and the personal reflections of the teachers in their journals, as well as the post-intervention questionnaires, provide insights into the relationships between individual teachers and their colleagues, principal, parents, the DES and the teaching profession as a whole.

The interview data, the questionnaires and the researcher's journal were the primary sources of data on the ***CPD Processes*** which teachers felt to be effective in bringing about change. From this an exploration of how to build a collaborative culture capable of supporting ongoing, whole school CPD was conducted e.g. the role of the principal, the need for discussion and reflection, the forms such reflection should take and how to find the time necessary for professional development activities.

4.8 Methodology for Developing a Model of CPD

The sequence of events and the methodology used in data collection, analysis and development of the CPD model proposed is summarised in Appendix XX.

Having discussed their needs with the teachers from each of the two Trial Sites, it emerged that teachers wanted continuous support over an extended period to improve their provision of science. The general concept of the trial model was discussed at length with teaching colleagues, the researcher's supervisors and with the teachers themselves. Arising out of these discussions, and in light of the literature review, the aims of the CPD model listed in Table 4.1 were formulated.

Aims of the proposed CPD Model
1. To give teachers the opportunity to decide on the focus of their CPD.
2. To give teachers the opportunity to propose and try out ***CPD Processes*** which they felt would best meet their needs.
3. To introduce teachers to a constructivist model of science teaching including alerting them to some of the common misconceptions held by children and the use of formative assessment to decide on appropriate interventions.
4. To support teachers to introduce more investigative-style science lessons.
5. To encourage teachers to collaboratively discuss and reflect on appropriate 'next steps' in the development of scientific concepts in children.
6. To support teachers to develop their own understanding of the scientific concepts they are endeavouring to teach.
7. To empower parents to support their children's scientific development through providing them with scientific education in those topics taught in school.
8. To empower parents to teach alongside teachers through Team-Teaching.
9. To support teachers in reviewing their identity as teachers to include that of life-long learner and researcher.
10. To encourage a culture of collaboration among the principal, teachers and parents.
11. To empower individual teachers and the school community to develop a sense of agency about its own development.

Table 4.1 Aims of CPD Model

The materials used in the CPD model came from various sources. In many cases the materials and methodologies were influenced by professional development courses on the teaching of primary science undertaken in the National Science Centre, University of York, England. The formative assessment approach was based on CPD materials published by the QCA, UK entitled *Assessing Progress in Science: INSET toolkit for Key Stages 1 and 2*. The diagnostic tests administered to children at the beginning of each topic were drawn from these materials.

Ideas for lesson planning were drawn from the Scholastic publications *100 Science lessons* (Wilson and Creary, 2007*); 200 Science Investigations for Young Students* (Wenham, 2001); *Teaching Tricky Science Concepts* (Newton, 2004) as well as materials used in the post-graduate diploma delivered in UCC entitled *The Teaching and Learning of Primary Science.* However, as teachers were encouraged to come up with lesson plans to target specific misconceptions identified, most of the final lesson plans used were the result of teachers collaborating under my guidance. A detailed description of the activities undertaken during the course of the year-long trial of the programme in Trial Site 2 (TS2) is given in Chapter 7.

4.9 Summary

This chapter has described the methodology used to collect and analyse the significant amount of data required for this research project. It also outlines the steps taken to ensure high levels of reliability and validity of the conclusions drawn.
The introduction provided a summary of the research design in the form of a diagram entitled ‘The research cycle’. The rationale behind the use of multiple methodologies was then presented together with a justification for the use of each research instrument. The use of the survey methodology was justified by reference to the findings in the literature concerning the desirability and necessity of conducting an inventory of the target population’s needs. Case-study/action research methodology was justified by reference to my desire to encourage teachers to re-evaluate their places of practice i.e. schools, as valid settings for their continuing professional development. Case-study methodology was felt appropriate to provide the contextual background with which to interpret data gathered via the surveys. My position in Trial Site 2 as a fully contributing member of staff served to distract from my role as

researcher. I also served as a role model for potential CPD leaders from within the staffs of both schools.

I attempted to illustrate how triangulation was achieved via the use of multiple methodologies and the use of three different samples from within the target population of Irish primary teachers. A description was provided of how each research technique was administered and how the data were collected and analysed. A brief description was given of how each of the different software types was used to analyse both the qualitative and quantitative data i.e. Excel, SPSS and *WinMax.* Finally an effort was made to show how each data source contributed to the Analysis Framework

An overview of the aims and *modus operandi* of the CPD trialled as part of this research was also presented. A summary of all the data collected and the materials created during this research project is presented in Appendix I.

CHAPTER 5

TEACHER FACTORS - A SCIENCE PROFILE OF IRISH PRIMARY TEACHERS

5.1 Introduction

Using the Theoretical Framework (Table 3.3) outlined in Chapter 3, Section 3.8, the underpinning factors of effective CPD derived from the literature were classified under the headings of Teacher, School and External Factors as well as those ***CPD Processes*** deemed effective. There is evidence to suggest that individual teacher factors are central indicators of how children experience science.

> ...of all the issues impacting on primary science, teachers' confidence and their ability to teach science were the areas of greatest concern to teachers. These factors were reported by half of all teachers surveyed. (Murphy et al., 2007 in Varley et al. 2008(a), p.13)

This chapter seeks to isolate which 'Teacher Factors' ought to be addressed in a model of CPD designed to improve provision of science at primary level. To this end, I attempt to profile the respondents in terms of their confidence teaching science, their educational background in the area of science, their attitudes towards science and their commitment to the teaching of science at primary level. A summary of the headings under which the data are examined is presented in Appendix XXIII.

Initially an effort is made to determine how representative the sample of the National Population is by reference to available statistics from the Department of Education and Science and, where available, with statistics for primary teachers internationally.

5.2 Profile of Individual Respondents

The age, gender, experience, role and class size of individual respondents in their respective schools were chosen as the factors to profile individual respondents. 60% to 92% of all primary teachers internationally in 2005 were female. The average age of primary teachers internationally in 2005 was 41 to 47 years (OECD, 2005, p.6). There were 30,368 primary teachers in Ireland during the school year 2007/2008 (http://www.education.ie/en/Publications/Statistics/stat_2007_2008.pdf).

At the time of this research (November/December, 2007) there were 3,282 primary schools from which a random selection of 1,000 was made. There being only one principal per school, approximately 11% of all Irish Primary Teachers would be expected to be principals. The response rate from principals to this survey was extremely high, with 55% of all respondents being principals. This is mentioned at the outset as it affects all the data and needs to be borne in mind when data are being interpreted.

5.2.1 Gender of respondents

65% of respondents were female and 35% were male. This reflects international trends at the time (DES, 2005). There is evidence to suggest that the over-representation of females among teachers may negatively affect female participation in the sciences. While girls have increased their up-take of science subjects in recent years (DES 2007, p.4), they tend not to pursue careers in the scientific arena (Little and de la Barra 2009, p.440). Ivinson and Murphy (2007) and Cervoni and Ivinson (2011) suggest that:

> ...message systems in a classroom can either open up opportunities for girls to learn in science or create barriers that trap girls into fixed positions.
> (Ivinson and Murphy 2007 in Cervoni and Ivinson 2011, p.468)

It is plausible that female teachers, who may have aligned themselves with social identities of incompetence historically extended to girls in science, could inadvertently interact with pupils in such a way as to reinforce this gender dynamic.

> One of the problems that persist is that children continue to align science with masculinity.
> (Cervoni and Ivinson 2011, p.462)

Rocard et al (2007, p.11) stress the need for gender issues to be tackled at primary level since "primary school corresponds to the time of construction of intrinsic motivation associated with long-lasting effects…it is the right time to tackle gendered patterns." If teachers, however, are not aware of how they may be contributing to a socio-cultural perception of science as objective and unemotional (Cervoni and Ivinson 2011, p.462) they cannot address the "pedagogic practices that close down possibilities for children to make connections" (Cervoni and Ivinson 2011, p.472). When a profession continues to be dominated by a single gender, I suggest that it is more difficult to disrupt the historical legacy of science as "masculine and objective". When that profession is predominantly managed by male principals it is possible that principals may not be best placed to establish a common vision of improved practice in the area of science among their predominantly female staffs.

5.2.2 Age of respondents

Nearly two thirds of all respondents in this survey were over the age of 40. The greatest number of responses was in the oldest category of 51 to 65 years at 35% which may reflect the over-representation of principals. A comparison of the ages of respondents with the available statistics is presented in Table 5.1.

Age categories of Irish Primary Teachers (OECD, 2009) http://www.oecd.org/education/skills-beyond-school/educationataglance2009oecdindicators.htm	%	NNA Age Categories (2007)	%
Less than 30	26	20-30	19
30-39	23	31-40	16
40-49	23	41-50	30
50+	28	50+	35
Total:	100		

Table 5.1 Age Categories of Irish Primary Teachers in 2007, (OECD, 2009) and NNA, 2007)

While the older age categories are over-represented, all sectors are represented in the NNA responses.

5.2.3 Roles of respondents

As can be seen from Table 5.2, 80% of all respondents were teaching. About two thirds of the principals were "teaching principals", reflecting the national statistics (DES Statistics, 2007).

Role of Respondents	All Respondents N=465	
	N	%
Administrative Principal	92	20
Teaching Principal	166	36
Class Teacher	177	38
Resource Teacher/Learning Support	30	6

Table 5.2 Role of NNA Respondents Within Their Respective Schools

We can see from the cross-tabulation of age and class taught in school in Figure 5.1 that a child in a multiple-senior class (e.g. 5th and 6th) is three times more likely to be taught by a person over the age of 40.

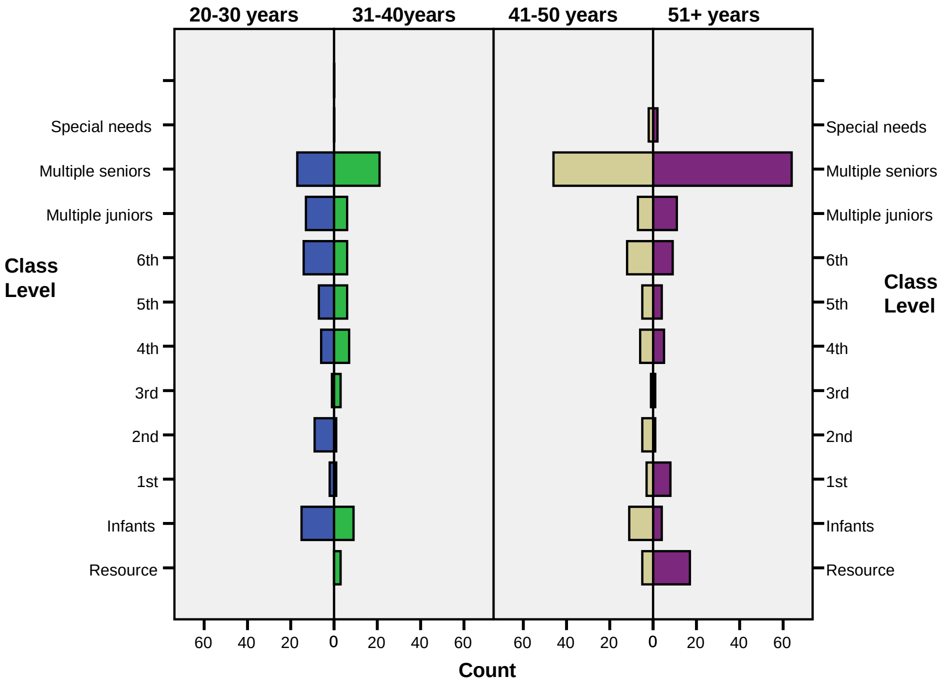


Figure 5.1 Distribution of Class-Levels According to Age of Respondents

In a rural school, the person teaching the senior classes is very likely to be the principal as well. The increasingly fading parameters of the principal's role as discussed in Chapter 2, Section 2.5.6 must impact on the educational experience of children in these classes. The 2007 DES/OECD publication *Improving School Leadership* queries the feasibility of the multiple roles of Irish principals.

5.2.4 Class size

The issue of class size is considered an issue very pertinent to the topic of primary science as classroom management is of particular relevance to practical science classes. The information for this section was derived from responses to Q.9 (NNA Questionnaire, Appendix V). The most common class size amongst those surveyed was 24 but about 50% of all respondents were teaching classes of 24 or more. The largest class size was 44 pupils.

Distribution of Class Sizes of NNA Respondents (2007)	1-19Pupils		20-24 Pupils		25-44 Pupils	
	n	%	n	%	N	%
Total number of classes, N=344	122	36%	100	28%	122	36%

Table 5.3 Distribution of Class Sizes in Relation to 2007 Irish Teacher-Pupil Ratio of 1-24

Table 5.3 illustrates that, in 2007, over one third of the respondents were teaching classes of 25 children or more. The *Education at a Glance* report showed that only 6 other OECD countries had bigger average class sizes than Ireland (OECD 2007, p.372). The negative impact of increased numbers on the provision of science at both primary and secondary levels was identified by the NCCA (Murray, 2008) - an impact likely to be compounded by other cost cutting measures (Duncan, 2013).

5.3 Profile of Respondent Schools

A profile of respondent schools was constructed from Questions 1, 2 and 3 of the NNA Questionnaire (Appendix V1), regarding the size and location of the respondents' schools as well as the gender of their respective pupils. 58% of all respondent schools had between 3 and 20 members of staff. The most common respondent school had between 3 and 10 teachers. This reflects the national average for the school year 2007/2008 which was 8.7 teachers per school. (http://www.education.ie/en/Publications/Statistics/Statistical-report-2007-2008.xls)

School Size (Number of Teachers) DES(2007) Categories	N=25,907 N	%	School Size Categories Assigned in NNA(2007) Survey	Approximate % of Respondent Schools in Each Category
<= 2	1008	4	<= 2	26
3-10	9406	36	3-10	35
11-19	8948	35	11-20	23
20+	6545	25	21+	16

Table 5.4 National Profile of School Size for 2007, taken from (http://www.education.ie/en/Publications/Statistics/stat_2007_2008) Compared to School Sizes of NNA Respondents

Nationally, 60% of all schools have 11 teachers or more (DES 2007). In this survey, only 39% of the respondent schools fell into this category. A possible reason for this mismatch may be that principals of larger schools were less in a position to complete the questionnaire than those in smaller schools. Each category of school size is nonetheless represented in the NNA respondent schools. The locations of the respondent schools were fairly equally divided between rural and urban areas and the distribution of schools according to size and location are illustrated in Figure 5.2 below. 77% of all respondent schools were co-educational, 12% were all boys, 6% all girls and 5% were single sex with a co-educational infant school.

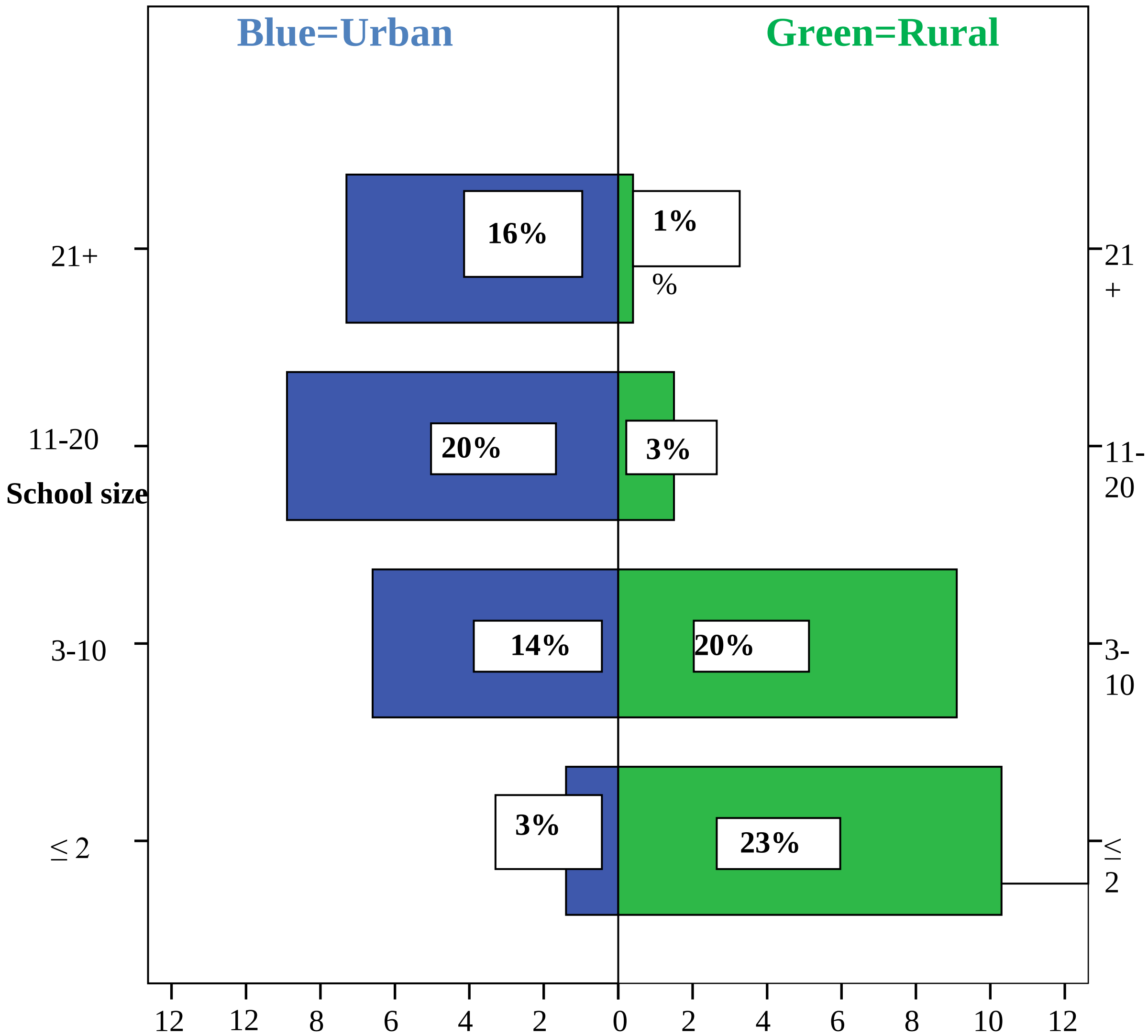


Figure 5.2 Distribution of Respondent Schools according to Size and Location, N=456

5.4 Science Education Profile of Respondents

The factors considered included respondents' post primary science education; their perception of their preparation in Training College to teach science; participation in the DES in-service provided prior to the introduction of the 1999 curriculum and participation in voluntary CPD in the area of science in the five years subsequent to the introduction of the 1999 primary science curriculum (September 2003).

5.4.1 Post-primary science education of respondents

This information was generated by Q.21 in Part 3 of the NNA questionnaire (Appendix V1). From the responses given, an ascending scale from 0 to 4 was established, whereby those respondents achieving a score of 4 could be said to have had a comprehensive post-primary science education, while those achieving a score of zero had no post-primary science education. The score for science education for the respondents was constructed by awarding 1 point for each level of science studied. This was found by combining individual responses to Question 21 pertaining to the Junior Certificate and Leaving Certificate. Scores were obtained for 455 cases in total, so that means only 12 of the entire population either had not had any science education or chose not to complete this question.

Level of Post-Primary Science Studied	**Science Score**	**% of Respondents for Whom a Science Score Could be Computed (N= 455)**
No science education	0	10
Junior Certificate science only	1	20
Junior Certificate science and 1 Leaving certificate science subject	2	46
Junior Certificate science and 2 Leaving certificate science subjects	3	20
Junior Certificate science and 3 Leaving certificate science subjects	4	4

Table 5.5 Post-Primary Science Education of Respondents

The mean score calculated using the SPSS software was 1.9 which would suggest the typical profile of a teacher as having studied Junior Certificate science and one science subject to leaving certificate level which was more than likely to be biology as Table 5.6 shows.

Science Subject Studied	All Respondents N=467		
	N	N	%
Junior Certificate Science only	455	90	20
Leaving Certificate Biology	461	239	52
Leaving Certificate Chemistry	464	139	30
Leaving Certificate Physics	464	82	18

Table 5.6 Science Subjects Studied by NNA (2007) Respondents

The revelation that 10% of all respondents had not studied any post-primary science is surprising, even though the percentage has dropped significantly from 34% (n=79) of respondents in my 1987 survey (Mulcahy, 1989). Junior Certificate science was made mandatory in about 99% of all post-primary schools subsequent to this survey, thus this scale of decrease is not unexpected. Table 5.7 juxtaposes the results from the 1987 survey with those from the 2007 survey.

Total Science Education	Science Score	All Respondents in 1987 Survey N=79		All Respondents in 2007 Survey N=455	
		N	%	N	%
No science education	0	27	34	44	10
Junior Cert. science only	1	10	13	90	20
Junior Cert.+ 1 Leaving Cert. science subject	2	27	34	209	46
Junior Cert. + 2 Leaving Cert. science subjects	3	10	13	92	20
Junior Cert. + 3 Leaving Cert. science subjects	4	5	6	20	4

Table 5.7 Comparison of Uptake of Science Subjects in 1987 with 2007

Keeping in mind that the sample sizes are very different, it is still interesting to note that there is an indication of improved uptake in nearly all categories. While fewer respondents in the 2007 study have no science education at all, 10% still chose not to study science at Junior Certificate level and 20% chose not to study science at Leaving Certificate level. This is the important point - when prospective teachers had a *choice*, 30% chose not to do science.

There does not, however, appear to be a major change in the type of choices primary teachers make regarding their science education at Leaving Certificate level. The majority of primary teachers continue to show a trend of studying science at Junior Certificate level and studying one science subject (still more likely to be biology) at Leaving Certificate level.

There has, however, been a decline in the percentage to choose three Leaving Certificate science subjects from 6% to 4%. These figures suggest that making science mandatory at Junior Certificate has decreased the percentages that get through the system without any science education at all. It has not, however, significantly changed the trend for the majority of primary teachers to study only one science subject at Leaving Certificate level. In order to confirm this perceived change in the scientific experience of teachers at post-primary level in the last twenty years it was felt important to cross-tabulate respondent's ages with their science education scores.

Age	**All Respondents N=453**		**Post Primary Science Education Score**									
			0		1		2		3		4	
	N	%	N	%	N	%	N	%	n	%	n	%
20-30 years	87	19	1	0	19	22	50	58	17	20	0	0
31-40 years	69	15	1	1	10	15	41	59	15	22	2	3
41-50 years	139	31	11	8	23	17	68	49	29	21	8	5
51+ years	158	35	30	19	38	24	50	32	30	19	10	6

Table 5.8 Cross-tabulation of Age with Post Primary Science Education, (N=453)

Table 5.8 highlights some interesting figures. The percentage of each group who achieved a score of 3 was very similar at about 20% across all age groups. This justifies the inference from the comparison of the 1987 and the 2007 results that there has been no significant increase in the numbers taking on two science subjects at Leaving Certificate level, in spite of the increased numbers taking science at Junior Certificate level. A higher percentage of those over the age of 40 had a higher level of science education at post-primary level. The 20-30 year olds were the least likely to show enthusiasm for science subjects at Leaving Certificate level as shown in Table 5.9 below.

Age of Respondents	**All Respondents N= 453**		**Total Taking Science at Leaving Certificate level**		**Total Taking at Least 2 Science Subjects at Leaving Certificate Level**	
	n	**%**	**N**	**%**	**N**	**% of Leaving Cert. students**
20-30 years	87	19%	67	77%	17	25
31-40 years	69	15%	58	84%	17	29
41-50 years	139	31%	105	76%	37	35
51+ years	158	35%	90	57%	40	44

Table 5.9 Cross-tabulation of Leaving Certificate Science Choices with Age

Table 5.9 indicates an association between age and uptake of science. In order to ascertain if this association is significant, the Pearson chi-square test was carried out.

The chi-square test for independence was carried out. It indicated a significant association between age and Post-Primary Science Education, chi-square (1, n=453) =48.597; df =12, p= 0.000.

Table 5.10 Chi-square Results for Cross Tabulation of Age and Post-Primary Science Education

Since 83% of all principals are in the 41+ age category, it is likely that those principals who did science to Leaving Certificate level were more likely to have had a more comprehensive post-primary science education than recent graduates. In order to confirm this inference it was decided to cross tabulate high science scores with the role of respondents. Table 5.11 below summarises the findings.

Role of Respondents	All Respondents N=467		Science Score 3-4 (Minimum of Two Science Subjects at Leaving Certificate Level)	
	N=466		N=454	
	N	%	N	%
Administrative Principal	89	20%	28	**31**
Teaching Principal	163	36%	36	**22**
Class Teacher	172	38%	40	**23**
Resource Teacher	29	6%	7	**24**

Table 5.11 Distribution of High Science Scores According to Role of Respondents

Table 5.11 confirms that of those who achieved a high score in science education as defined by participation in science study at post-primary level more than half were principals. In order to confirm whether or not this association between role and a high science score was significant the chi-square test was conducted.

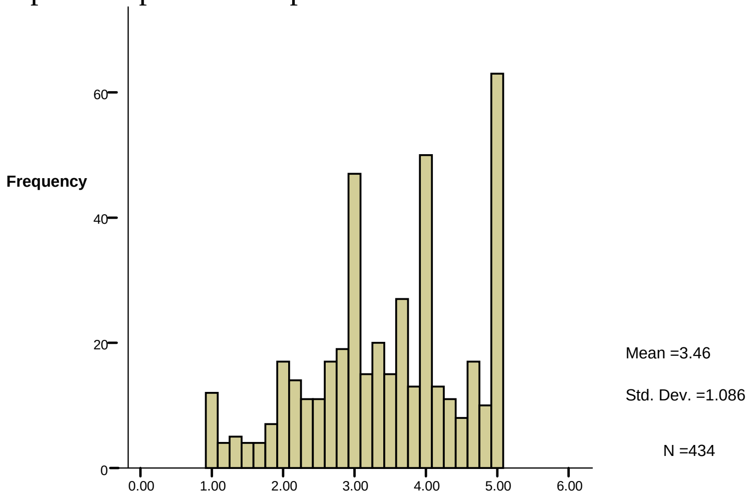
The chi-square test for independence was carried out. It indicated a significant association between role and a high science score, chi-square (1, n=454) =28.016; df =16, p= 0.031.

Table 5.12 Chi-square Results for Cross-tabulation of Role and High Science Score

The significance of this analysis is that those who are not in classrooms teaching i.e. the administrative principals, are more likely to have had a higher level of post-primary science education than their staff members. This may account for the qualitative data from some principals who perceive great need amongst their staffs for more CPD in the area of science. Having potentially had a better post-primary science education, they may be in a position to identify weaknesses in the scientific knowledge of their respective staffs.

5.4.2 Perception of preparation for science teaching at colleges of education

A Likert Scale was used to indicate respondents' perceptions of their pre-service preparation and a score was computed. A score of 1 indicates a perception of having been well-prepared whereas a score of 5 indicates a perception of not having been prepared at all. The score for satisfaction with pre -service preparation was calculated from information generated by Q.24 of the NNA questionnaire (Appendix V). The scores for each of the items in Q.24 were combined and an average overall score was calculated. The individual items included the four strands of the Primary Science Curriculum: Living things; Materials; Energy and Forces and Environmental Awareness as well as two 'Process' elements of the primary science curriculum; Working scientifically and Designing and Making. Regarding satisfaction with their preparation in Colleges of Education the mean score obtained was 3.5. This would indicate that teachers perceive the preparation received to teach science at the Colleges of Education as inadequate. The histogram (Figure 5.3) of the distribution of these scores indicates that the values are skewed to the right, indicating a negative perception of pre-service provision for science education.



Code: 1=Well prepared; 2=Prepared; 3=A little preparation; 4=Not well prepared; 5=Not prepared at all

Figure 5.3 Respondents' Perception of Their Preparation in Colleges of Education to Teach Science at Primary Level

The scores for perception of Colleges **o**f Education preparation to teach Science were categorised according to the criteria laid out in Table 5.13 below.

Score	**Interpretation**
Less than or equal to 2	Prepared
Greater than 2 and less than 3.5	Some preparation
Greater than or equal to 3.5	Poor to no preparation

Table 5.13 Collapsed College of Education Scores

Using these interpretations, the percentage of respondents in each category was computed.

Total Respondents N=467	**Perception of Preparation at Colleges of Education**	**Frequency**	**% of Total Population (N=434)**
		n	**%**
	Well prepared	53	12
	Some preparation	259	60
	Poor to no preparation	122	28
	Total	434	100

Table 5.14 Respondents' Perceptions of Their Preparation in Colleges of Education to Teach Primary Science

It is necessary to cross-tabulate these perceptions with the age of respondents in order to determine if there has been any change in this perception over the last two decades.

Age of Respondents	**All Respondents N=433**		**Well Prepared**		**Some Preparation**		**Poor to No Preparation**	
	N	%	N	%	n	%	n	%
20-30 years	87	20	32	37	50	57	5	6
31-40 years	69	16	8	12	40	58	21	30
41-50 years	136	31	6	4	84	62	46	34
51+ years	141	33	7	5	85	60	49	35

Table 5.15 Cross-tabulation of Perception of Pre-service Preparation to Teach Science with Age of Respondents.

The data indicates that the youngest respondents were more likely to be satisfied with their preparation to teach science than those respondents in the older age categories. This correlation between age and perception of preparation was found to be significant.

The chi-square test for independence was carried out. It indicated a significant association between age and Perception of College of Education provision for Science, chi-square (1, n=453) =75.463; df =6, p= 0.000, phi=0.000.

Table 5.16 Chi-square Results for Cross-tabulation of Age and Perception of Colleges of Education Provision for Science

Since only 37% of the youngest age categories express a sense of having been well prepared to teach science there is a need to explore further the current provision for science in the Colleges of Education. As discussed in Chapter 2, Section 2.3 and summarised in Tables 2.1 and 2.2, provision for science in the Colleges of Education has not been standardised and therefore the college attended will greatly determine a teacher’s preparation to teach science.

In order to determine if the gender of the respondents affected their perception of the provision of science in the Colleges of Education it was decided to see if any relationship between the two was evident. Of the 147 males who participated in the survey, only 11 of them perceived themselves to have been prepared to teach primary science. This represents only about 7% of the male respondents. Of the 287 females who participated, 42 or 15% of them perceived their training to be adequate. The Pearson chi-square test was conducted but no significant association was found to exist between the gender of respondents and their perceptions of their preparation to teach science at the Colleges of Education.

Gender of Respondents	All Respondents N=434		Well Prepared to Teach Science at College of Education		Some Preparation		Poor to No Preparation	
	N	%	N	%	n	%	n	%
Male	147	34	11	7	95	65	41	28
Female	287	66	42	15	164	57	81	28

Table 5.17 Cross tabulation of Respondents' Perception of College of Education Preparation to Teach Science with Gender

It is possible to conclude that dissatisfaction with Colleges of Education preparation to teach science was common to both genders. Only 12% of the entire population expressed the view that they felt well prepared to teach science in the Colleges of Education. Those who left college within the last 10 years are more likely to have had a positive perception of their preparation to teach science.

Statistics from the DES for 2005 showed that the average age of teachers was between 41 and 47, and 65% of the NNA respondents were 40 years or over. Within these age categories 95-96% felt they either had not been well prepared to teach science or were not prepared at all. The percentage for the age group 31-40 years who did not feel well-prepared to teach science is even higher at 98%. Even amongst the most recent graduates 63% felt they had not been well-prepared. This is worrying in light of the fact that some of these respondents would have attended college while the 1999 curriculum was already in place. In order to determine when the youngest respondents had attended college, I cross-tabulated the number of years they had been teaching with their ages in Table 5.18.

Age of Youngest Respondents	**All Respondents**		**Total Experience**			
	N=463		0-5 years		6-10 years	
	N	%	n	%	N	%
20-30 years	88	19	43	50	45	50

Table 5.18 Years of Experience of the Youngest Respondents

From Table 5.18 it can be seen that half of the respondents within the 20-30 year age group had been in college within the 5 years prior to this survey (pre 2007). The Science curriculum was already being implemented for nearly 5 years when this survey was conducted. The other half of respondents had been in college within10 years of this survey and therefore would have been educated to teach the current curriculum (DES, 1999) compared to the older respondents.

What changes have the colleges made to their provision for science in the light of the demands of the 1999 Curriculum? Varley et al (2008(a), p.24) provide a summary of what the colleges aspire to in relation to science education.

> The content of the science curriculum courses in all the colleges is similar in that *in general they aim at providing students with the opportunity to use and learn about using a range of methodologies in the teaching of primary science...Aspects of the courses are also aimed at developing the students' personal conceptual and procedural knowledge in science.*
> (Varley et al., 2008, p.24 emphases added)

This indicates that the developing "personal conceptual knowledge" appears to receive less attention than exposing students to "a range of methodologies". Since so many respondents expressed dissatisfaction with pre-service training, I sought to ascertain the degree of agency on the part of respondents in addressing this deficit in preparation. I also attempted to determine teachers' satisfaction or otherwise with this CPD. Section 5.4.3 now considers levels of CPD participation among respondents.

5.4.3 Attendance at primary science in-service courses

The type of in-service reviewed in this section included both (i) the mandatory DES in-service provided as an introduction to the 1999 curriculum and (ii) any voluntary science in-service attended since 2003 (the year when the science aspect of the 1999 curriculum was formally introduced to schools). The main focus when considering the DES mandatory courses was to determine teachers' perceptions of whether or not they equipped them to implement the 1999 curriculum. I will also look at teachers' perceptions of their personal need for further CPD in this area.

Information for this section was generated from responses to Q.10; Q.13; Q.14; Q.15; Q.16; Q.17 and Q.18 of the NNA questionnaire (Appendix V).

5.4.4 DES mandatory in-service

The Primary Curriculum Support Programme (PCSP) was set up by the DES in 1999, prior to the launch of the Primary School Curriculum (DES, 1999).

> In the academic year 2002-3 the PCSP provided teachers in all national schools with an in-service course to support them in planning and teaching the Primary Science Curriculum. This comprised two seminar/workshop days, and a further day dedicated to school planning.
> (Varley et al. 2008(a), p.23)

The data regarding attendance at the DES courses merely gives a predictable majority as having attended, as these were mandatory for all serving teachers at the time.

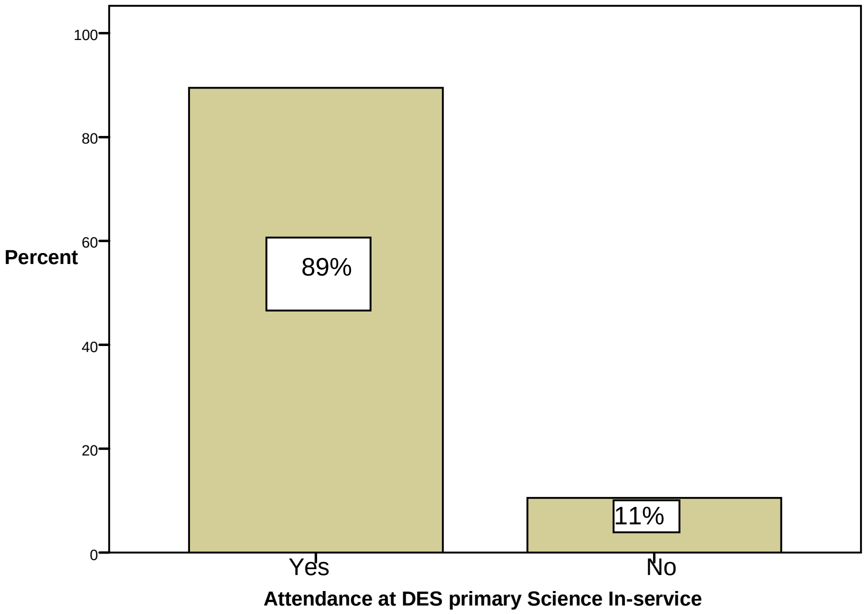


Figure 5.4 Attendance at DES Primary Science In-service Courses

A clear majority attended these courses and those respondents who did not attend or did not respond to this question indicated that they had been on career break; had not yet commenced service; or had not been invited due to teaching outside of mainstream schools. With regard to teachers' reactions to the DES introduction to Primary Science the satisfaction rate was quite high. Again a Likert scale was used to indicate levels of satisfaction and a score of 1 indicates a very positive response while a score of 5 indicates a very negative response.

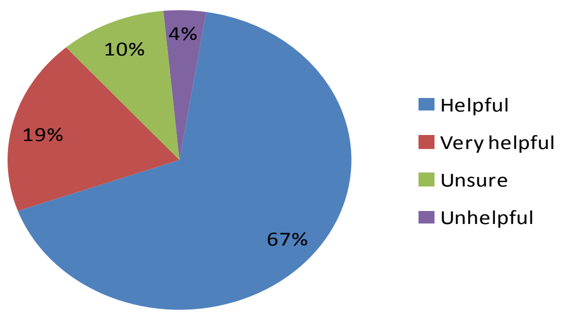


Figure 5.5 Rates of Satisfaction with DES Science In-service

About 86% of all those who indicated their perception of the DES Science in-service courses considered them to be helpful or very helpful.

I attended these DES in-service days. While Varley et al.'s (2008, p. 23) claim that teachers had opportunities to try out some "hands on activities" is not disputed, the assertion that "the skills associated with the Primary science curriculum were "covered" is not accepted.

> Teachers were provided with opportunities to engage in hands-on activities suitable for use in the primary classroom... The hands-on nature of science and *the skills associated with the Primary Science Curriculum were covered in the in-service workshops*, although progression in these skills was not a particular feature of the in-service provided at the time.
> (Varley et al. 2008(a), p.23)

While teachers were positive in their assessment of the DES courses, the qualitative data which will be discussed in Chapter 6, gives greater depth to this data by indicating that for many the courses were considered very helpful as *an introduction* to the science curriculum but were insufficient of themselves. Did this translate into voluntary pursuit of further support?

5.4.5 Voluntary science CPD

Attendance at voluntary in-service courses was looked at to determine whether or not teachers felt strongly enough about the place of science on the curriculum to voluntarily pursue further CPD in the area of science.

49% of respondents had undertaken some voluntary in-service in the area of primary science in the 5 years previous to the survey. The voluntary in-service participation was predominantly of one day's duration (67%) and most likely to have been provided by the Discover Primary Science (DPS) team. Discover Primary Science was developed by Discover Science and Engineering, the national programme designed to promote awareness of science and engineering subjects in Ireland. Since 49% of all respondents attended some form of CPD in the area of science, there is some evidence to show that there is demand for appropriate courses in the topic of science. This is supported by the findings of Varley et al. (2008).

> The figures for 2007-2008 represent an uptake of this initiative (DPS) in 90% of Irish primary schools.
> (Varley et al. 2008(a), p.25)

The fact that the DPS courses are of only one day´s duration and available to only one teacher per school is a source of concern, as opportunities for dissemination in busy schools are limited.

> In most instances, just one teacher in a given school takes part in the Discover Primary Science programme in a given year. Participating teachers and their principals are encouraged to support the dissemination of the programme in school, for example by communicating the ideas to other staff.
> (Varley et al. 2008(a), p. 25)

Interestingly, there is a slight indication that those who perceived their preparation in college to teach science as adequate were more likely to pursue CPD in this area.

Voluntary attendance at CPD	All Respondents N=433		Prepared		Not Well Prepared		Poor to No Preparation	
Yes	n	%	n	%	n	%	N	%
	213	50	29	59	126	49	58	50
No	211	50	20	41	127	51	64	50

Table 5.19 Relationship between Positive Experience at College of Education and Attendance at Voluntary Science CPD

If, as is indicated in Table 5.19, adequate preparation at pre-service level can positively influence participation in CPD, it is even more important that under-graduate preparation meets teachers' needs. 70% of respondents said they needed more CPD in the area of science and both females and males were equally aware of such need (68% of all males and 71% of females). In spite of this, data from the NNA survey reveals that 51% of all respondents had no subsequent training in the five years following the introduction of the curriculum. It was deemed important to profile respondents´ attitudes to science in order to understand this apparent lack of agency in addressing these expressed needs.

5.5 Respondents' Attitudes to Science

An attempt was made to describe the attitudes of respondents to science by combining their responses from the following five questions: Q.14: Voluntary participation in CPD; Q.22: Amount of time spent teaching science; Q.25: The place of science in the primary curriculum; Q.26: Importance of science relative to other subjects; Q.21: Indication of exercising a choice to study science at post-primary level and Q.35: Willingness to pay for a third level qualification in primary science.

5.5.1 Exercise of choice at post-primary level

Respondents were allocated 1 point for each science subject chosen at Leaving Certificate level. Junior Certificate Science was not included in this scale as this was not considered to have been a choice on behalf of the younger respondents. The percentages of respondents who achieved each score is summarised in Table 5.20 below.

Total Respondents Who Chose to Study Science at Leaving Certificate Level, N=321	**Score**	**n**	**%**
Three Science Subjects at Leaving Certificate Level	3	20	6
Two Science Subjects at Leaving Certificate Level	2	92	29
One Science Subject at Leaving Certificate Level	1	209	65

Table 5.20 Leaving Certificate Science Choices of Respondents

This information suggests that only 321 out of 467 respondents or 69% studied science to Leaving certificate level. We know from Table 5.5 that 10% of all respondents chose not to do post-primary science. This indicates that 21% who did science for Junior certificate did not pursue it beyond that level.

5.5.2 Voluntary attendance at science CPD

This information was generated from responses to Q.14. A score of 1 was accorded to anyone who had chosen to pursue science CPD on a voluntary basis in the 5 years prior to the NNA survey.

Total Respondents N=455	**Voluntary Attendance at Science CPD**	**Score**	**n**	**%**
	Yes	1	224	49
	No	0	231	51

Table 5.21 Voluntary Attendance at Science CPD

About half of all respondents had demonstrated some agency towards their science needs. This was considered an indication of being positively disposed towards science. At the very least it is an acknowledgement of its place on the primary curriculum and the need to teach it.

5.5.3 Time spent teaching science

This information was derived from responses to Q.22. A decreasing score from 3 to 0 was constructed to reflect the amount of time spent teaching science per week. The Departmental Guidelines stipulate that one hour per week should be spent on science. I believe one hour should be the minimum time-allocation if a constructivist/active learning approach to science were to be attempted. The maximum time, 2 hours or more, was accorded a score of 3 while the shortest time, less than one hour, was awarded a score of 0. The percentages of the sample who achieved each score are outlined in Table 5.22.

Total Respondents N=395	**Time Spent Teaching Science per Week**	**Score**	**N**	**%**
	2 hours or more	3	7	2
	1-2 hours	2	41	10
	1 hour	1	197	50
	Less than one hour	0	150	38

Table 5.22 Amount of Time Spent Teaching Science per Week by Respondents

It is interesting to note that 38% of respondents do not use the time allocated for science each week. This neglect may well influence the formation of attitudes towards science amongst current pupils.

5.5.4 Opinions regarding the relative importance of science on the primary curriculum

Information for this section was generated from the responses to Q.25 and Q. 26. 99% (N=459) of all respondents thought that science should be taught at primary level. Each respondent who gave this positive response was accorded 1 point. A score was computed for responses to Q.26 regarding the relative importance of science compared to most other subjects. The allocation of scores to respondents is described in Table 5.23.

Total Respondents who View Science as an Important Element of Primary Curriculum N=402	**Rating Relative to Most Other Subjects**	**Score**	**n**	**%**
	Much more important	3	8	2
	More important	2	41	10
	About the same	1	353	88

Table 5.23 Perception of Relative Importance of Primary Science

The responses indicate that teachers seem to believe science to be at least just as important as most other subjects on the primary curriculum.

5.5.5 Willingness to pay for a third level qualification in primary science

A respondent's willingness to incur the costs of attending a third level institution to acquire a qualification was regarded as an indication of a very positive attitude towards science. Only 21% of all respondents indicated such a degree of commitment. Those who were *very willing* were allocated a score of 2 while those who were willing to participate were allocated a score of 1. The percentages which were allocated scores are presented in Table 5.24.

Total Respondents Willing to Pay for a Third Level Qualification in Primary Science N=99	Degree of Willingness	Score	N	%
	Very Willing	2	39	39
	Willing	1	60	61

Table 5.24 Degree of Willingness to Pay for a Higher Level Qualification in Primary Science

That only 21% of respondents (N=467) would countenance paying to attend an accredited course indicates that this is not the preferred route to up-skilling in the area of science.

5.5.6 Computation of attitudinal scores

From the values assigned in Tables 5.20; 5.21; 5.22; 5.23 and 5.24 a scale was computed by adding these factors together. A scale emerged with a minimum value of 0 and a maximum value of 12. A score of 12 indicates a very high level of commitment to Science.The most common score achieved was 4 at 28% of the total for whom a score could be calculated. This would indicate a respondent who more than likely had chosen to do one science subject for Leaving Certificate believes science should be taught at Primary level; teaches science for the allotted time of one hour per week and believes science is just about as important as most other subjects. 26% could be described as being non-committal towards science. These have a score below 4 which would indicate at least one of the factors above is missing. Scores between 5 and 6 were achieved by 36%. This rating indicates someone who has made a choice to voluntarily do more than the minimum required of them which suggests more enthusiasm. Values above 6, achieved by 10% indicate a high degree of enthusiasm for the subject. Table 5.25 attempts to interpret these scores.

Total Respondents for Whom Score was Calculated N=359, Missing values=108	Interpretation of Scale	Attitudinal Score	n	%
	Lip-service Only	0-3	92	26
	Compliant	4	101	28
	Actively Pursuing Science	5-6	128	36
	Very Enthusiastic	7-12	38	10

Table 5.25 Distribution and Interpretation of Attitude Scores

The above interpretation of these scores indicates that about half of the respondents for whom a score could be calculated, or 46% of the entire cohort, could be described as showing enthusiasm for science and are actively seeking to improve their practice. 28% of all respondents could be described as compliant, in that they agree science has a place on the curriculum and they teach it for the required length of time each week, but they do not indicate a willingness to pursue CPD in the area. 26% of those for whom a score could be computed indicate that at the very most they pay only lip-service to the place of science on the primary curriculum and do little, if anything, to improve their practice.

In order to obtain a deeper insight into respondents' attitudes towards science it was decided to consider their opinions regarding the place of science in the curriculum together with the amount of time they spend teaching the subject weekly in detail. Expressions of acceptance of science as equally important as all other subjects (88%) cannot be taken at face value, as practice does not appear to support such claims (see Table 5.22). This neglect of science by some may possibly be accounted for by inadequate confidence levels teaching the subject. Section 5.6 now considers levels of confidence expressed by respondents.

5.6 Respondents' Confidence Teaching Primary Science

I decided to consider the respondents' perceptions of their confidence to teach science, and to compare this expressed level of confidence with teachers' expressed levels of confidence teaching the other core subjects of English, Irish, maths, history and geography. The information pertaining to respondents' confidence teaching science was generated by Questions 23 and 28.

5.6.1 Confidence scores for core subjects

Question 23 asked teachers to rate their levels of confidence teaching English, geography, history, Irish, maths and science on a Likert scale where a score of 1 indicates a high degree of confidence and 5 indicates no confidence. See Table 5.26 for comparison of mean scores for each subject.

Subject	Mean Confidence Scores	Min.	Max.	Standard Deviation
English	1.4	1	3	0.493
Irish	1.47	1	5	0.694
Maths	1.28	1	3	0.489
History	1.46	1	4	0.597
Geography	1.49	1	4	0.637
Science	2.07	1	5	0.962

Table 5.26 Comparison of Confidence Ratings in SESE Subjects and Core Subjects

This comparison of confidence teaching the core subjects was done using the crude measure of asking teachers to rate their confidence teaching science as a general topic. From the distribution graph below (Figure 5.6) it can be seen that for the majority of respondents, their confidence teaching science is lower than that for the other subjects.

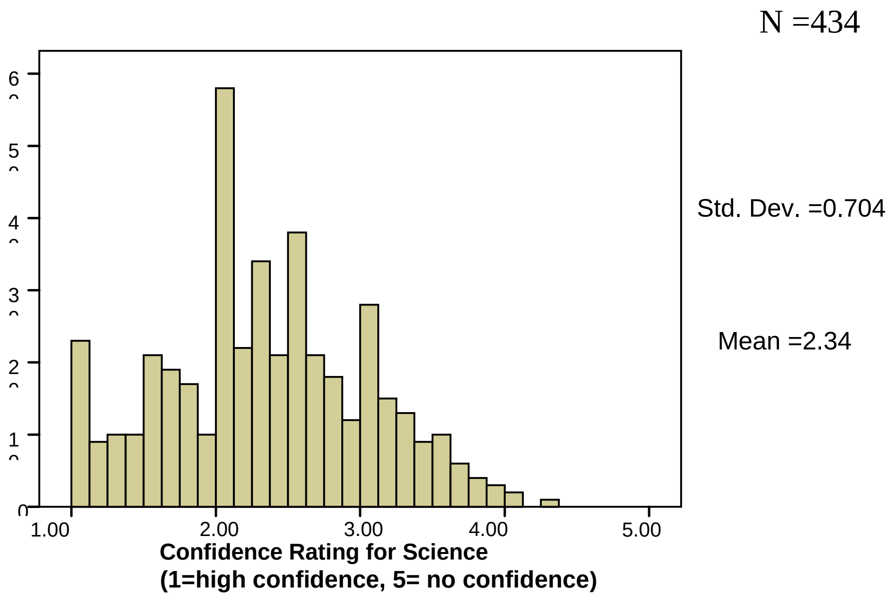


Figure 5.6 Distribution of 'Simple Confidence Ratings' for Science

The measure of confidence for teaching science was refined by measuring the confidence levels indicated for a selection of topics taken from three strands of the science curriculum namely Living Things, Materials and Energy and Forces. These topics included "Plant and Animal life", "Chemical and Physical Changes" and Forces and Energy (See Q. 28, NNA Questionnaire, Appendix V). No reference was made to the strand from which the topics originated. The resultant confidence score is referred to as the 'Refined science confidence rating'. Table 5.27 illustrates how this 'refined science confidence rating' compares to the 'simple science confidence rating'.

Subject	Mean Confidence Scores	Min.	Max.	Standard Deviation
English	1.4	1	3	0.493
Irish	1.47	1	5	0.694
Maths	1.28	1	3	0.489
History	1.46	1	4	0.597
Geography	1.49	1	4	0.637
Science (simple)	2.07	1	5	0.962
Refined Science Rating (based on confidence rating for each of three strands)	2.34	1	4.33	0.707

Table 5.27 Comparison of 'Simple Science Confidence Rating' with 'Refined Science Confidence Rating'

As can be seen from Table 5.27 the refined measure indicates a lower mean-confidence rating when individual strand-topics are taken into consideration. It can be concluded that teachers are much more likely to express confidence in their ability to teach English, Irish, maths, history or geography than they are in their ability to teach science.

5.6.2 Generation of 'refined confidence rating' for science strands

In order to assess confidence teaching each strand, I grouped the topics from Q.28 of the NNA (Appendix V) according to the strand to which they belong. An average rating for each strand was then calculated. The mean rating for each of the three strands considered were combined and an average computed.

		Confidence Teaching Science					
Total Respondents N=467		**Strand of Primary Science Curriculum**	**Confident**		**Low Confidence**		**Little or No Confidence**	
n	%		N	%	N	%	n	%
451	97	Living Things	312	69	133	30	6	1
448	96	Materials	167	37	191	43	90	20
446	96	Energy and Forces	166	37	236	53	44	10

Table 5.28 Summary of Confidence Levels for Individual Strands of Irish Primary Science Curriculum (Curaclam na Bunscoile, 1999)

Table 5.28 confirms that teachers are more likely to feel confident teaching the Living Things strand than teaching the Materials or the Energy and Forces strands as noted in my 1989 research (Mulcahy, 1989). A cross-tabulation was carried out to determine if there is an association between perceived confidence teaching a strand and the study of its related science subject at Leaving Certificate level. Table 5.29 summarises the findings.

Strand	**Confidence (%)**	**Low Confidence (%)**	**Little or No Confidence (%)**	**Significant Association Between Study of Related Subject to Leaving Certificate Level**
Materials	37	43	20	Yes (p= 0.007)
Energy and Forces	37	53	10	Yes (p=0.013)
Living Things	69	30	1	Yes (p=0.000)

Table 5.29 Relationship Between Confidence Levels and Study of Related Subject to Leaving Certificate Level

It appears that there is a strong association between study of the relevant science subject at Leaving Certificate level and confidence expressed for the related strand of the primary curriculum. This strengthens the argument for a high degree of input on scientific knowledge on CPD courses in each of the branches of science - physics, chemistry and biology if confidence levels for these strands are to be improved. It also suggests that the Colleges of Education need to address student- teachers' understanding of basic concepts in the Materials and Energy and Forces strands.

In order to see if there was much difference between the sexes in levels of confidence expressed, the average ratings obtained for each strand were combined and collapsed into 3 categories of confidence.

Total Respondents N=467		**Confidence Rating for the Teaching of Primary Science**	**Frequency**	**Percentage**
n	**%**		**n**	**%**
434	93	1. Confident	151	35
		2. Low Confidence	265	61
		3. No Confidence	18	4

Table 5.30 Respondents' Confidence Teaching Primary Science as Deduced from Confidence Teaching Individual Topics, N=434

This confidence rating was then cross-tabulated with the gender of the respondents as illustrated in Table 5.31.

			Confidence Teaching Science					
Total Respondents N=434		**Gender of Respondents**	**Confident**		**Low Confidence**		**No Confidence**	
n	%		N	%	n	%	n	%
151	35	Male	58	38	69	46	24	16
283	65	Female	93	33	136	48	54	19

Table 5.31 Cross-tabulation of Gender of Respondents with Level of Confidence Teaching Science (N=434)

While a slightly higher percentage of males claim confidence, a chi-square test indicated that there is no significant difference between the number of males and the number of females who lack confidence teaching science (Chi-square (1, n=436) =1.5, p=0.46).

In order to determine if there is a link between scientific education and confidence levels I cross-tabulated the confidence levels with the respondents' Science Education Scores (which indicate the total science education the respondents had at pre-service level, computed and discussed in section 5.4).

Total Respondents N=425	**Total Post-Primary Science Education**	**Confidence**		**Low Confidence**		**Little to No Confidence**	
		n	**%**	**n**	**%**	**n**	**%**
35	No post primary science	9	26	18	51	8	23
86	J. C. or equivalent	24	28	42	49	20	23
198	J.C. + 1 L.C.	62	31	102	52	34	17
87	J. C. + 2 L.C.	42	48	31	36	14	16
19	J.C.+ 3 L.C.	9	47.5	9	47.5	1	5

Table 5.32 Cross-tabulation of Refined Confidence Scores and Science Scores (J.C. = Junior Certificate Science or Equivalent; L.C. = Leaving Certificate Science Subject or Equivalent)

It would seem that the percentage of respondents who express confidence increases as the amount of science studied at post-primary level increases. Those who had studied science at Junior Certificate level and had studied at least two science subjects for Leaving Certificate level were the least likely to express low confidence teaching science.

The chi-square test for independence was carried out. It indicated a significant association between the amount of science studied and the level of confidence teaching primary science, chi-square (1, n=425) =16.432; df =8, p= 0.037, phi=0.037.

Table 5.33 Results of Chi-square Test for Cross-tabulation of Post-primary Science Education and Confidence Teaching Science

It would seem that for post-primary science to have an impact on confidence levels, teachers would need to study at least two subjects at Leaving Certificate level. This implies that the traditional primary teacher option of Junior Certificate science and Leaving Certificate biology do not significantly improve confidence levels teaching primary science. In fact the highest numbers (136 or 69%) expressing little or no confidence in the teaching of science are to be found amongst those respondents who had made this traditional choice.

Evidence from the cross-tabulation of individual Leaving Certificate science subjects and the related areas on the primary curriculum indicated increased levels of confidence teaching these strands. This strongly suggests the need for the Colleges of Education and CPD programmes to develop teachers' scientific subject knowledge as well as methodology in the area of science. The quantitative data indicates that teachers are not leaving the Colleges of Education with a sense that they can confidently implement the science curriculum.

5.7 Summary Profile of Respondents

This chapter sought to isolate the 'Teacher Factors' which would under-pin the design of a CPD package to improve provision of science at primary level. I have attempted to profile the respondents in terms of their confidence teaching science, their educational background in the area of science, their attitudes towards science and their commitment to the teaching of science at primary level.

The individual respondents were predominantly female, and were more likely to be over the age of 40 with an average of 17 years' teaching experience. This reflects the international situation for the year 2007 as indicated by the OECD publication *Education at a Glance* (OECD 2007, p.407 and p.404). 55% of all respondents were principals, half of whom were male, which accounts for an over-representation of males in the overall survey. In spite of the over-representation of principals and therefore males, it is felt by reference to the available statistics from the DES (2007) that all roles, genders and school types were reasonably well represented in the NNA survey.

All class levels were represented, however the single largest class type was that described as 'Mixed Seniors'. This describes the situation where one teacher has responsibility for one class which contains within it multiple class levels from 4th to 6th class. The high incidence of this type of class within the data reflects the large number of respondents who were Teaching Principals (35.6%). Urban and rural schools were fairly equally represented and the average school size was 11 (i.e. the number of teaching staff in the school). Most of the schools fell into the category of less than 20 staff members.

In relation to attitudes to science, the data indicates that while teachers almost unanimously believe science should be taught in primary schools, a large percentage (38%), are not using the allotted time for science per week. This may be accounted for by the fact that there are indications that teachers are less confident teaching science than other subjects. While it might be expected that teachers would be more confident teaching the core subjects of Irish, English and maths it would be hoped that a similar confidence would be displayed for all component subjects of SESE (Social, Environmental and Science Education). This however is not the case, with science lagging behind history and geography.

In terms of scientific background it would appear that the majority of respondents have completed science to Junior Certificate level and most have also taken at least one science subject to Leaving Certificate level. There is still a trend for the majority

(52%) to take biology. Of those taking a science subject to Leaving Certificate level, 30% had taken chemistry and 18% physics. This represents an increase in the uptake of the non-biological sciences since my 1989 survey (Mulcahy, 1989) and is in line with international data about the increase of females taking up the physical sciences as discussed in section 5.2.1 (DES 2007, p.4; Kelly, 1985, Keller, 1985, Ivinson and Murphy, 2007).

While there is an increase in the numbers taking science to Junior Certificate level among the youngest age group (20-30 years) due to the mandatory nature of such participation in most schools, this has not translated into an increase in the numbers *choosing* to pursue science subjects to Leaving Certificate level. In fact the youngest age group were the only age category in which nobody had taken all three science subjects to Leaving Certificate level. The data suggest that teachers were less than satisfied with the preparation received in their respective Colleges of Education to teach science. The non-standardised allocation of time to science in the Colleges of Education, verified by Varley et al. (2008(a)) and discussed in Chapter 2, Section 2.3 reflects the absence of a national policy on the teaching of science in Colleges of Education.

A majority of the respondents attended the DES in-service courses provided prior to the introduction of the 1999 Science curriculum. Teachers expressed satisfaction with these but qualified this expressed satisfaction by saying more follow-up and support was required. The majority of respondents accept that science has a place on the primary curriculum. Considering the lower levels of confidence teaching science than other subjects, it is surprising that 51% of all respondents did not attend any form of science in-service training since the introduction of the science curriculum in 2003. This is disappointing because 70% of respondents expressed the need for more

CPD in the area of science. Both genders were aware of such need (68% of all males and 71% of all females).

Why did teachers not access science CPD if they felt it was needed? Is it the case that CPD was unavailable, inaccessible or unsuitable? Or is it that the 54% who were found to be lukewarm in their attitudes towards science (See Table 5.25) did not feel strongly enough about the relevance of science to seek out CPD which meets their needs?

While the quantitative data indicate that a model of CPD needs to address teacher-knowledge, methodology and attitudes towards science, such information is of limited value if teachers choose not to participate. Chapter 6 seeks to extract from the data the types of professional development activities valued by Irish teachers. It also seeks to identify those constraints which prevent teachers from engaging in CPD.

CHAPTER 6

TEACHER FACTORS - CPD PRIORITIES OF IRISH PRIMARY TEACHERS

6.1 Introduction

Chapter 2 explored the literature on teacher change and from that review I concluded that "understanding the preferences of participants is a significant issue" (Kshir, 1999, p.325).

From the profile of respondents described in Chapter 5 Irish teachers are less confident teaching science than most other subjects and, particularly so, when teaching the Materials and Energy and Forces strands of the 1999 curriculum. 38% spend less than the allotted time teaching science and, in spite of their self-professed lack of confidence teaching science, 51% have not had any CPD in the area of science. This is despite their almost unanimous agreement that science should be taught at primary level. It behoves us, therefore, to establish teachers' beliefs and attitudes around CPD.

These beliefs and attitudes will be deduced from the quantitative data generated from the NNA and are considered under headings drawn from the Theoretical Framework (Table 3.3): Teacher Factors; School factors and External Factors. Irish primary teachers' perceptions of effective CPD processes are then compared to international agreement on what constitutes effective CPD processes.

6.2 Teacher Factors

Section 6.2.1 seeks to understand what Irish teachers want from CPD and which CPD processes they believe to be most effective. Teachers were asked in Q.29 to indicate the relative importance they would attach to: Personal Scientific Knowledge; Teaching ideas; Investigations and Concept Development. These topics cover a combination of science subject mastery and pedagogy components.

6.2.1 CPD components considered effective

Table 6.1 indicates the hierarchy of needs expressed by teachers.

Total Respondents N=467	**Aspect of CPD**	**Considerable to a Lot of Help Required on These Course Elements.**	
		n	**%**
446	Teaching Ideas	332	74
440	Investigations	315	72
432	Concept Development	288	67
431	Personal Scientific Knowledge	226	52

Table 6.1 Priorities of Teachers Concerning Course Content of Primary Science CPD

A total of 74% of the respondents prioritise *Teaching Ideas*. This, together with the 72% who want a lot of input on *Investigations*, reflects a desire to impact on practice in the classroom. The development of concepts ranks lower at 67%. A shallow interpretation of the data would be to say that this reflects a desire for ‘quick-fix’ teaching ideas as opposed to a commitment to developing scientific concepts or increasing personal understanding of science. However, it may be that by emphasising the practical over the theoretical, teachers may be attempting to communicate their need for CPD to be focussed on improving practice. Is this interpretation borne out elsewhere in the data arising from the NNA?

Q.30 asked the teachers to consider the importance of ten CPD factors/processes. Table 6.2 ranks these processes in order of the percentages of respondents who considered them important.

Aspect of CPD	Total Respondents N=467	% of Respondents Who Consider This Aspect to be Important	% of Respondents Who Are Unsure of the Importance of This Aspect of CPD	% of Respondents Who Consider This Aspect to be Unnecessary
Realistic ideas about how to teach particular topics	n=453	98	1	1
Tutors with relevant classroom experience	n=457	97	1	2
Materials to support teaching	n=454	97	3	0
Opportunity to try out new methods and materials in own classroom between sessions	n=454	95	3	2
Opportunity to identify school needs	n=457	91	5	4
Long-term support from knowledgeable others	n=453	86	11	3
A focus on individual needs	n=450	84	7	9
Time for discussion and reflection	n=454	81	12	7
Opportunity to observe other teachers	n=451	75	13	12
Recent relevant research	n=449	54	33	13

Table 6.2 Importance Attributed to Various CPD Processes

Table 6.2 illustrates that those processes most closely linked with day to day practice such as materials to support practice, realistic teaching ideas and experienced tutors are almost unanimously considered to be very important. This echoes the findings in the literature (See Chapter 2, Section 2.5.2).

Why do teachers feel the need to emphasise this aspect of CPD over all other aspects? One would have thought this to be self-evident to CPD providers. It may be the case that teachers feel their concerns and needs have not always been the lynchpin of the CPD programmes they have encountered. Indeed the literature supports such an appraisal since, up to recently, CPD was the tool of innovators who sought to introduce new policy (Borko 2004, p.3; Hooge et al 2011, p.299). The expectation that teachers will ‘re-train’ to meet every demand made upon them is unrealistic and alienating for those who may feel that their own needs are neglected as a result (See Chapter 2, Section 2.5.2).

While teachers seem to believe that ‘teaching ideas’ and ‘materials’ are the most important aspects of professional development to improve their practice, these aspects alone may not be sufficient to sustain confidence or good practice in science teaching. How do teachers view mastery of scientific knowledge or recent relevant research as components of their CPD?

6.2.2 Subject mastery or pedagogy?

Personal Scientific Knowledge ranked lowest on respondents’ list of priorities. Does this low ranking indicate teacher confidence in their scientific knowledge or a reluctance to tackle insecure understanding of the scientific concepts being taught? Table 6.1 above illustrates that the second lowest ranking component was ‘concept development’. It is possible that this low ranking represents teachers’ fears of being over burdened with scientific theory and receiving insufficient material immediately applicable to practice. This is a valid theory as discussed by Lawlor (2006, p.70).

In an effort to interpret teachers’ tendency to give priority to methodological issues over mastery of the scientific concepts, teachers’ expressed levels of need in relation to their scientific knowledge were cross-tabulated in Table 6.3 with their levels of confidence teaching science.

Total Respondents N=467	**Amount of Help Required with Personal Scientific Knowledge**	**Confidence Teaching Science**					
		Confident		**Low Confidence**		**Little or No Confidence**	
		n	**%**	**N**	**%**	**N**	**%**
n= 209	A lot of help required	46	34	149	59	14	78
n=145	Some	58	42	85	35	2	11
n=53	Little/none	33	24	16	6	2	11
Total= 407		137	100	250	100	18	100

Table 6.3 Relationship Between Teachers' Perception of Subject Mastery as a Constituent of a CPD Course and Their Confidence Levels Teaching Science

Of those who expressed low levels of confidence teaching science, 105 of a total of 268 or 39%, feel they do not need a lot of input on their personal scientific knowledge. This indicates that it is not possible to attribute the low ranking of 'Personal Scientific Knowledge' to teachers' high levels of confidence teaching science. It may possibly be attributed, however, to a lack of appreciation of the relationship between mastery in the subject and confidence teaching it. Such a superficial approach would certainly account for widespread lack of confidence and may derive from teachers' exposure to short, sporadic in-service which, by its nature, can do no more than treat the subject in a superficial manner. There is a danger that providing only 'teaching ideas and materials' could reinforce this limited view of CPD. Teachers' association of CPD with remediation for current deficits and acquisition of 'teaching ideas' and 'materials' could suggest a limited concept of professional development as short-term, sporadic in-service days or courses (Bolam and Weindling (2006, p.77). While teachers' concerns that their needs will not be adequately met are justified, it is important that their concept of CPD is broadened beyond such a limited definition.

Evidence from Chapter 5, Section 5.4.4 and section 5.4.5 indicates that the vast majority of teachers only experienced short sessions of science CPD, lasting from one to five days.

This may account for teachers´ association of CPD with short, superficial treatment of topics and may explain the lack of association between scientific knowledge content as an element of CPD and increased confidence. Teachers' negative attitudes towards the 'Knowledge' content of courses raise questions about teachers' perceptions of CPD.

6.3 CPD Processes - Priorities of Irish Primary Teachers

The responses from Table 6.2 in this chapter were categorised and discussed according to the themes of the Theoretical Framework (Table 3.3): Individual practice-related processes; School/Collaboration processes and External Support processes. These processes and their sub-categories are summarised in Table 6.4 below.

Individual Practice-based Processes	**School/Collaboration-based Processes**	**External Support Processes**
Realistic ideas about how to teach particular topics	Opportunity to identify school needs	Recent relevant research;
Materials to support teaching	Opportunity to observe other teachers	Long-term support from knowledgeable others;
Opportunity to identify individual needs	Time for discussion and reflection;	
Opportunity to try out new methods and materials in own classrooms between sessions		
Tutors with relevant classroom experience	Tutors with relevant classroom experience	Tutors with relevant classroom experience

Table 6.4 Categorisation of CPD Processes According to Themes Identified in the Theoretical Framework

Each category is now discussed individually.

6.3.1 Individual practice–based processes

The individual practice-based processes isolated for consideration, refer to those processes which involve the individual teacher working to improve his or her own individual practice. Table 6.5 below summarises the relative importance attached to each.

N= 467	**Individual Practice-related Processes**	**Important**		**Not Sure**		**Not Necessary**	
N		**n**	**%**	**n**	**%**	**N**	**%**
453	Realistic ideas about how to teach particular topics	444	98	6	1.3	3	0.7
457	Tutors with relevant classroom experience	445	97	4	1	8	2
454	Materials to support teaching	441	97	7	2	6	1
456	Opportunity to try out new ideas and materials in own classroom	431	95	14	3	9	2
450	Focus on individual needs	376	84	33	7	38	9

Table 6.5 Level of Importance Attached to Individual Practice-Based Priorities of CPD

As discussed in section 6.2.1 in this chapter, there is clear evidence that teachers want their CPD to provide ideas and materials which they can use in their own classrooms, preferably provided by tutors who are familiar with their working conditions. The importance of the practical relevance of the CPD to classroom work is evident in the large percentage (95%) who would like to have an opportunity to try out materials between sessions in their own classrooms. This supports the conclusions drawn in section 6.2.1 that both the content and the methodology of CPD provision should focus on individual, actual practice.

Table 6.5 above, however, reveals some ambiguity. Teachers want assistance addressing their individual teaching issues but are less enthusiastic about revealing their specific needs than about identifying whole school needs (See Table 6.2). The work of Kennedy (2004) and Usak et al. (2011) indicates that subject knowledge in the area of chemistry presents problems, not only for Irish primary teachers, but also internationally for student teachers of chemistry. If students who "are more highly-motivated and highly-achieving science students" (Usak et al. 2011, p.419) experience difficulty teaching scientific concepts, how are teachers with little or no background in the subject, and of whom 88% felt ill-prepared to teach science (See Chapter 5,Table 5.14), expected to teach the subject and why should they feel reluctant to admit this?

The evidence from the UK indicates that up to recently needs-identification was not a feature of most CPD programmes (Bolam and Weindling 2006, p.66). If teachers have never had the opportunity to state their needs as part of CPD, then the process would be unfamiliar and possibly daunting for those who do not feel confident about their knowledge. Many respondents included a note with their questionnaire expressing their appreciation that someone was at last asking questions about their needs.

6.3.2 Making 'Needs-Identification' acceptable to Irish primary teachers

It would seem that needs-identification is a recognised, valuable component of effective CPD (Bolam and Weindling, 2006, p.66 and Kshir 1999, p.331; Chapter 2, Section 2.5.2). Many universities, including teacher training colleges internationally, routinely conduct an inventory of student teachers' knowledge. They use what are known as Concept Inventories (CIs) which are a multiple-choice test based on research into commonly held misconceptions and “were developed to evaluate conceptual understanding of ... college students” (Treagust, 1986; Hestenes et al. 1992; Libarkin, 2008). The success of these inventories in the improvement of student outcomes in terms of conceptual understanding and changing teaching practice, together with the evidence regarding the benefits of formative assessment on student outcomes, has led to the approach being adapted for use at post-primary level in the UK (Haslam and Treagust, 1987; Millar and Hames, 2003).

There is evidence therefore that needs-identification works. The difficulty remains, however, of persuading Irish primary teachers that such a process need not be threatening. If, as it appears from the data, (Table 6.2) teachers are less inhibited about identifying school needs, then the constructivist approach of creating ‘cognitive conflict’ by encouraging teachers to collectively acknowledge shortcomings as a school, may be a first step to encouraging more openness about individual needs. The priority, when recruiting teachers should not perhaps consist solely of the academic level achieved by candidates, but should also take into account their disposition to learn and their openness to alternatives. Section 6.3.3 looks at what the data reveals about teachers’ attitudes towards school-based CPD processes.

6.3.3 School-based processes

The school-based processes included an opportunity to identify school needs, an opportunity to observe colleagues and time for discussion and reflection. The importance attached to each of these by respondents to the NNA is presented in Table 6.6.

	School-based Processes	Important		Not Sure		Not necessary	
N		**n**	**%**	**n**	**%**	**N**	**%**
457	Opportunity to identify school needs	417	91	21	5	19	4
454	Time for discussion and reflection	367	81	56	12	31	7
451	Opportunity to observe colleagues	340	75	59	13	52	12

Table 6.6 Importance of School-based Processes

When we compare Table 6.5 with Table 6.6 it is clear that teachers are far more likely to endorse the identification of school needs (91%) than they are individual needs (84%). However, it should be borne in mind that 55% of all respondents to the NNA comprised of principals. The apparent enthusiasm for exploring school needs may reflect principals' efforts to raise awareness of needs around science amongst staff.

Nonetheless the endorsement of this process of school-needs identification by 91% of respondents suggests a sense of collective responsibility for provision in schools. Such a conclusion is somewhat weakened when it is noted from Table 6.6 that nearly 20% of respondents did not appear to value having time for discussion and reflection on practice. If teachers are sincere about seeking to address the problems associated with poor confidence then it is difficult to understand the apparent reluctance by 19% to engage in discussion and reflection on the problems experienced. It is possibly the case that for this 19%, CPD means short, intensive courses as in the traditional mode of in-service, and any time for discussion and reflection may be considered a waste of time as discussed in Section 6.2.2. This suggests a perceived lack of teacher agency in influencing the type of CPD they engage in and a portrayal of teachers as silent receivers of others' wisdom.

The literature suggests that professional development activities where

teachers are passive recipients of information are less effective than those which promote “active learning” (Desimone et al. 2002, p.101). The absence of interaction with one’s colleagues was considered by The National Science Foundations’ Urban Systemic Initiative in the USA (Chapter 3, Section 3.6.3) to be a “serious omission” (Borman et al. 2005, p.79). Is this apparent reluctance on the part of Irish primary teachers to engage with colleagues supported anywhere else in the NNA data? 75% considered the opportunity to observe another teacher teaching as being an important element of CPD but 25% expressed misgivings about its merits. In fact 12% considered it to be unnecessary. Such a development in CPD would appear to be more controversial than other aspects as it was the least favoured aspect of school-based CPD processes. Why so?

It is likely that the most familiar experience of observation for most respondents would have been in a ‘performance’ setting, either at under-graduate level or for the purposes of inspection. There is some evidence to suggest that the use of micro-teaching at pre-service level is a negative experience for many.

> Frank maintained that a quarter of the men in his year in Mary I (*Irish College of Education*) left as a direct result of being undermined and ridiculed during their teaching practices/micro teaching experiences.
> (Hayes, 2008 p.57-58, parentheses added)

The relationship between the observer and the observed in these circumstances would differ significantly from the use of observation to improve the practice of both participants.

In spite of evidence about the perceived value of observation as an element of professional development, Irish teachers are not unique in their reticence to include observation as a process in their professional development.

> …In fact, the simple practice of observation in colleagues' classrooms for the purpose of professional learning is rare in the United States.

(Darling-Hammond, 1997; Darling-Hammond & Ball, 1998 in Lewis, Perry and Murata 2006, p.3)

Why are teachers so reluctant to engage in observation? One conclusion possible is that the culture of schools may not be sufficiently developed to support the use of peer-observation. Observation as a CPD process would need strong alignment of reform goals among all staff members and agreement on processes to achieve goals. Thus, while teachers may accept the value of the process, they may not have adequate leadership or school support to put it into practice. Borman et al. (2005, p.197) in Chapter 3, Section 3.6.3 concluded that school culture was "the missing lever" in achieving sustainable reform.

From the analysis of the data, it appears that teachers have consciously or unconsciously constructed a concept of CPD as short in-service training (Bolam Weindling (2006, p.112). If such a concept should inhibit teachers benefitting from engaging in more effective CPD processes, it would be important that teachers are encouraged to make their concepts of CPD explicit. It is only by being aware of their prior concepts and having opportunity to discuss and reflect that teachers will be in a position to assess whether or not they wish to change how they approach CPD.

While CPD providers are often concerned with impacting on beliefs and attitudes towards the reform effort, I propose that initially teachers' attitudes towards what constitutes effective CPD should be addressed in a collaborative manner, as part of the CPD which has been shown to have the capacity to impact on beliefs and attitudes (Bolam and Weindling 2006, p.111).

The data seem to suggest that teachers' preconceptions of what constitutes CPD is impacting on what they would prioritise in a programme of CPD. Similarly, Borman et al. (2005, p.28, discussed in Chapter 3, Section 3.6.3) found that "those in positions of authority have command of the resources necessary to …influence the direction reforms will take" and found that their beliefs about professional development impacted strongly on how teachers ultimately engaged with the reform efforts. Therefore, not only do we need to take into consideration the preconceptions of teachers to professional development, we also need to heighten awareness among programme administrators of their preconceived attitudes to what constitutes effective CPD:

> …if the perceptions held by policy planners for INSET do not accord with the perceptions of teachers...then the likelihood of sustained and effective change being implemented is attenuated.
> (Kshir 1999, p.325)

This leads us to examining the findings of the NNA about how teachers view CPD processes which originate outside the school.

6.3.4 Externally-based processes

These processes refer to the means by which teachers access support from agencies outside school, e.g. third level, the inspectorate, the community and other stakeholders. The supports offered for consideration in Q.30 included 'long-term support from knowledgeable others' and 'recent relevant research'. The perceived importance of each is summarised in Table 6.7 below.

Total Respondents N=467		**Support From External Sources**	**Important**		**Not Sure**		**Not Necessary**	
N	%		n	%	n	%	n	%
453		Long-term support from knowledgeable others	391	86	50	11	12	3
449		Recent relevant research	244	54	146	33	59	13

Table 6.7 Respondents' Perception of Importance of External Sources of Support

There are three distinct issues – duration of support; the disposition of those providing the support and the contribution of research.

(i) Duration of support

The conclusion that Irish primary teachers would view long term support favourably is justified by reference to the 86% of respondents to the NNA who consider it to be very important, and by reference to the numbers of teachers who lamented the fact that the mandatory DES course provided prior to the introduction of the 1999 Primary science curriculum did not have any element of follow-up (discussed in the analysis of the qualitative data in Chapter 9). Since 81% of teachers consider time for discussion and reflection a very important part of their professional development activities (Table 6.6) it is a valid conclusion that support over a longer period is highly desirable for teachers. However, merely providing access to someone with in-depth knowledge of the field is an insufficient guarantee of adequate support for teachers.

(ii) Disposition of those providing support

Those who are in a position to influence the type of professional development experienced by teachers carry with them attitudes and beliefs which impact on how teachers experience that support. Borman et al. (2005, p.28, Chapter 3, Section 3.6.3) found that those administrators who viewed professional development from a behaviourist perspective which involved "adequate training from outside experts with external incentives for teacher participation" were far less effective in supporting reform implementation than those who saw "teachers as agents of their own learning". This evidence is supported by the findings of Bolam and Weindling (2006, p.27, See Chapter 2).

> The CPD coordinator role was crucial but often underdeveloped. Many CPD coordinators could benefit from professional development if they were to inter-relate system with individual needs.
> (Bolam and Weindling 2006, p.27)

Not only must external supporters be knowledgeable in their field, their beliefs and attitudes about what constitutes effective CPD need to align with those of teachers and those considered to be best practice.

(iii) Place of Research as a CPD constituent

Nearly half of all respondents were ambiguous about the relevance of research to their professional development. From Table 6.7 it is clear that teachers do not appear to view 'the knowledge and theory' generated by others as supportive of their own efforts. As discussed in Chapter 2, Section 2.5.8 research is often criticised for its inaccessibility. It may be that research results appear too remote from immediate practice to be relevant.

This leads us to consider which course formats are most attractive to teachers. Section 6.4 seeks to understand the perceptions of respondents regarding the CPD format considered to constitute the most accessible and effective.

6.4 Respondents' Personal CPD Needs

If teachers choose not to engage in professional development provision then all efforts to design the optimum model are in vain. How can we best ensure the accessibility of CPD? As well as ensuring that programmes adequately empower teachers to address their professional needs, the personal needs of teachers must also be considered.

> We motivate people to change by respecting them; we respect them by listening to them and acting on what they say.
> (Kshir 1999, p.326)

There is also a need to consider what is most effective in terms of contact time with participants. This section considers what respondents to the NNA perceive as the optimum conditions for CPD.

6.4.1 Preferred length and timing of CPD

From the professional priorities highlighted in Tables 6.5, 6.6 and 6.7 teachers indicate that their preference is for a programme which would allow opportunities for trying out the reform activities in the teacher's own classroom and having a chance to review this trial with expert support. This suggests a desire for support to be available in some format over a longer period than the traditional one week courses which generally are conducted off-site. Q. 31 asked teachers to indicate which time structure they would prefer from a choice of five options. These options, together with teachers' preferences are summarised in Table 6.8 below.

Time Structure	**N=453** **n**	**% for Whom this was a First Choice**	**% for Whom this was not an Option**
1-3 days	148	33	14
1 week in the summer	119	26	19
Built into working day	114	25	19
Afternoon/evening sessions during term	41	9	23
Online course	31	7	23

Table 6.8 Respondents' Preferences Regarding the Time Structure of CPD

This data indicated teachers' preferences rather than their perception of what optimised their learning. Table 6.8 indicates that nearly a quarter of teachers would/could not spend time outside of school hours during term time to attend CPD. Current provision of such courses would imply an off-site course which would most likely involve travel, parking and expense. In total, 42% considered professional development (excluding online courses) within term-time as not an option for them.

The most popular first choice option was the short 1-3 day course which reflects the time structure of DES mandatory courses or the DPS 1 day courses. One quarter opted for including CPD into their working day as their first choice and a similar percentage made the traditional summer course their first choice.

The first choice options warrant more investigation. Why is the summer course still so popular? Is the provision of EPV (Extra Personal Vacation) days a powerful motivator to attend these courses? How does the desirability of having an opportunity to try out ideas and materials expressed in Table 6.5 fit in with such short provision?

In order to understand the thinking behind the first choice options of respondents to Q.31 some cross-tabulation of responses was done.

6.4.2 Correlation between format preference and perceived need for discussion and reflection

In order to determine which values governed the first choices of course format of respondents, the value they place on Discussion and Reflection was cross-tabulated with their responses to Q.31. The results are presented in Table 6.9 below.

			Importance of "Discussion and Reflection"					
Total Respondents N=453		**First Choice Option**	**Important**		**Unsure**		**Unnecessary**	
N	%		n	%	n	%	N	%
148	**33**	1-3 days	117	79	20	14	11	7
119	**26**	Summer course	91	77	18	15	10	8
114	**25**	Part of working day	96	84	12	11	6	5
41	**9**	After school, during term	37	90	2	5	2	5
31	**7**	On-line course	26	84	3	10	2	6

Table 6.9 Importance of Discussion and Reflection According to First Choice Options for Course Length

A higher percentage of those who opted for courses which involve working during term time seem to place a high value on Discussion and Reflection (highlighted in red on table). In order to clarify the trends in this data, the options which reflect a desire for longer duration, in-term professional development were combined to form a new category called 'In-term'. Those who indicate a preference for shorter, stand-alone traditional models of professional development were placed in a new category called 'Child-free' i.e. they do not involve working with students and usually take place off-site outside of the school year. An attempt was then made to cross-tabulate these two categories of respondents with the importance they attach to discussion and reflection. Those who opted for on-line courses were excluded from either of these two new categories, as it was felt that there were too many unknown variables about this first preference choice to allocate them to either category. The collapsed data is summarised in Table 6.10 below.

Importance of Discussion and Reflection				
Total Respondents N=453		**First Choice Option of Course Format**	**Important N=367**	
N	%		n	%
267	59	Child-free:1-3 days or summer course	208	78
155	34	In-term: Part of working day or after school hours	133	86
31	7	On-line course	26	84

Table 6.10 First Choice Options of Those who Consider Discussion and Reflection Important

Table 6.10 indicates that a higher percentage of those who would choose in-term CPD value Discussion and Reflection as an element of their CPD. This indicates a predisposition for "active learning" (Desimone et al., 2002) among those respondents who opted for term-time CPD which would run over a longer period than the traditional stand-alone courses.

It may possibly be inferred that those who undertake on-line courses may do so for the opportunity it gives them to access long-term support as a high percentage (84%) of them clearly value discussion and reflection. The most notable conclusion however, is that 66% expressed a preference for courses which have "external incentives" associated with a "behaviourist perspective" (Spillane, 2002). In order to attempt to further understand the reasoning behind teachers' choices of course I decided to consider the respondents' perceptions of an opportunity to trial the new methodology and materials in their own classes.

6.4.3 Correlation between format preference and perceived need for trialling methods and materials

The attitudes of the two new categories of respondents were cross-tabulated with the value they place on an opportunity to trial new methods and materials in order to determine which values influenced their first choice of course format. These data are presented in Table 6.11 below.

Importance of Opportunity to Trial New Methods and Materials in Own Classroom Between Sessions				
Total Respondents N=453		**First Choice Option**	**Important N=429**	
N	%		N	%
267	59	Child-Free:1-3 days or summer course	251	94
155	34	In-term: Part of working day or after school hours	150	97
31	7	On-line course	28	90

Table 6.11 Course Choices of Those who Consider Trial of Materials and Methods Between Sessions Important

There appears to be a contradiction between teachers' first choice of course and the opportunities they wish courses to provide. 94% of those teachers content to continue with the summer or short course model also want courses to allow for trial of materials etc. with an opportunity to feedback difficulties or successes. A slightly larger percentage (97%) of the 'active learning' group value a 'staggered' provision of professional development. As it is currently provided, the traditional summer course is not conducive to providing feedback or long term support to teachers. In the light of the evidence provided in Table 6.11, there is a strong case for amending the summer course model to include an in-school element after the summer break. In order to establish if this is a correct interpretation of the data, the respondents were offered a simple choice between a 'stand alone' course and a 'two part' course in Q.32.

6.4.4 Single continuous or two-part course?

In order to better interpret the values indicated in Tables 6.8, 6.9, 6.10 and 6.11 teachers were asked directly whether or not they would opt for a course which had a built-in mechanism for allowing teachers time between sessions to try out the methodologies and materials suggested and would provide opportunity for feedback. The results are presented in Table 6.12.

Total Respondents N=467	**Format of Course**		
	Preferred Course Format	**N=447**	
		n	%
	One-off continuous course	78	17
	2-Part course	369	83

Table 6.12 Respondents' Preferences Regarding CPD Format

Table 6.12 indicates that an overwhelming majority, 83%, would prefer a second part to courses which would allow them time to try out materials, methods and perhaps discuss progress with colleagues and receive feedback from support personnel. This supports the expressed dissatisfaction with the DES mandatory course for not providing any form of feedback to teachers.

The responses to Q.30, Q.31 and Q.32 taken together imply that even the 59% of respondents who would opt for traditional formats of CPD are dissatisfied with the impact of such courses on their practice. We cannot infer the motivation of the 83% who would prefer courses to be of two parts from Q.32 alone. However, accumulated information from Q.30, Q.31 and Q.32 indicating the high percentages of those who desire to have an opportunity to try out innovative suggestions from courses in their own classrooms, to access feedback (95%) and long-term support from knowledgeable others (86%), suggests that teachers feel the need for more support after initial contact than is currently provided.

6.4.5 Preferred location of CPD

From experience providing courses for teachers I am aware of the difficulties many of them experience in regard to distance, parking, expenses and time involved accessing courses. Q.33 asked teachers to rank the locations for courses in order of preference. The choices given were the teachers' own school, an Education Centre or a Third Level Institution. Opportunity was provided for respondents to suggest an alternative to these three.

Total Respondents N=467	**Location**	**First Option**		**Not an Option**	
		n	**%**	**n**	**%**
465	School	283	61	78	17
466	Education Centre	135	29	97	21
464	Third Level Institution	17	4	162	35
438	Other	11	3	346	79

Table 6.13 Respondents' Choice of Location for CPD

The responses indicate that an overwhelming majority of 61% of respondents would prefer to be based within their own schools while undertaking some form of CPD. This fact, taken together with teachers' desires to undertake courses which would have some form of follow-up suggests that school-based CPD is preferable to undertaking CPD which is based off-campus. This conclusion is supported by the priority given to identifying school needs in Q.30 (See Table 6.6). Teachers' reluctance to access research as a means of support for their practice, together with the low percentage (4%) that would choose to pursue professional development at third level institutions, suggests that teachers have become distanced from the research community and possibly perceive third level provision as lacking relevance for their practice. The issue of the relationship between primary and third level will be investigated further later in this chapter.

A clear majority of 61% opted for CPD within their own schools with 29% opting to have CPD in Education Centres. This may reflect a perception that the CPD provided in school or in Education Centres is better tailored to teachers' needs than that provided elsewhere.

The 'Other' options suggested included local hotels. This is a reflection of the use of hotels for many of the DES mandatory courses and supports my hypothesis that prior experience colours the choices teachers make.

6.4.6 Attractive or effective CPD?

When teachers were presented with a choice of CPD formats they tended to opt for the more familiar traditional models. This correlates with the findings of Bolam and Weindling (2006, p. 76-77). It was not clear initially whether teachers opted for the more traditional model because of a perception that these were more effective or more attractive for other reasons. Even though 59% of respondents opted for the more traditional models of CPD, teachers clearly highly value many activities more closely associated with what Desimone et al. (2002) call "active learning" models. The high value placed on such activities indicates that Irish primary teachers value the same kinds of professional learning activities identified internationally as most effective. This dichotomy between what teachers view as professional development and how they would like to learn is echoed in the findings of Bolam and Weindling (2006):

> …"when asked 'How do you learn? teachers refer to a much greater range of activities with an emphasis on learning from the job and from their collaborative work with colleagues."
> (Bolam and Weindling 2006, p.76)

A third of all respondents (34%) expressed their preference for an in-school, in-term model of CPD and this represents a shift away from the traditional week-long course and is an acknowledgement of the limitations of its time structure. The 59% majority who wish to retain a more traditional form of provision are contradicted by the desire of 83% for a two-part course. How can these two contradicting pieces of evidence be reconciled?

The emphasis on the traditional, more familiar format may be linked with the provision of three EPV (Extra Personal Vacation) days in recognition of participation. If this is the main issue, EPV days or some other acceptable form of recognition could potentially be accorded to all CPD participation.

81% of all respondents consider time to discuss and reflect with colleagues to be an important aspect of CPD. Time for this would be difficult to justify within the confines of a course lasting between one and five days. A common complaint amongst participants at these short courses is that by the time they come to implement the ideas and materials, usually two months later, the impetus and enthusiasm is much diminished, if not forgotten. In spite of the apparent reluctance to abandon the traditional Irish summer course model of professional development there is strong evidence that any such individually pursued CPD lacks "capacity to influence teacher or pupil change" (Bolam and Weindling 2006, p.22 and p.109). It would seem therefore that it is time for a major overhaul of how Irish teachers experience professional development.

As discussed in Chapter 5, Section 5.5.2 only 51% of respondents had undertaken any science CPD in the five years prior to this survey, 67% for whom this consisted of a day's in-service. When one considers that so many teachers (70%) admitted to a need for further science CPD, it is necessary to consider what might inhibit participation in CPD.

6.5 Constraints on Participation in CPD

Respondents were asked to indicate the significance or otherwise of seven constraints on their participation in CPD listed in Q.34. They were also given the opportunity to suggest other constraints not listed. The question was about CPD in general and therefore no conclusions about attitudes to science can be inferred from responses. The results are listed in Table 6.14.

Total Respondents N=467	Constraint	Significant		Not Sure		Insignificant	
		N	%	N	%	n	%
454	Teacher’s time	435	96	10	2	9	2
438	Additional work-load	312	71	51	12	75	17
441	Family responsibilities	281	64	57	13	103	23
435	Lack of local providers	262	60	132	30	41	10
445	Finance	225	51	98	22	122	27
427	Poor quality/ unsuitable courses	218	51	141	33	68	16
426	Lack of interest	131	31	103	24	192	45

Table 6.14 Perceptions of Constraints on CPD Participation

There is considerable overlap between many of these constraints. For ease of discussion the constraint identified by the majority as significant, *Teacher´s Time* will be used as an umbrella topic under which to discuss the others.

6.5.1 Time

The most striking conclusion from Table 6.14 is that teachers’ time is by far the greatest impediment to their involvement in CPD with almost the entire cohort of respondents (96%) indicating this was to be a significant constraint. This means that time is an impediment across all ages, all career stages and for both genders.
This constraint would be compounded if appropriate CPD opportunities were unavailable within a reasonable distance of the individual’s home/school (60%) and if the work-load demanded an excessive commitment of time (71%). For those teachers for whom family concerns are an issue, time and finance (51%) become even more significant constraints as people juggle their lives to balance competing

demands. Similar constraints were found to impact on teachers in the UK (Bolam and Weindling 2006, p.26).

The difficulty of reconciling often conflicting demands may be the reason teachers compromise when choosing a format of CPD. It is possibly the anxiety of trying to meet both professional and personal commitments that leads teachers to select short, traditional courses rather than the more 'active' professional learning activities which teachers have identified above (see Section 6.3) as being of greater value in terms of meeting their professional needs. Professional development in Ireland continues to be a voluntary, individual pursuit (See Chapter 5, Section 5.4.3) which leads to a vast array of professional development experiences. Tables 6.10, 6.12 and 6.14 show the difference between the CPD format teachers would choose and that which they actually choose.

A reasonable conclusion from this data is that teachers engage not necessarily in that professional development which they perceive to be most effective but rather what constitutes a compromise between that which is best for both their professional and personal lives. This indicates significant conflict for teachers and raises the issue of teachers' professional identity.

6.5.2 Conflict

Irish Primary teachers' commitment to their profession has traditionally been held in high regard and has been quantified anecdotally in relation to the amount of time teachers are willing to spend on extra-curricular activities. Irish teachers' awareness of the value of this investment of after-school time led to teachers using it as a bargaining tool during the 2010 'work-to rule' industrial action opposing budget cuts to education (Donnelly, O'Regan and Melia, January 26th, 2010). For teachers who care about how their level of commitment is perceived, the difficulty of maintaining a balance between personal and professional demands can be a source of anxiety and stress.

> Anxiety is even more pertinent when professional and personal lives become detached from one another, i.e. "when the public realm of teaching performance is segregated and divorced from the private realm of personal feeling."
> (Hargreaves and Tucker 1991, p. 500 in Malm 2009, p.85)

In addition to the conflict between personal and professional expectations of an individual, educational developments may also challenge teachers' professional identities. Teachers who graduate with a clear concept of how to teach can feel diminished when subsequent policy indicates that this is no longer considered 'good teaching'. Innovation which threatens one's sense of professional identity may be rejected.

Is professional identity of Irish primary teachers responsive to development, or is it a static, reactive entity? What conclusions can be drawn about Irish teachers' professional identity from the data?

6.5.3 Professional identity

The "rucksack philosophy" (Buchberger et al. 2000, p.16) of teacher education in Ireland, where initial teacher education was traditionally viewed as sufficient to sustain teachers over a lifetime of teaching, is evident in teachers' responses to Q.16 and Q.31. Should a teacher choose to add on an extra week of work every summer to enhance his/her practice, that is viewed as a sacrifice on the part of the teacher and deserving of reward in terms of extra personal leave. A teacher who opts for a year long course of study receives no support at all, the traditional salary allowance recently having been withdrawn for new entrants to the profession.

(http://www.education.ie/en/Circulars-and-Forms/Active-Circulars/cl0008_2013.pdf)

The nature of the supports provided (or absence of them) reinforces a perception of CPD as an added extra rather than an intrinsic part of the profession. This perpetuation of the view of professional development as extrinsic to practice exacerbates the conflict between personal and professional demands. A professional identity which does not include a commitment to professional development will lead to increased conflict between personal and professional issues when teachers resent what they may perceive as the burden of unnecessary extra time spent on professional development.

The research into the increasing demands on teachers (Hooge, 2011) and changing perceptions of teachers' professionalism (Buchberger et al.2000) suggest that conflicting demands will become an even greater source of stress on teachers (van den Berg, 2002, p.579).

If those interested in introducing change neglect to acknowledge the validity of teachers' personal claims on their lives and neglect to take into consideration the vulnerability of what is for many a 'static' professional identity, then teachers will continue to compromise when making choices, as they struggle to meet conflicting demands. The anxiety associated with such conflict will not serve the profession well and could lead to diminished morale among teachers if not to the loss of valuable personnel from the profession. The purpose of this research is to address this conflict. How can professional development be designed so that it eliminates the conflict between personal and professional needs and effectively empowers teachers to be active agents in the development of themselves and their profession?

6.5.4 Conflict resolution

The individual, voluntary nature of professional development provision in Ireland means that experience of CPD is dictated by access to time, money and availability of suitable courses (Table 6.14). One possible solution involves providing professional development in schools, within the working day where all would have equal access and professional development becomes intrinsic to practice. Are teachers sufficiently interested in such reform of their practice to incorporate professional development into their everyday working lives? Q.34, asked if 'Lack of Interest' in CPD was a significant constraint on participation.

6.5.5 Lack of interest

31% of respondents indicated that lack of interest is a significant impediment to pursuing professional development and another 24% were unsure. Q.34 did not specifically ask if the impediments were relevant to them personally, so conclusions are limited about whether the responses reflected views of others or personal opinions. However, taken together with evidence from elsewhere in this chapter some conclusions are justified.

The apparent lack of relevance of research for Irish teachers as discussed in this chapter, Section 6.3.4, as well as the apparent reluctance to tackle weak understanding of difficult concepts discussed in Section 6.2.2 mirrors the *laissez faire* attitude indicated by the 31% who felt that lack of interest is a significant constraint on CPD participation. It also strengthens my opinion that the 'rucksack philosophy' pervades Irish education as discussed in Section 6.5.3. When the constraint 'lack of interest' was cross-tabulated with the ages of respondents it was seen that this was considered an impediment across all age groups but particularly among the youngest. See Table 6.15 below.

Age of Respondents	All Respondents		Significance of 'Lack of Interest' as an Impediment to CPD					
	N=425		Significant		Not sure		Insignificant	
	N	%	n	%	n	%	N	%
20-30 years	82	19	33	40	19	23	30	37
31-40 years	66	16	22	33	17	26	27	41
41-50 years	130	30	40	31	26	20	65	49
51+ years	147	35	36	24	41	28	70	48

Table 6.15 How old are the Disinterested?

Does this lack of interest imply that teachers would not pursue CPD at all unless obliged to by the DES or if, as proposed, registration with the Teachers' Council becomes contingent on participation in CPD? The oldest group, in spite of coming near to the end of their careers, are the least likely to express such apathy. This raises the question of how young teachers perceive themselves. These data suggest that their professional identity does not include a commitment to life-long learning. Apathy among younger teachers means that NQTs may encounter teachers whose attitudes towards professional development may reinforce a 'static' professional identity. For a discussion of the influence of the dominant culture on newly inducted teachers see Chapter 2, sections 2.5.3 and 2.5.4. This may be the greatest challenge to providing CPD. If teachers are simply not interested then any effort to provide what is effective and accessible will be futile.

6.5.6 Gender

To determine whether or not lack of interest was a significant impediment across genders cross-tabulation was carried out.

Gender of Respondents	All Respondents N=467		Significance of 'Lack of Interest' as an Impediment to CPD	
	N=426		Significant	
	N	%	n	%
Male	149	35	38	26
Female	277	65	93	34

Table 6.16 The Significance of 'Lack of Interest' as an Impediment to CPD in Relation to Gender of Respondents

Males are less likely to quote lack of interest as an impediment to CPD generally. This may reflect the large number of principals (predominantly male) who responded to the NNA or it may be that males, being more likely to pursue opportunities for promotion (as deduced by the disproportionate numbers of them in administrative positions as discussed in Chapter 5) are more likely to be interested in CPD which may further their aspirations. Do females have a different agenda to males when opting to pursue teaching? Is it the case that females are more preoccupied with family responsibilities? The evidence presented in Table 6.17 indicates that 'family responsibilities' as a constraint is an issue for similar percentages of both male and female respondents.

Gender of Respondents	All Respondents N=467		Significance of 'Family Responsibilities' as an Impediment to CPD	
	N=441		**Significant**	
	N	%	N	%
Male	152	34	94	62
Female	289	66	187	65

Table 6.17 Significance of 'Family Responsibilities' as an Impediment to CPD in Relation to Gender of Respondents

In order to explore further the 'Lack of Interest' indicated in Q.34, a deliberately provocative question was asked in order to elicit affective responses to issues of cost, accreditation and attitudes to CPD. Q.35 unambiguously asked teachers if they would pursue an expensive, third level course. It was also felt important to attempt to determine how desirable accreditation of CPD for teachers is, by attempting to see how willing they would be to pay for it.

6.6 Motivation for Pursuing CPD

Q.35 proved to provoke strongly worded responses, due predominantly to the finance issue. This will be discussed in further detail in Chapter 7, Section 7.3. In spite of all the constraints enumerated in Table 6.14, 22% were still willing to pursue such an expensive course. See Table 6.18 below for a summary of responses.

		Willingness to Participate in a Third Level Accredited Course Which Costs Approximately €1,200 per Year					
Total Respondents N=467		**Willing**		**Unsure**		**Unwilling**	
N	%	N	%	N	%	n	%
458	98	99	22	121	26	238	52

Table 6.18 Willingness of Respondents to Participate in an Accredited 3rd Level Course

In total 52% said they would be unwilling to participate in an accredited course which would cost about €1200 per annum. Even for those who were willing to participate in such an expensive course, more than half of them said finances would be an issue for them. See Table 6.19.

Willingness to Pay for an Accredited Course	**All Respondents N=467**		**Significance of 'finances' as an impediment to CPD**	
	N=444		**Significant**	
	N	%	N	%
Willing	99	22	53	54
Unsure	121	26	57	47
Unwilling	238	52	114	48

Table 6.19 The Significance of Finance as a Deterrent for Those Willing to Pursue 3rd Level Fee Paying Courses

The cost of such a course would be a deterrent for 54% of those willing to pursue same. This may account for such a negative reaction to this question. The notion of pursuing a course of this nature seems very unpalatable to respondents. The qualitative data may illuminate this very strong negative response but it is possibly because this traditional type of extra-curricular course combines all of the constraints teachers consider to be significant impediments to participation (See Table 6.14). It is important to look at the profile of those who are willing to do these types of courses in order to ascertain why, in spite of the constraints inherent in this type of course, they are considered worth the associated sacrifices.

6.6.1 Who is willing to pay for expensive but accredited CPD?

The first step in identifying the 'willing respondents' was to determine their age. See Table 6.20 below.

Age of Respondents	**All Respondents N=467**		**Willingness to Participate in 3rd Level Fee-Paying Course**	
	N=456		**Willing**	
	N	%	N	%
20-30 years	87	19	26	30
31-40 years	72	16	18	25
41-50 years	139	30	30	22
51+ years	158	35	25	16

Table 6.20 The Breakdown According to Age of Those Willing to Pursue 3rd Level Fee-Paying Courses

A larger percentage of the youngest age group seems to be more willing than the older age groups to pursue this type of course, perhaps because they possibly have more disposable income, are less likely to have family commitments and possibly have more free time. It is also possible that they may be more ambitious for promotion.

6.6.2 Is it a 'boy thing'?

The gender of respondents was cross-tabulated with responses to Q.35 to determine if there was a stronger tendency for one or other of the genders to pursue accredited CPD. The data is presented in Table 6.21.

Gender of Respondents	All Respondents N=467		Willingness to Participate in a 3rd Level Fee-Paying Course	
	N=458		Significant	
	n	%	N	%
Male	160	35	31	19
Female	298	65	68	23

Table 6.21 The Gender Profile of Those Willing to Pursue a 3rd Level Fee-Paying Course

Slightly more females than males are prepared to pursue this type of course. It was felt important to establish if there **was** a significant relationship between gender and willingness to pay for an accredited course.

The chi-square test for independence was carried out. It indicated a significant association between gender and willingness to pay for an accredited third level course, chi-square (1, n=458) =13.646; df =4, p= 0.009

Table 6.22 Chi-square Results for Cross-tabulation of Gender and Willingness to Pay for a 3rd Level Course

A possible explanation for the higher incidence of females pursuing expensive accredited professional development may relate to greater competition among females for promotion opportunities. The predominance of male principals, in a predominantly female profession, may oblige women to be much more highly qualified to compete for these positions.

It seems therefore that costly, accredited CPD is more associated with younger female teachers, possibly keen to advance their careers or even their employability.

To conclude this section it would seem that, if teachers are to have their expressed needs met in the area of Primary Science, for the majority of respondents it appears unlikely to be done on their own initiative or at their own expense.

6.7 Summary

If the DES is to attempt to upgrade the provision of science for primary school children it must seriously address the issue of how best to increase the confidence of primary teachers since *all* respondents expressed having less confidence teaching science than they do for any of the other SESE subjects. The need for science CPD for all levels of experience, age groups and both genders is unambiguous. The need for CPD to be accessible and effective in increasing confidence is also without question. The task in hand, therefore, is to develop a model in line with principles of effective CPD endorsed by teachers and the international literature which addresses the inhibiting constraints.

I used the Theoretical framework (Table 3.3) to construct a matrix (Appendix XXIV) which would facilitate the deduction of beliefs and attitudes of Irish primary teachers in relation to CPD pertinent to formulating a model of effective CPD. The CPD factors and processes identified by respondents to the NNA will then be compared to those acknowledged internationally to be effective. A synthesis of the two will provide the philosophical basis for a model of CPD.

In order to design a model of CPD which is perceived to be effective by Irish teachers and addresses the conflicting demands of teachers' personal and professional lives, it is necessary to amalgamate the evidence to provide a clear picture of what our teachers are saying to us.

It appears that although teachers want CPD in line with the international best practice principles, they have become accustomed to compromising what they would like with what is available and feasible. Although teachers value a chance to discuss and reflect with their colleagues, they are very aware of the restrictions of time, travel and finance and seem anxious that whatever time is devoted to CPD should be spent on what is immediately relevant to practice. They do not validate the use of CPD time for research or subject knowledge but would rather short circuit the knowledge-building element and get straight to the workable ideas for classroom practice. This is evidence that they have come to associate CPD with Hunzicker's (2011, p.177) "one shot sit and get" programmes.

Teachers seem to accept the best practice principles in theory (Column 1, Appendix XXIV) but are sceptical about the practicality of putting them into practice (Column 2, Appendix XXIV), possibly because of their association of CPD with short intensive programmes. My challenge is to reconcile these conflicting views and design an effective programme of science CPD which is also accessible.

<u>CHAPTER 7</u>

CASE-STUDY ACCOUNT

7.1 Introduction

It would seem from the data that Irish teachers have some attitudes and beliefs about CPD which do not always converge with internationally accepted best practice principles (See Appendix XXIV). This divergence of beliefs may "interfere with the goals of standards based reform efforts" (Borman et al. 2005, p.84). Taking into consideration the attitudes and beliefs of Irish teachers towards science and CPD, I sought to establish if it was possible to bridge the gap between internationally accepted best practice principles of CPD and Irish endorsed principles as described in Appendix XXV. This study is exploratory in nature in that I was attempting to discern both "success factors" (Bhreathnach, 2011) and the limits of the principles found in the literature, when applied in reality. In order to increase the potential of application of this study, I used two sites in which to trial and refine a model of CPD. What follows is a description of how the principles were applied in both sites. The journal entries used to supplement description of the two sites are taken from the researcher's field notes and/or the teachers' journals.

7.2 The Context

The first case study was used as a pilot study for the main case study. Both sites were average sized schools with staff sizes ranging from 15 to 20 including ancillary staff. The ages and gender of the staffs were mixed with their experience ranging from newly-qualified to those who had over thirty years' experience. The first school, Trial Site 1(TS1), was a single-sex school while the second, Trial Site 2

(TS2), was a co-educational setting. The principal in TS1 was a male principal in the 30 to 40 year age range, while the principal of TS2 was female and was in the 40 to 50 year age range. Both principals were keen to improve the provision of science in their schools. The principal of TS1 expressed very little personal knowledge of science, while the principal of TS2 had completed the Diploma in the Teaching and Learning of Primary Science in University College Cork. Three teachers of TS1 were involved in the same course at the time of the trial. Both schools were therefore aware of my credentials prior to the trial. The model was trialled at the first site during the summer term of 2008 from March to June. A revised model was implemented at the second site for the entire school year of 2008 to 2009.

7.3 The Pilot Study

The offer to work with the teachers in one school for a term, with the intention of improving science provision, was made to the participants in the post-graduate primary science course in University College Cork. This offer was extended in the autumn term of 2007. TS1 was selected because of the enthusiasm of the principal towards the concept, the size of the school, the range of experience of its staff members, as well as the obvious enthusiasm of three of its teachers who were participating in the UCC post-graduate course.

7.3.1 Description of Trial Site 1 (TS1)

TS1 is an all boys' school in a small town with a large rural hinterland which caters for children from second class to sixth class. The children were from a predominantly rural background. At the time it also had four units for autistic children. In total there were about 180 children in the school with thirteen teachers plus the principal who was non-teaching. Five of these were mainstream class teachers, four were resource/learning support teachers; four taught in the autistic units and there were four Special Needs Assistants also. Three of these SNAs were assigned to the autistic units and one was assigned to a child in one of the mainstream classes. The physical building was very old and completely overcrowded with minimal facilities (Journal entry, 12th April, 2008). This school had no interactive white boards, relatively few computer facilities, no common meeting room, not even a staff room; however, the atmosphere was very positive and enthusiastic. The energy and commitment of the staff to improve their practice were noteworthy and the predominant culture was collaborative.

7.3.2 The birth of the CPD model

The two goals of the project were presented to the whole staff as follows:

1. **To increase the teachers' confidence in teaching science by**:

- increasing the scientific knowledge of the teachers;
- introducing some teaching methodologies which would incorporate theories of constructivism into the teaching of science;
- involving the entire school community including the parents, in driving a focus on science for the duration of the project.

2. **To enhance the scientific experience of the children in the school.**

The third goal of the research which sought to change teachers' attitudes about what constitutes legitimate CPD was not made explicit. The methodology for the project as proposed to the teachers is outlined in the Provisional CPD Model for Primary Science as described in Figure 7.1 below.

	Features of Provisional CPD Model as Proposed to Teachers in TS1
1.	School based.
2.	Whole staff involvement.
3.	Assessment of school needs (through anonymous assessment of individual needs).
4.	Food to be provided in comfortable surroundings to increase development of convivial relationships among staff.
5.	Work (for the most part) to be conducted within the school day.
6.	Issues of substitute cover to facilitate release of teachers for coaching sessions to be addressed.
7.	Personal/family issues of time, workload etc. to be addressed.
8.	Modelling/observation of lessons in the style of '*Jugyou Kenkyuu*' to be used.
9.	Provision of lesson plans and supplementary materials by researcher.
10.	Researcher to be responsible for equipment sourcing and storage.
11.	Coaching to be provided as source of long-term support for teachers trying to change their practice.
12.	Group meetings to be held weekly or fortnightly to review progress.
13.	Parental and community involvement through joint education with teaching staff.
14.	Evaluation of the model to be based on teachers' and children's subjective experience of science throughout the trial.
15.	Teachers to be requested to keep a journal of their experience of the project.

Figure 7.1 Features of Provisional CPD Model

These features were presented to the teachers at the initial meeting and were accepted without any attempt to question, negotiate or indeed reject them. This response was unanticipated (Journal entry March 27th, 2008). I also presented a possible time-frame for the intervention project together with more detail about how the features of the CPD model might be experienced. This was presented in the form of a Six Step Cycle as summarised in Figure 7.2 below.

Step 1	**Step 2**	**Step 3**	**Step 4**	**Step 5**	**Step 6**
Introduction and negotiation of proposed CPD model. Needs Analysis (anonymous) ↓	Individual coaching session for teachers. Introduce assessment of prior concepts among children. ↓	Researcher models science lesson for individual teachers in their own classrooms. ↓	Teachers who have experienced Step 3 now model lesson for colleagues. DVD created. ↓	Whole staff meeting. Team-Teaching introduced. ↓	Coaching training for volunteers. ↓
Whole staff meeting. Discuss results of school needs analysis. Select focus topic for CPD. Discuss features outlined in Fig. 7.1 ↓	Carry out assessment of children with teacher. ↓	Researcher and teacher analyse evidence of concept-development and decide on next step. Co-design lesson plan to address 'next step' identified. ↓	Partners/ small groups analyse lesson together. Discuss possible improvements. Examine evidence of children's stage of under-standing. Decide on 'next step' in concept development. ↓	Focus of Team-Teaching selected. Lesson plan co-operatively designed. ↓	Teacher-coaches and partners commence coaching cycle. ↓
Whole community science education (teachers, parents and interested parties from community) ↓	Interpret formative assessment tasks with teacher. Decide on 'next step' to address mis-conceptions identified. ↓	Researcher observes teacher teaching lesson. Use of camcorder to create DVD for teacher's private use. ↓	Teach lesson again to a different class. (in teams if desired) incorporating suggested improve-ments. DVD created. ↓	Lesson taught to selected class. Team analyse mis-conceptions identified in each group. Children consistently failing identified. ↓	Provision of support for coaches. ↓

Meeting with individual teachers to determine prior experience, attitudes and needs. Establish coaching goal. ↓	Individual teacher and researcher co-design lesson – plan to address mis-conceptions identified. ↓	Coaching session to analyse lesson. Cooperative work to improve lesson plan if necessary. ↓	Group meeting to view/analyse lesson. Viewing may be done privately. Final amendments/ suggestions for improvement made. Analyse assessment tasks to identify 'next step'. ↓	Team teach lesson to different classes, rotating lesson element for which teachers are responsible until all teachers have taught each element once. ↓	On-going whole-staff science/ class group science education. Subject matter and pedagogical issues discussed. ↓
Introduce community science project to stimulate interest of stakeholders.	Whole staff meeting.	Repeat Step 3 until progress to Step 4 is possible.	Design next lesson. Repeat cycle of teach – observe – amend – teach.	Select new focus and repeat Step 5.	Repeat from Step 3 for new topic substituting teacher for researcher.

Figure 7.2 Proposed Six Step Model of CPD

I also presented a time-frame in which I felt it would be possible to complete at least one cycle of the Six Step programme (Table 7.1).

Number of Week	Date	Step of Six Step Cycle (Fig. 7.2 above)
Week 1	March 27th-31st	Step 1
Week 2	April 2nd-6th	Step 2
Week 3	April 9th-13th	Step 3
Week 4	April 16th-23rd	Step 3
Week 5	April 26th-30th	Step 4
Week 6	May 3rd-7th	Step 4
Week 7	May 10th-14th	Step 5
Week 8	May 17th-21st	Step 5
Week 9	May 23rd-27th	Step 6
Week 10	May 30th-June 4th	Step 6

Table 7.1 Proposed Time Frame for Completion of One Cycle of 6-Step Programme

7.4 Bridging the Gap in TS1

I spent ten weeks in TS1, from March 27th to June 6th 2008. In that time all teachers, bar the one 'non-runner' and the principal, planned and taught a series of lessons on the topic of Forces. The responses from the parents, children and teachers in the school indicate that their experience of science through the project was a positive one which increased awareness of the nature of science amongst all concerned. I experienced many disappointments along the way, however, as the initial model was eroded and redefined many times.

The ultimate model as it evolved in TS1 managed only to cover the objectives of the first three steps of the 6-Step Cycle outlined in Figure 7.2 which, it is now realised, was too ambitious within the available time-frame. The model as it was experienced in TS1 is summarised in the flow chart below in Figure 7.3.

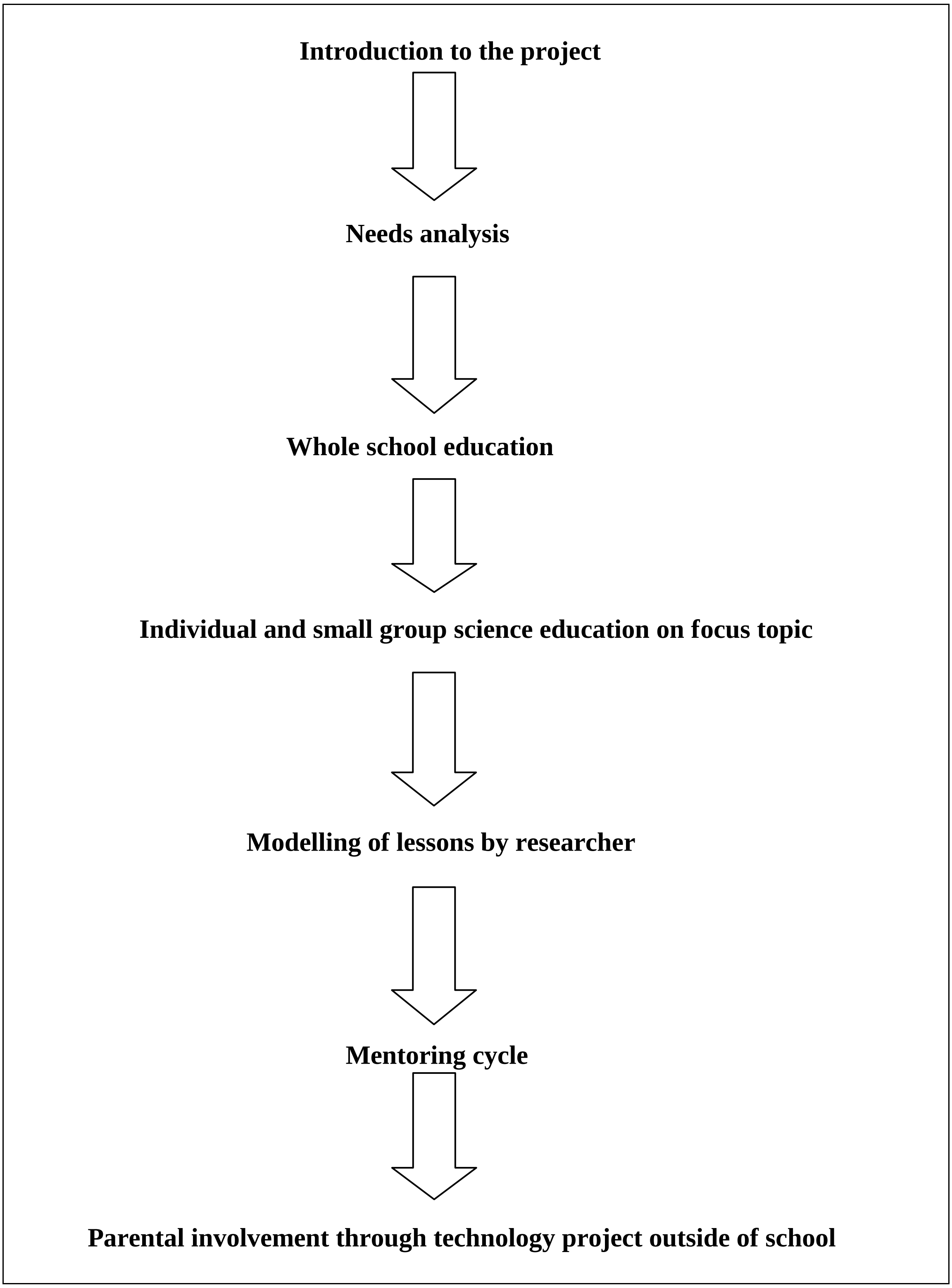


Figure 7.3 CPD Model as Experienced in Pilot School

I now describe my experience of the first trial of the WSIS CPD model.

7.5 Reflections on my Experience of the Pilot Trial

The model of CPD, as first proposed, evolved to meet some of the individual and collective needs of TS1. My reflections on some of the key issues as derived from the literature review and discussed in Chapter 2 are detailed here. These include the issues of leadership; reflection and time; idiosyncratic needs of individuals; culture; research; collegial support; coaching and mentoring.

7.5.1 Influence of the principal

The issue of how the values of authority figures e.g. principals, impact on how teachers experience CPD, highlighted in the literature (e.g. Borman et al. 2005, p.28) was evident throughout the pilot phase of the WSIS model of professional development While this pilot study did not allow for specifically exploring the principal's attitudes to the use of school-time for professional development activities, it is hoped that the difficulties experienced in facilitating all teachers may have caused him to reflect on the issue of time. One solution suggested by the teachers themselves, and approved by the principal, was to reduce the number of teachers participating at any one time. I was invited to return to the school for the following year under such conditions. While this did not provide me with the freedom I needed to explore the use of the model as I wished, this adaptation of the model to suit the school's needs exemplifies the manner in which Lewis, Perry and Murata (2006) suggest programmes should be adapted locally.

> Local adaptations are expected and studied as sources of potential improvement to innovation design and theory.
> (Lewis, Perry and Murata 2006, p.7)

While I believe the whole-school element of the programme could and should continue apace with all stakeholders discussing progress and receiving education together, it should be possible to stagger the individual coaching element of the programme until sufficient numbers of staff were trained in its use to coach each other.

The reticence from the principal regarding a greater level of involvement from parents was a particularly disappointing departure from the proposed model.

> *If I were to do this again I would find some way of getting the parents on board before even meeting the children. I did attempt this but the principal was not so keen due primarily to lack of meeting space - there is no assembly hall in the school. I also wanted to invite the parents to some of our classes but this was also rejected - I was not given a reason – I believe lack of space is a major issue. It also raises the thorny issue of parents in the Irish primary education system - are they just fundraisers? Comment from a principal on the role of parents in his school "They let us do our job and they do theirs - at home!! i.e. "ne'er the twain will meet".*
> (Journal entry, June 4th, 2008)

While many schools pay lip-service to the inclusion of parents, and comply with the departmental requirement to draw up a policy regarding the involvement of parents, the reality seems to be that parents are still valued only in their fundraising capacity in many schools (National Parents' Council (NPC), May 2012, DES June 2012).

> Despite the range of policies and procedures that have been developed that reinforce parental involvement in schools, parents report consistently to NPC that they do not feel supported to be involved in the key partnership role they have in their children's education.
> (NPC, May 2012)

While lack of space was the ostensible reason given, I believe that the physical limitations would not have precluded parents' involvement if the principal was positively disposed towards their inclusion. The second site at which the Model was trialled had similar space difficulties. This did not, however, impact negatively on the involvement of parents. The reason for the differing outcomes at each of the sites may have been due to the degree to which the principals' values aligned with those which under-pinned the WSIS CPD model (Borman 2005, p. 28-29).

The other significant way in which the principal impacted on the CPD experience was through his professional identity as the principal. It seemed that, being a very efficient principal who ‘gets things done’, he facilitated a passive teacher identity among the staff. A teacher-identity which presumes lack of agency led to complete acceptance of the proposed model of professional development without any open discussion on issues arising. This lack of discussion or negotiation reflects the trend detected in the NNA where teachers situate themselves in a silent, receptive position relative to authority figures as reflected in their choice of traditional modes of professional development (See Chapter 6, Section 6.4.1). Unfortunately, this passive mode can, and does, lead to resentment and non-alignment with the reform goals. The final point regarding the principal’s role is the suggestion by the Teaching Council that responsibility for CPD should form part of a principal’s remit. Having witnessed at first hand the strain that this particularly conscientious and efficient principal was under to meet all of his obligations at the time, I could not see how he could realistically be expected to also undertake the work I was doing, even though he was a non–teaching principal.

His greatest contribution was his unequivocal support for the teachers’ efforts to change and his leadership in this regard. He led by example. In spite of being very enthusiastic, he only ever managed to attend one education session with me and managed to observe one lesson. He made himself available for coaching whenever he could but was inevitably called away every time. To his great disappointment, he never managed to teach a science lesson as part of the programme. He expressed at interview stage the huge difficulty that the issue of time presented for him personally in meeting all of his obligations. During the time I was in TS1, there was a very supportive middle management in place in this school and the principal enjoyed excellent cooperation from his staff. With all of this support, the principal was still under a constant strain to keep on top of everything. While he certainly facilitated me and my efforts, he was not in a position to undertake the professional development of his staff as well.

7.5.2 Addressing individuals' needs

This research reinforces the futility of providing generic CPD. While coaching was appropriate for some teachers, mentoring was needed for others. Some teachers were comfortable about being observed while others found this aspect too stressful. Creating a relationship of trust wherein teachers could safely express their needs allowed them to select from a variety of supports which were on offer. The fact that the participants of TS1 invited me back to the school to continue the programme in the subsequent school year indicates that teachers felt safe to adapt the programme to their needs and that they felt it was worthwhile pursuing.

7.5.3 Time and culture

While the principal of TS1 facilitated the programme by making time available within the school day, he did so in a way in which he felt he could still meet all of his obligations as principal. I was very grateful for the time allocation but it fell far short of the time needed to fully experience the whole-school element of the programme. It had been envisaged that teachers would be willing to spend some time outside of the teaching day involved in CPD activities. While teachers appeared very passive regarding the proposed programme at the initial meeting, they were strongly resistant to the notion of dedicating personal time to their professional development and expressed this resistance through the principal. Only one teacher openly discussed this with me. She felt that staying on after school hours would be problematic for many teachers.

In both schools where I trialled the model I observed that the majority of teachers spent considerable time in school, both before and after teaching hours. This time was spent preparing for the following day or catching up on other voluntary pursuits such as the school garden, sport, school displays etc. This voluntary time was not resented by teachers. However, the suggestion that such time be mandated created ill-feeling. This culture needs to be explored further.

7.6 Description of Trial Site 2(TS2)

I worked at Trial Site 2 for the entire school year from September 2008 to July 2009. It was a co-educational rural school catering for children from infant classes to sixth class. It had grown from being a small two-teacher school of homogenous Irish students to being a burgeoning school of over two hundred mixed-race students with a staff of thirteen teachers. Of this thirteen, eight were class teachers, two were learning support/resource teachers, one was a special needs teacher, one a language support teacher and the principal. The principal is what is known as a 'walking' principal. Of the class teachers only one taught in the original building. All of the other seven were accommodated in pre-fabricated classrooms which occupy a lot of the available play space. These are all coloured grey and have the effect, together with the hard surface of the playground, of creating a bleak backdrop to the school's endeavours (Journal Entry October 4th, 2008).

The standards of discipline were very good and the children seemed very content and happy. Eleven staff members were female and two male. They were predominantly in the 20 to 30 age group, apart from the principal and two other members of staff.

7.6.1 Establishing a common vision

The predominant difference between TS1 and TS2 with regard to introducing the model, was the origin of the impetus to introduce CPD. While the invitation to support the staff of TS1 had come from within the ranks of its own staff, the introduction of the WSIS model of CPD to TS2 was my agenda which was supported by the principal. Unfortunately, the staff did not share her vision. This disparity in perception of need led to some conflict between the staff and the principal.

7.7 Needs Identification

In response to the findings of the NNA about teachers' reluctance to reveal their personal needs, an anonymous questionnaire was designed to assess the personal, professional and school needs of the staff (See Appendix VI). Analysis of this was conducted immediately; the findings summarised and used to determine the needs and attitudes of the staff in relation to science.

7.7.1 Summary of TS2 needs

The teachers at TS2 seemed more enthusiastic in their endorsement of the place of science in the curriculum than the national cohort. 50% of the TS2 staff considered science to be more important than most other subjects compared to 11% of the NNA respondents. This apparent endorsement of the pivotal place of science on the primary curriculum was not borne out by reference to existing practice in the school. Subsequent interviews with staff revealed that there was a very low level of implementation of the science curriculum in the school. The previous experience of TS2 staff members of science in post-primary education and the Colleges of Education, as gleaned from interviews and conversations, does not explain such high regard for science. This discrepancy between portrayed belief and practice may possibly be explained by a desire to display compliance.

90% (N=13) of the staff felt that they needed further training to implement the 1999 curriculum and science was the subject they felt least confident teaching relative to the core subjects of English, maths, Irish, history and geography. All of the staff felt that improved provision of science was important to them. This indicated a commitment to develop the science provision throughout the school and provided me with the mandate to proceed. In choosing a topic for the focus of the CPD, two methods were used. Firstly, I asked teachers which strand they would like to focus on. I also asked them to indicate their level of confidence teaching a number of topics from each strand. Responses were similar to those received from the NNA survey, with confidence levels declining for the chemical and physical sciences. While many teachers suggested Electricity as a focus topic, it became obvious that none of the pre-requisite knowledge in the area of Forces was properly understood, and had not been taught in the school. This information, together with the fact that 70% (N=13) requested work on the area of Forces confirmed the decision to begin with this topic.

From the National Needs Analysis some evidence seemed to be emerging that the class-level taught was an indicator of confidence in the area of science. It emerged that teachers were less confident teaching science to both the older classes and

Special Needs pupils and explained this lack of confidence by reference to their own insecure understanding.

> *I feel I wouldn't know what to do and feel embarrassed if experiments didn't turn out the way they should.*
> (Anonymous Pre-Intervention Questionnaire 10, TS2)

This lack of confidence was explored in conversations with teachers who explained their unease.

> *I would be more comfortable with junior classes as I am not confident in my own science knowledge; I am afraid of questions I cannot answer; I hate teaching science and all my friends and I agree that if we have to drop a subject any week it will always be science as we find it so difficult to teach.*
> (R6, TS2)

The conclusion that can be drawn is that while lack of experience at a particular level of the school is a factor in diminishing confidence, the predominant factor is a lack of confidence in the teachers' own scientific knowledge. This information was used to qualify the goals of the CPD programme. Not only was it desirable to equip teachers to teach science, but it was also imperative that the CPD programme would endeavour to empower teachers to teach science *at all levels of the Primary School.*

Having identified teachers' perceptions of their individual needs and my perception of the school's needs I set about 'bridging the gap' between actual practice and ideal practice, by reference to accepted international best practice as derived from the literature. Section 7.8 describes how the individual elements of the programme were experienced in TS2.

7.8 The Model as it was Experienced in TS2

The initial priority was to develop relationships within the school and to broaden all stakeholders' views of what constitutes the school community. The tools used to develop relationships within the school community and to improve provision of science in the school are described in Figure7.4

- **Relationship building - securing a common vision**
- **Needs identification**
- **Whole school education (Teachers, Principal and Staff - unfortunately auxiliary staff were excluded even though they eventually participated in the Team-Teaching element of the programme)**
- **Lesson-Modelling (I modelled lessons for individual teachers and for groups of teachers)**
- **Individual, paired and small group-mentoring to plan, teach, observe and analyse lessons**
- **Whole-school discussion of programme;**
- **Team-teaching (Lessons were planned and reviewed by 5 leaders per lesson drawn from parents, teachers and SNAs i.e. special needs assistants); these lessons were designed to give teachers experience of teaching class levels other than their own to increase confidence at all levels of the primary school**
- **Community science education**
- **Community involvement in technology project**
- **School Science Day**

Figure 7.4 WSIS CPD Programme as Experienced in Trial Site 2 (2008/2009)

Each of these elements is discussed in detail in Chapters 8, 9, 10 and 11.

The core means of support for teachers attempting to change their practice was provided in the form of a mentoring cycle illustrated in Figure 7.5. Unlike TS1, none of the teachers of TS2 were sufficiently scientifically literate to avail of coaching and therefore mentoring was considered to be more appropriate. The teachers in general needed to develop their own understanding of the concepts of Forces and Materials before learning appropriate pedagogy. I taught the teachers as I would have done the children, and, in this way I modelled the type of pedagogy I hoped they themselves would eventually implement.

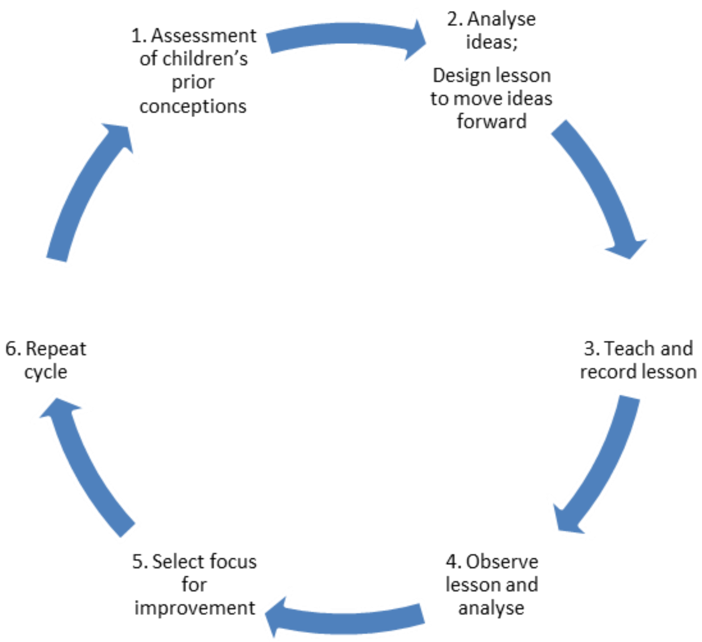


Figure 7.5 Mentoring Cycle Used to Support Teachers

Section 7.10 now presents a strategy for assessing the Whole-School, In-School (WSIS) programme of CPD as it was experienced in both Trial Sites.

7.9 Strategy for Assessing the Effectiveness of the WSIS CPD Model

This section attempts to compare how the WSIS model was implemented in each of the Trial Sites. Initially a summary of how the model was experienced in each of the schools is presented in Figure 7.6. Figure 7.6 uses a colour code to compare the extent to which the 6 Step Cycle outlined earlier in this Chapter, Section 7.3.2, was implemented in each of the schools where the CPD model was trialled.

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
Introduction and negotiation of proposed CPD model. Needs Analysis (anonymous)	Individual coaching session for teachers. Introduce assessment of prior concepts among children	Researcher models science lesson for individual teachers in their own classrooms.	Teachers who have experienced Step 3 now model lesson for colleagues. DVD created.	Whole staff meeting. Team-Teaching introduced.	Coaching training for volunteers.
Whole staff meeting. Discuss results of school needs analysis. Select focus topic for CPD. Discuss features outlined in Fig. 7.1	Carry out assessment of children with teacher.	Researcher and teacher analyse evidence of concept - development and decide on next step. Co-design lesson plan to address 'next step' identified.	Partners/small groups analyse lesson together. Discuss possible improvements. Examine evidence of children's stage of understanding. Decide on 'next step' in concept development.	Focus of Team-Teaching selected. Lesson plan cooperatively designed.	Teacher-coaches and partners commence coaching cycle.
Whole community science education (teachers, parents and interested parties from community)	Interpret formative assessment tasks with teacher. Decide on 'next step' to address misconceptions identified.	Researcher observes teacher teaching lesson. Use of camcorder to create DVD for teacher's private use.	Teach lesson again to a different class. (in teams if desired) incorporating suggested improvements. DVD created.	Lesson taught to selected class. Team analyse misconceptions identified in each group. Children consistently failing identified.	Provision of support for coaches.
Meeting with individual teachers to determine prior experience, attitudes and needs. Establish coaching goal.	Individual teacher and researcher co-design lesson – plan to address misconceptions identified.	Coaching session to analyse lesson. Cooperative work to improve lesson plan if necessary.	Group meeting to view/analyse lesson. Viewing may be done privately. Final amendments/ suggestions for improvement made. Analyse assessment tasks to identify next step'.	Team teach lesson to different classes, rotating lesson element for which each teacher is responsible until all teachers have taught each element	On-going whole-staff science/ class group science education. Subject matter and pedagog-ical issues discussed.

				once.	
Introduce community science project to galvanise interest from stakeholders.	Whole staff meeting.	Repeat Step 3 until progress to Step 4 is possible.	Design next lesson. Repeat cycle of teach-observe-amend-teach.	Select new focus and repeat Step 5.	Repeat from Step 3 for new topic sub-stituting teacher for researcher.

Figure 7.6 Comparison of Degree of Implementation at Both Trial Sites

Code:

Trial Site 2 only

Both Trial Sites

Neither Trial Site

Reasons for the variations between the two sites will be discussed in Chapters 8 and 9.

In order to avoid exaggerated claims of effectiveness, it was deemed wise to use two conceptual frameworks to consider the progress of the participants' change efforts. As well as the Harland and Kinder's (1997) typology of outcomes, I also refer to the "Concerns Based Adoption Model" (Hall et al., 1973) to assess the degree to which the desired teaching outcomes were integrated into practice, thus indicating the degree to which the CPD model supported teachers to change.

Harland and Kinder's 1997 typology of in-service (CPD) outcomes (adapted from Kennedy's 2004 summary, p.216-217).	**WSIS CPD Outcomes**	**Concerns-Based Adoption Model (CBAM) Levels of Use (Hord 1987, p.111; Kennedy 2004, p.209)**
1. Material and Provisionary Outcomes: This refers to the physical resources such as lesson plans; handbooks equipment etc.	While lesson plans were created during the CPD programme, these are not ultimately intended to be used unaltered, as one outcome of the CPD was that teachers would adapt materials to respond to the particular misconceptions in their own classes. Nonetheless, the Team-Teaching plans devised for the introduction of topics to various class levels could be deemed to fulfil this criterion of CPD as they could be transferred for use in any other class or school. A significant outcome of the CPD programme was the manner in which the problematic issue of management of equipment was organised in the school. This was considered to have a positive impact on implementation.	**Level I: Orientation- "The individual shows interest in innovation and seeks information about the innovation."** The most difficult aspect of the programme was enlisting teachers' support to trial the programme. Securing a common vision in a culture where coercion is more the norm than collaboration was difficult. The provision of model lesson plans and modelling of lessons by the researcher served to stimulate interest in what was on offer.
2. Informational Outcomes: Being briefed about background facts about curriculum development with implications for practice.	Whole staff lectures and workshops on the target concept, constructivist science teaching, formative assessment teaching strategies and common misconceptions provided the necessary 'informational outcomes'.	**Level II: "Preparation - The individual is preparing to use the innovation".** The whole staff education provided a uniform baseline of education with regard to concepts and relevant pedagogy. It also provided a common language with which both teachers and parents could engage in discussion about the innovation.

3. New Awareness: Conceptual shift from previous assumptions about appropriate content and delivery of curriculum.	The informational outcomes together with the lessons I modelled broadened participants' understanding of the kinds of science lessons we were aiming for. This was evidenced by teachers using an improved repertoire of constructivist methodologies which they were incorporating into other subjects in both schools. (M8 and R4).	**Level III** **Mechanical Use:** Teachers shifted from completing a page of a workbook or following instructions to provide a 'Wow' science lesson to trying to understand the concept they were teaching and thinking about how to maximise the children's understanding.
4. Value Congruence: The degree to which individual teachers' beliefs, values and practice coincide with the beliefs and practice being promoted in the programme.	Teachers were observed to introduce formative assessment strategies and other constructivist principles into their teaching. Science lessons included more investigative type work. Teachers were more likely to refer to assessment of previous lesson to decide on the subject of the next science lesson. Teachers moved from resenting the principal's vision for the school to embracing it as their own.	**Levels IVA, IVB** **Routine and Refinement:** Teachers routinely taught constructivist type lessons and abandoned previously used workbooks; teachers sought to work collaboratively to decide on next step lessons and appropriate interventions. Children were experiencing more active involvement in lessons with more use of equipment. Teachers moved from a position of recalcitrant participants in a programme which they felt had been 'imposed' upon them to assuming responsibility for their own development. Teachers changed from working in isolation to working collaboratively.
5. Affective Outcomes: These refer to teachers' initial responses to the programme and may include initially positive responses followed by negative feelings.	The opposite effect was witnessed at TS2 where many participants were witnessed to view the prospect of participation with trepidation. This was followed by more positive feelings as education was provided and successful lessons were experienced.	Teachers became empowered to see themselves as agents in their own learning and as having a responsibility for their on–going development. This led to teachers seeking out support for themselves and offering support to colleagues. There was a shift from individual, protected practice to a more collaborative, experimental practice.

6. Motivational and Attitudinal Outcomes: Enhanced enthusiasm and motivation to implement the ideas received during the CPD experience.	As teachers became more confident they sought out the support they needed to continue the implementation rather than waiting on the researcher to initiate a cycle of lessons. This represented increased motivation and enthusiasm for the values being promoted. Experiences of success motivated teachers to request extended education and support to pursue topics in more depth.	**Levels V and VI: Integration and Renewal:** Teachers progressed to make 'deliberate efforts to co-ordinate with others in using the innovation' and sought 'more effective alternatives to the established use of the innovation'. Teachers began to have more input into the design of the lessons and were more inclined to question the value of my suggestions and replace them with their own ideas.
7. New Knowledge and Skills: Deeper and more critical understanding of the curriculum and teaching approaches.	Whole staff education was provided at the beginning of each topic. This was supplemented by lesson modelling, small group and individual mentoring/coaching. Individual teachers were seen to attempt constructivist teaching methodology which involved a deeper understanding of the target concept and of the support needed to help children to assimilate the desired scientific concept.	
8. Institutional Outcomes: This refers to the collective impact on groups or indeed whole school. Consensus, collaboration and mutual support are listed as outcomes to support the innovation.	Because the whole school was involved in the WSIS programme, teachers were equally well informed and acquired equal opportunity to improve their proficiency. Parents received the same science education as teachers. This led to a consensus to work together to improve teachers' ability to deliver science to all classes in the school. This evolved in the form of a Science Team-Teaching programme in TS2 which included parents. This can be interpreted as an institutional outcome which	Teachers began to see the potential of the professional development model for other areas of the curriculum. Teachers began to review their **notion of 'professional development' as** an optional activity provided by outsiders and taking place outside of school, to a concept of professional development as a core element of their profession. Teachers also began to review their images of themselves as professionals and came to perceive their own potential as professional development

	led to a broader concept of 'The School' to include parents as active contributors to the teaching and learning endeavours in the school.	leaders in their own areas of interest. Special Needs Assistants (SNAs) became aware of a need for more opportunities to be included in whole school education in order to better fulfil their obligations to the children in their care. Parents appreciated having access to the same education as teachers in the area of science as it better enabled them to support their children's education at home. Teachers came to better appreciate the support of parents and became aware of the potential of parents in a school setting. An increased trust was evident between teachers and those parents who became involved.
9. **Impact on Practice**: The focus of this outcome is on teacher behaviour rather than beliefs. The ultimate intention is to bring about changes in practice.	The focus of the WSIS project was on changing practice. The programme sought to support teachers to teach a series of science lessons in a constructivist manner during a cycle of coaching which encouraged them to observe the researcher, their colleagues and themselves teaching and to select an aspect of their own teaching to improve.	All members of staff taught more science than they had prior to the programme. They all taught science lessons which were based on constructivist methodologies. Children had more opportunity to engage in hands-on, investigative style lessons. All classes experienced science lessons on the same topic at the same time. Most children had the opportunity to apply the science they learned in a technology project either within school or at home with their parents.

Table 7.2 Framework to Assess the Effectiveness of the WSIS CPD Model

From this framework (Table 7.2) it can be seen that teachers seemed to progress from a reliance on text-book lessons which involved mechanically following pre-determined lessons, to developing their own lessons in response to children's levels of understanding as assessed by the teacher and with reference to up-to-date research on children's misconceptions. Teachers became more open to the idea of working alongside parents and colleagues. Teachers also began to review their concept of professional development to include a greater sense of responsibility for their own development. They also became empowered to bring about change in their own schools and thus came to recognise their own potential as agents of change.

7.10 Summary

This chapter summarises how the WSIS CPD programme was firstly envisaged and how it evolved and adapted to local conditions at both Trial Sites. Some issues such as lack of confidence in teaching topics from the Materials and Energy and Forces strands and lack of confidence teaching senior classes, which arose in the National Needs Analysis, were seen to be common to participants at both Trial Sites. I have outlined the efforts made to tailor the programme to the specific needs of the participants at each site, while simultaneously attempting to bring about other changes which were not made explicit to the participants. These alterations included a change in attitude towards what constitutes professional development and the 'professional learning community'; the nature of the relationships in schools and teachers' attitudes to their own potential as providers of professional development to their colleagues.

Themes arising from these case studies will be discussed in the following chapters.

CHAPTER 8

ONE SUCCESS FACTOR - CONTEXT RESPONSIVE

8.1 Introduction

As stated in Chapter 7, this research was exploratory in nature and set out to identify the ‘success factors’ as well as the ‘inhibiting factors’ in attempting to design and implement a model of CPD in line with international best practice and the perceptions of Irish teachers. This chapter attempts to illustrate why Borko’s (2004) “fidelity” or Wayne’s (2008, p.469-470) “specificity” (see Chapter 3, Section 3.7.1) would have been counter-productive in the two sites in which the WSIS professional development programme was trialled. The chapter begins by considering the extent to which ‘context’ determines the learning experiences of adults and illustrates how socio-constructive principles of CPD were applied to the WSIS model. This is followed by a review of the ‘change-related values’ of Irish teachers deduced from the questionnaire data. The chapter concludes with the claim that one of the success factors of the WSIS model is its flexibility to adapt to a range of different contexts.

8.2 Which Learning Theory for Irish Primary Teachers?

During the course of implementation of the Whole-School, In-School (WSIS) model of professional development I was simultaneously involved in delivering a more traditional programme of professional development in a university setting. This created a heightened awareness of the difference between the learning theories (unspecified) utilised in each setting. The learning theory assumed was in part dictated by the setting or context. On the one hand teachers were involved in setting their own agenda and learning styles while, on the other hand, teachers were on the receiving end of a transmission of fixed quantities of knowledge from a fairly rigid programme set down by college authorities. It seemed to me that teachers as learners do not always benefit from the latest research into learning theories Fullan (1993, p.7).

This led me to consider which theories, if any, underpin adult learning. It would appear that the context influences which learning style is considered appropriate both by participant and provider. When time is limited, there appears to be pressure from both recipients and course providers to ensure coverage of course material. This results in a 'didactic' transmission of information. This is relevant when one considers that the current most common model of professional development accessed by teachers is the "one shot sit and get" model (Hunzicker, 2011, p.177).

When teachers were asked about those elements of professional development programmes which they considered to be most effective in the National Needs Analysis there was a clear preference for those elements associated with what has been termed 'active learning' or social-constructivism as discussed in Chapter 3, Section 3.7 e.g. discussion, reflection, observation, etc. The following elements were reaffirmed as being considered effective by the participants in the two Trial Sites.

8.2.1 Learners construct their own meaning

Teachers were active, reflective learners throughout the trialling of WSIS in that they took responsibility for developing their own conceptual understanding and knowledge of pedagogy. The whole school education provided in TS2 gave teachers the opportunity to discuss the target concepts with all stakeholders and to engage in experiments designed to create cognitive conflict, illustrate a concept and to get them thinking. They were active learners in that they decided how to avail of the supports available. Some teachers chose to read supplementary materials on the concepts being taught. Four of the teachers from TS2 decided to participate in the UCC diploma in the Teaching and Learning of Science concurrently. Some teachers chose to meet with colleagues to discuss their emergent understanding with and without my support. Some chose to meet with me individually or in groups to ask questions and to trial ideas for teaching the concepts.

> *It was good to actually sit down and talk about the science before embarking on teaching it. It made things very clear in my own head. Predicting what the children might say was also very helpful.*
> (Anonymous post-intervention Questionnaire No.11, TS1)

All participants observed me teaching and had the chance to listen to the children's discussions and ideas. They all had the chance to review the assessment tasks completed by the children with me and, through this analysis had the opportunity to review their own thinking in the light of these ideas. Some teachers chose to discuss their emerging understanding of the target concept. Many teachers also said that they discussed the target concepts informally with children at playtime and family members at home. The fact that the same topic was being pursued throughout the school at the same time meant that everyone was in a position to share in this active construction of understanding.

> *It was very helpful to listen to the questions they asked. It gave me another point of view.*
> (Anonymous post-intervention Questionnaire No.3, TS2)

The WSIS model was designed to give teachers maximum opportunity to interact socially, not only with their colleagues, but with the entire school community. The degree to which this was achieved depended on the alignment of the respective principals' values in relation to social interaction. TS2 had a much higher level of social interaction with a broader range of stakeholders and over a longer period than did TS1.

> *It was good to get ideas off each other and to know we were doing the same things so we could see what worked/didn't work in our classes. Great support also.*
> (Anonymous post-intervention Questionnaire No.2, TS2)

The social interaction of the participants with other members of the school community played a critical role in the construction of knowledge.

8.2.2 New learning depends on the learner's existing understanding

In order to base the new learning on existing understanding it was necessary to initially assess teachers' needs in relation to the 1999 science curriculum. The WSIS CPD model was premised on the needs of teachers as deduced from both the NNA data and the data collected at each of the two Trial Sites. The data from all three sources confirmed that Irish teachers have particular problems teaching topics from the Energy and Forces and Materials strands. This is confirmed in the literature (Varley et al., 2008). The information gleaned from the questionnaires was supplemented by conversations with participants, both formal and informal.

8.2.3 Authentic learning tasks are essential for meaningful learning

The focus of the learning throughout the experience of the WSIS CPD programme was classroom-based i.e. teachers were attempting to address a self-identified problem, inadequate implementation of the 1999 science curriculum, in the setting where that problem manifested itself i.e. their own classrooms with the children they actually teach.

> *It was useful to observe another teacher and the reactions and actions of the students.*
> (Anonymous post-intervention Questionnaire No.9, TS1)
>
> *Explained what I did well and gave ideas and advice on what to improve*.
> (Anonymous post-intervention Questionnaire No.6, TS1)

It was because teachers were engaged in such an authentic learning experience that they were motivated to take responsibility for their own learning and to exploit the supports provided by me.

8.2.4 Zone of proximal development

The notion of 'cognitive apprenticeship' whereby one learns by working on the job while closely supported by a 'more knowledgeable other' has long been used successfully in other professions e.g. the period of internship in medicine. My presence on site at TS1 and TS2 every day was based on this model. I was available whenever teachers wanted to ask a question; discuss or review a lesson; clarify thinking etc. The ease of access to expertise contributed greatly to the learning of all involved.

> *It was great to be immersed in this project for a few weeks. It was quite intense but great things were achieved. You can't beat having*

> *somebody who knows their stuff and more importantly who is eager to share good practice.*
> (Anonymous post-intervention Questionnaire No.11, TS1)

Analysis of the international CPD programmes reviewed, and comparison of the experiences of the WSIS programme with the basic tenets of constructivism as outlined by Applefield (2000/2001, p.35-53) and discussed in Chapter 3, justifies the conclusion that constructivist theories underpin those elements of CPD deemed by the international community and Irish teachers to be effective. Teachers' 'change-related values' are, therefore, a function of the *context* in which they find themselves. Section 8.3 now considers some of these values which were evident among respondents.

8.3 Change-Related Values of Irish Teachers

Three attitudes to CPD were predominant among the respondents to the NNA and were also witnessed at Trial Sites 1 and 2. These were categorised as follows: 'the investment'; 'the deficit' and 'the life-long learner' perspectives. Among the respondents to the NNA and those who chose not to participate in the trials of the WSIS model another perspective was identified – those who professed 'lack of interest' or 'apathy' as their reason for non-participation in CPD. As the CPD programme progressed, a new perspective emerged at Trial Site 2 - what I termed 'the needs-response D.I.Y. perspective'.

8.3.1 The investment perspective

This perspective suggests that the only reason for undertaking further professional development beyond initial qualification is for the purposes of advancing one's career i.e. to improve opportunities of changing jobs or gaining promotion and the concomitant increase in salary. This ‘investment’ perception is borne out by the following respondents who feel they no longer need to engage in professional development as they do not stand to gain from such work. These older teachers feel that there is little for them to gain out of participating in professional development.

> *At this stage in my career not worth it, also other commitments.*
> *(Res NNA 85)*

This lack of intrinsic value in professional development was not confined to older teachers. Many younger teachers’ responses also indicate the ‘investment attitude’ whereby the possibility of an additional qualification would be an incentive to participate.

> *An extra qualification takes a lot of time and effort but there is the financial incentive.*
> (Res NNA 152)

Conversely the absence of any reward in terms of financial remuneration or promotion would be an impediment to participation.

> *Wouldn't be recognised for pay/promotion so don't see the point.*
> (Res NNA 69)

The existence of such an “investment perspective” or utilitarian attitude to education is supported by Brint (1994, p.17; 2002, p.245). Such an investment perspective of education at any level is valid. However, when such utilitarian considerations take precedence over all others, I consider such a perspective to be problematic, particularly if it is the sole driver of post-graduate development. It is of even greater concern when this attitude is the single determinant of whether or not primary teachers, role models for attitudes to education for all children, undertake to pursue education subsequent to graduation.

The ‘investment perspective’ to professional development was found to be common across all age groups but varied in terms of the responding behaviour: older teachers avoided CPD because it was not considered worth their while; younger teachers participated if they felt there was a tangible reward to be achieved; conversely they justified lack of participation by reference to the absence of incentives. The self-serving ‘investment perspective’ of CPD evident in responses to the NNA (2007) is unlikely to promote Fullan’s (2005) “educational sustainability”. Another perspective of CPD which emerged from the data was termed the “deficit perspective” (Kshir 1999, p.300) which similarly falls short of Fullan’s (2005) “continuous improvement consistent with deep values of human purpose”.

8.3.2 The deficit perspective

It would appear that many teachers leave training college with the attitude that their education is complete. Any suggestion that they need to continue their education is interpreted as a slur on their proficiency. This attitude is what Kshir (1999, p.300) calls the “deficit perspective” and was found to be common to all age groups in this research. A “deficit perspective”, defined by Kshir (1999, p.300-301) is “the assumption that teachers have weaknesses in their teaching, or gaps in their knowledge that require correction”. From this perspective, professional development is considered to be a “way to correct a defect rather than as a normal growth process of CPD” (Kshir 1999, p.300).

> *Young teachers are well trained but us older ones need help!!*
> (Res NNA 316)

This sentiment was echoed by Res NNA 381, a younger respondent.

I feel that college really prepared me for teaching science at Primary level. I am confident to attempt all areas of the science curriculum. I qualified in 2002. I think that teachers that have recently qualified are far more confident when it comes to science. Perhaps more in-service is needed for those teachers that are qualified a long time and possibly did not have any science training in college. But for me & colleagues of a similar age, I feel there is not a huge need for more in-service.
(Res NNA 381)

In the National Needs Analysis many teachers responded in an acrimonious manner when asked if they felt they needed further development to support their teaching of primary science. Some respondents made it quite clear that they interpreted this question as a slur on their ability and presumed a positive answer implied a 'deficit' in their capacity.

I can teach science sufficiently well without needing another course.
(Res NNA 253)

To the query if he/she would be willing to pay for a programme of professional development the following response indicates strong antagonism.

Not a chance in HELL.
(Res NNA 264)

Others quoted their qualifications in science and therefore their absence of a 'deficit' to explain why they have not undertaken further development in primary science subsequent to the introduction of the 1999 Curriculum.

Feel I have good knowledge of science having done physics & chemistry at honours level for Leaving Cert.
(Res NNA 80)

Those who claim to have done sufficient work as part of their under-graduate studies to equip them to teach science were contradicted by participants at both Trial Sites who were nearly all quite disparaging of their preparation to teach science.

R9, TS2 graduated from (College of Education) *in 2002;*

> *…She recalls doing science for 1 hour per week some semesters in college. ....She does not remember doing any science background in college. She feels she has a little confidence and needs more help with science to be able to answer the children's questions. In her opinion all young teachers feel equally lacking in confidence teaching science*
> (Journal Entry, March 2009)

This is typical of the accounts given at both of the Trial Sites which do not justify the claims that preparation at under-graduate level does not need supplementing at post-graduate level. These views are consistent with a 'deficit' view of CPD which may threaten one's self-esteem and thereby limit participation to all, bar those who do not feel threatened by their own lack of understanding, i.e. the life-long learners.

8.3.3 Life-long learners

43 of all respondents to the NNA (approximately 9%) referred to the benefits of ongoing professional development to their practice, when asked why they would like to participate in further in-service in the area of science. Three of the fourteen staff at TS1 and two of the thirteen staff at TS2 were already involved in CPD, which involved course work and attendance at lectures (online or otherwise) during the school year in their chosen area of expertise. Four more from TS2 embarked on the UCC diploma in the Teaching and Learning of Science during the year of the WSIS trial. They, like the following respondents, indicated a view of themselves as life-long learners.

> *I believe in life-long learning - you never know everything & science is changing.*
> *(Res NNA 116)*

The following respondent illustrates the attitude of a lifelong learner but indicates, understandably, that recognition of this extra work would be appreciated.

> *Education is always good! Even more so if it was recognised in some way. At the moment only 'big' qualifications (e.g. degree, masters …) get an extra allowance and you need to pay for a 5 day course to get 3 course days. At the risk of whining too much - it would help.*
> (Res NNA 371)

While the following older respondent, Res 308, is somewhat ambiguous about participation it is also possible to discern excitement at the possibility of further learning.

> *At my age would it be worth it, but I might!!*
> *(Res NNA 308)*

What is incumbent on us is to find out which factors inspire these life-long learners? Why do some embrace every opportunity to keep learning while others feel new learning is a slight on their self-construct of proficiency? Section 8.3.4 discusses those teachers who profess apathy to the process of change.

8.3.4 'Lack of interest' perspective

From Table 6.14 in Chapter 6, it can be seen that nearly a third of all respondents are simply not interested in undertaking further professional development. This lack of interest expressed by 31% (N=467) of all respondents was not in fact as common amongst the over 50 age group but actually increased to 40% of all the 20 to 30 year olds (Chapter 6, Table 6.15). The fact that the percentages that perceive lack of interest as a significant impediment to CPD are also quite high at 33% for those over 30 years of age, is a cause for concern and may be explained by a view of CPD as superfluous. If one hopes to establish CPD as "a natural and expected component of teachers' professional activities" (OECD, 2010, p.32) it is important that teachers are given the opportunity to reflect on their perspectives of CPD.

Individuals so disaffected as to indicate ‘lack of interest’ as an impediment to participation in CPD must feel disconnected from the goals of the schools in which they work and possibly from the profession as a whole. It may be that prior experience of CPD has caused them to become disenchanted with CPD as a means to improve their individual capacity. Whatever the reason, it is imperative that such a ‘lack of interest’ be investigated further.

8.3.5 Needs response: D.I.Y.

As the trial of the WSIS programme progressed in TS2, some teachers increasingly displayed more autonomy in accessing the type of support they needed. They started to read books on the target topics; they were coming to me asking for meetings; they began to organise teams for Team-Teaching lessons in their own classes; they formed partnerships to support each other mastering the target concept. In other words, they began to take ownership of the programme.

> *R5: … I feel, you know it was great this year, you were coming to us and in the end we were actually coming to you as well, you know which was great.*
> *(Interview R5, TS2)*

This development provides the evidence that eventually, the WSIS CPD model could be the springboard from which teachers might take ownership for their own development and that of the teaching profession. An effort is now made to understand how some of these perspectives on professional development may have evolved.

8.4 The Origin of Teachers' 'Change Values'

Each of the attitudes to professional development outlined above is valid and they are not mutually exclusive. There will be times in one's career when a deficit in knowledge is acknowledged and professional development is sought to redress the deficit; or a goal is set which can only be attained through investing in professional development. An overload of externally mandated CPD, possibly perceived as irrelevant to practice, may elicit a response of apathy on the part of some. It is proposed that these perspectives have evolved through the context within which teachers have been socialised.

I suggest that the historical context of the educational system in Ireland is very much premised on external rewards with high points in the Leaving Certificate being the ultimate reward at post primary level. The instrument of the Leaving Certificate is the determining factor in gaining access to third level education and therefore worthwhile employment. Similarly, those in receipt of an honours degree traditionally received higher remuneration (now discontinued since 2012). By connecting academic success with financial remuneration, a link has been established between education and financial gain. While the link between a good standard of education and employability cannot be dismissed lightly, unfortunately the intrinsic value of education is diminished somewhat.

Negative attitudes which perceive CPD only as a means to an end are compounded by the actions of the DES which historically has provided short, sporadic in-service without any effort to establish the needs of those for whom it was intended.

> *At this stage I forget what happened, as we were bombarded with individual/isolated days for in-service in various subjects…often totally unrelated…absolutely no follow up or continuity.*
> (Res NNA 425)

This sporadic provision indicates to teachers that development opportunities are only provided when the DES has an agenda. This adds weight to the ‘deficit’ perspective of CPD whereby the DES is complementing what it sees as lacking in the profession. An excess of what many teachers referred to as ‘Central-CPD’ i.e. professional development which did not seek to address the needs of local schools or individuals, but rather pursued the needs of the DES, resulted in many teachers becoming disaffected from participation in voluntary CPD because of its perceived irrelevancy to their own needs.

> *Science courses were available but like with many teachers my general uptake of courses in recent years have been minimal due to the high level of central in-service being undertaken………all in-serviced out!!*
> (Res NNA 202)

In spite of the DES provision being explicitly about the DES’ needs rather than teachers’ needs (which were not identified), many teachers felt very enthused and were keen to engage with the science education being provided. Unfortunately the nature of the programmes provided did not exploit this enthusiasm of the teachers, many of whom were meeting science for the first time.

> *Helpful on the days but totally inadequate as a few 45mins of exposure to trying out apparatus on forces etc, was only a drop in the ocean of my total lack of knowledge in science.*
> (Res NNA 177)

It was unfortunate that the DES introduced a totally new subject to teachers with such short courses and then abandoned them to their own devices.

> *Too much to take in at one go.*
> (Res NNA 323)

Many respondents to the NNA lamented the lack of continuity of provision that the in-service provided.

> *In-service should have been ongoing. We as teachers got hung up on policies*.
> (Res NNA 415)

> *Courses too condensed and rushed - impossible to remember much of content and techniques. Also, the resources used in course not easily attainable.*
> (Res NNA 427)

Short, sporadic courses designed to achieve short term goals do not promote a value in lifelong learning. This type of provision encourages a 'deficit' view of professional development.

Historically, a teacher's relationship with other members of the education system has been a function of the system's hierarchical nature with teachers being at the receiving end of the wisdom of those in a position to 'know better'. The absence of opportunity for dialogue in the education system does not lend itself to the convergence of goals or constructs of proficiency. It has been suggested that the trait of awaiting intervention from an authority further up the chain of command is a product of historical and cultural contexts. Hearne (2010) suggests that "the impact of our colonial legacy, the famine, the Catholic Church, the civil war and parties that emerged from it …influenced the development of a cultural deference for authority, a lack of confidence and a constant self- degrading." Dr. Hearne also suggests that many of our social and economic problems in Ireland have been negatively affected by such a culture:

> .... which has led to State institutions (including the DES) allocating their spending according to electoral cycles, reacting to crises and emergencies as they emerge….and to an absence of long-term planning that prioritises society's and the economy's strategic and sustainability requirements. It has also forced a consensus-based public dialogue and an anti-intellectualism that is characterised by a discouragement of radical or challenging opinions.
> (Hearne, 2010)

Teachers slow to take initiatives to address self-identified needs may reflect such a culture of obeisance to a higher authority. Such an unequal relationship between individual teachers and the DES is a major obstacle to the development of the teaching profession as a self-regulating, self-developing body. This top-down relationship reinforces the negative perceptions of CPD witnessed in this research. Section 8.5 now outlines how the WSIS model of CPD contributed to developing the 'Needs Response D.I.Y.' attitude to CPD whereby understanding was "facilitated by exchanges that occurred through social interaction, through questioning and explaining, challenging and offering timely support and feedback" (Applefield et al., 2000/2001, p.38, see Chapter 3).

8.5 Context Responsiveness - One Success Factor of the WSIS CPD Model

When teachers were given the opportunity at TS1 and TS2 to reflect on and express their own needs and 'personal vision' on their own and in collaboration with others; when they were supported to address their identified needs collaboratively; when opportunity was provided for them to increase their mastery of the target subject but predominantly when they were challenged to reassess their acceptance of the status quo, teachers' views of themselves as professionals changed - they were empowered to become 'agents of change'.

The relationships encountered during this research which formed the context within which the CPD was provided were:

- The teacher's relationship with him/herself;
- The teachers' relationships with their employer, the DES;

- The teachers' relationships with one another;
- The teachers' relationships with the principal;
- The teachers' relationship with me, the leader of the programme;
- The teachers' relationships with the children and their guardians;
- The teachers' relationship with the subject of science.

Since each of these relationships is idiosyncratic, not alone for each school but for each teacher, any effort to pre-determine the "frequency, duration and quality" (Wayne et al. 2008, p.469-470) of programme elements is futile at best, and possibly even counter-productive.

My initial efforts to introduce the WSIS programme of professional development to TS1 as I had envisaged it, were thwarted by the physical limitations of the school and the lack of contact time with teachers and parents. Abandoning my pre-determined programme in order to accommodate the school's physical limitations, the principal's conditions and the teachers' needs required courage. It demanded the ability to be flexible since the context of the teachers' working lives meant that it was impossible to plan too far ahead and I was constantly juggling to adapt to their needs. In spite of this constant re-negotiation of the elements of the programme I needed to retain a vision of the programme.

In TS1 the elements of the programme which did not feature in the manner in which I had anticipated were the teacher-parent interaction, the whole-school education and the parents' education. Similarly in TS2, I struggled to establish collegiality through whole-staff discussion groups. The entire first term was devoted to building relationships among the staff and raising awareness of the need to improve implementation of the 1999 science curriculum. This was unanticipated. My choices in both schools were to either insist on 'fidelity' to the programme as I had designed it or, as I chose to do, work within the context of each school. I did not however relinquish the objective of these elements i.e. to provide opportunities for dialogue in order to facilitate the collegial nature of the programme.

8. 5.1 Adapting to context

In TS1 it was not possible to teach science to the whole staff at one time. However, I still sought to develop the teachers' conceptual understanding by working with the teachers in pairs and in small groups. I was not permitted to invite parents into the school for the purposes of increasing their understanding of the science topic being taught, so I sought to include them by sending home information and inviting them to participate in a home-school technology project which supported the children's knowledge of the topic of Forces. In TS2 not all teachers were willing to devote their free time after school to whole school discussion groups. Eventually 'breakfast groups' emerged, which fulfilled the same function. In other words, while I had envisaged how I was going to promote dialogue among teachers, parents and children in order to build a 'learning community', I had to adapt the methods to suit the idiosyncratic needs at each site. While the methods may have changed, the objectives did not. While I do not claim that these objectives were adequately met in all cases, I do claim that this research shows what is possible when the facilitator is willing to take into consideration the context in which the CPD is to take place and to accord appropriate dignity to those for whom the CPD is intended. My research, focussed as it is on one facilitator in two schools initiating the process of professional development, though narrow in its remit, shows “images of the possible” (Shulman, 1983, p.495). …“not only documenting that it can be done, but also laying out at least one detailed example of how it was organized, developed, and pursued”.

This research has shown that each context is unique and therefore that it is more important that programmes of professional development, respecting the unique context of each school, should maintain fidelity to the objectives rather than fidelity to the “specifics” (Wayne et al. 2008) of the programme elements.

8.6 Summary

This chapter set out to illustrate how my experience of the WSIS model of science CPD reinforces my view that socio-constructive theories of learning underlie internationally accepted, best practice CPD (as described in Chapter 3) and the elements of professional learning deemed by Irish teachers to be most effective (as determined by the NNA and WSIS participants). I then attempted to show how these theories were applied in the implementation of the WSIS CPD model in the two schools in which it was trialled. Concluding that socio-constructivist theories provide the philosophical basis for CPD deemed to be effective, I attempted to demonstrate that it is counter-productive to attempt to implement a CPD programme without taking cognisance of the context within which it is to take place. I attempted in Section 8.5 to illustrate how teachers’ perceptions of CPD have a historical and cultural context which needs to be understood when attempting to introduce teachers to an alternative and broader notion of professional development which includes viewing the classroom as a legitimate site for investigation. Finally, by reference to my experiences at both Trial Sites, I showed how the WSIS CPD model demonstrated its ability to respond to the idiosyncratic contexts of Irish schools. Chapter 9 now looks at another of the ‘success factors’ of the WSIS CPD programme-building individual capacity.

CHAPTER 9

BUILDING INDIVIDUAL CAPACITY

9.1 Introduction

The evidence for Chapters 9, 10 and 11 is taken from my own observation journal and the interview data. The conclusions drawn were validated by the participants at both Trial Sites. In that sense, these chapters provide a platform for participants to share their experience of the WSIS model of CPD and address KeYu's (2011) concern that participants' voices are often "mute" in research reports.

There is a sense from the data arising out of the NNA and the case-studies that the implementation of the 1999 science curriculum is not as successful as other aspects of this curriculum. All participants in this research indicated less confidence teaching this subject than any other subject and 70% of the NNA respondents (N=467) indicated that they need further support.

Bell and Gilbert (1996) claim that presumptions of individualism often hold individual teachers accountable for failed innovations. While I am not suggesting that the effort to establish science in Irish primary schools has failed, I propose that it is possibly because the 1999 science curriculum was so dependent on what Fiszer (2004, p.32) refers to as the "individual drive" of teachers that implementation is so uneven (Varley et al. 2008).

Irish Primary Teachers' attitudes towards professional development as discussed in Chapter 8 indicate how they perceive themselves as professionals. For many, rather than critically challenging their own practice with a view to revitalising it, they display a sense of powerlessness in their responses.

> *I have been teaching for a long time and have become 'burnt-out' with so many courses over recent years.*
> *(Res NNA 429)*

These sentiments are not uniquely Irish and are echoed by Fullan (1993) below.

> In an extensive study of teacher burnout, Farber (1991) identifies the devastating effects of the growing "sense of inconsequentiality"......, as "the inevitable difficulties of teaching ... interact with personal issues and vulnerabilities, as well as social pressure and values, to engender a sense of frustration and force a reassessment of the possibilities of the job and the investment one wants to make in it".
> (1991, p.36 in Fullan 1993, p.2)

The origin of teachers' disenfranchisement may be the 'individualisation' of innovation efforts where the emphasis has been on retraining individuals. In contrast, it has been argued in Chapter 8 that 'effective components' of teacher development programmes reflect 'constructivist' theories of learning. The socio-constructive nature of cognition necessitates the transfer of responsibility for implementation of innovative practice from the individual to the collective.

In this chapter I attempt to show that a culture of isolationism in Irish schools has militated against the development of collaboration. I begin by looking at how Irish primary teachers' professional 'identities' are a product of their relationships with the DES, colleagues, principal, parents, children and society. I make the argument that unless teachers are affirmed in each of these relationships, so that the emerging identity is that of a valued professional, teachers will be unable to engage in the critical dialogue necessary to engage in transformative, collaborative practice.

The chapter concludes by suggesting how the culture of isolationism of Irish schools might move towards a more collaborative model by building individual capacity.

9.2 Irish Teachers' Professional Identity

The various perspectives of professional development evident amongst the respondents to the National Needs Analysis (NNA), and discussed in Chapter 8, suggest that many Irish teachers are more likely to await externally mandated professional development rather than voluntarily initiating or pursuing voluntary CPD. The following sections attempt to illustrate how the various relationships in a teacher's life contribute to his/her evolving identity as a teacher.

9.2.1 Significant relationships

Teachers' various relationships with the state, the community, their colleagues and children ensure that teachers are "far from being independent" but rather are "constrained in numerous legal, moral, social and political ways" (Soder, in Goodlad and McMannon, 2004). If a teacher does not receive affirmation it is unlikely that he/she will have a strongly constituted sense of self-worth, thus limiting his/her willingness or ability to engage in innovative practice. Because teachers are subject to the vagaries of public opinion and the expectations of parents and children, it is incumbent upon fellow members of the profession to support the development of a strong sense of self-worth among their colleagues. The primary relationship that dictates the identity of Irish teachers is that with the state in the form of the DES, which dictates conditions of employment. The effect of this relationship on teachers' engagement with innovation was referred to many times in the NNA data.

9.2.2 Teachers' relationship with the DES

Teachers indicated in the NNA that willingness to co-operate with innovation is a function of the degree to which the DES affirms teachers' identities as 'professionals'. Teachers suggest that this affirmation should include up-skilling on a continuous basis 'as in other professions'.

> *In-service must be during working hours like with every other professional. Employer should pay.*
> (Res NNA 259)

Teachers also felt that the DES does not acknowledge efforts made by teachers who strive to pursue professional development independently.

> *No incentive in salary scale for ANY up-skilling.*
> (Res NNA 99)

About half of all respondents made similar comments regarding the absence of recognition on behalf of the DES for sustained courses undertaken after graduation. It would appear that teachers rely on the DES to reflect back to them a notion of professionalism and that their response to innovation is determined to a degree by the 'identity' imposed on them by the DES.

> *Other professions get training as part of their jobs - why don't we?!*
> (Res NNA 312)

Respondents to the NNA seem to feel that a sense of respect is absent in the manner with which the DES provides for their professional development.

> *Wouldn't be recognised for pay/promotion so don't see the point.*
> (Res NNA 69)

This lack of affirmation may undermine one's sense of professionalism as suggested by Cooley (1902) who found that perceived opinions of others and their expectations have an influence on the "construction of self" (Cooley (1902) in Day et al. 2006, p.

602). If the DES, as the teacher's employer, withholds the necessary affirmation, then opportunities to work with colleagues become even more essential to developing a "constituted sense of self as respected and competent individuals" (Zembylas 2005, p.945).Unfortunately opportunities to work with colleagues are limited in Irish schools and has led to a culture of isolationism.

9.3 Isolationism

Throughout this research there was evidence of teachers differentiating between themselves and colleagues in terms of age, qualifications, commitment, proficiency etc. and seeking to justify their responses to the 1999 curriculum in terms of these 'relative constructs of self'. This tendency towards 'isolationism' is reinforced by staffing and timetabling arrangements which militate against collaboration in Irish schools.

> The isolation of teachers at all stages of their careers is well documented (Goodlad 1984; Lieberman and Miller 1984; Lortie 1975), and it is clear that the daily rhythms of schools typically provide little time for teachers to talk, reflect, and share ideas with colleagues.
> (Little 1987; Lytle and Fecho 1991 in Cochran-Smith and Lytle 1992, p.301)

Traditional models of CPD in Ireland reinforce such isolation of teachers. CPD provision which is aimed at individuals, as in the case of the traditional summer courses in Ireland and post-graduate courses, can reinforce divisions between colleagues. The difficulties associated with targeting just one member of staff for CPD were raised repeatedly by teachers during this research. The Discover Primary Science courses were widely lauded by all respondents. The only complaint about these courses was that they are targeted at only one teacher per school.

Discover Primary Science is an excellent resource - it would be wonderful if every teacher could attend the training day as opposed to just one representative from each staff.
(Res NNA 251)

Respondents to the NNA are clearly aware of the futility of educating just one member of staff in isolation from his/her colleagues. This awareness of the need to develop the entire staff is confirmed by participants at the two Trial Sites who commended the whole school aspect of the model.

I think if you worked with half the staff, I don't think it would have worked as well. I think it needed to be done as a whole school thing where everyone was involved and science was being done throughout the school rather than just in certain classes for continuity. I think it definitely should have been done as a whole staff. I couldn't imagine doing it as part of the staff. I don't think it would work to be honest. No, I don't think you would have had the same enthusiasm or the same energy. I don't think it would've worked as well.
(Interview TS2, R6)

Selective provision of professional development could lead to those who have not been offered the same opportunity to feel disenfranchised and therefore disaffected. In spite of this awareness that whole staffs need equal training, many of the responses to the NNA suggest that professional development should be offered selectively on the basis of need with some respondents (particularly principals) distancing themselves from that 'need'. This identification of some groups as being needier than others reflects the 'isolationism' which is reinforced by the organisational structure of our schools. This projection of need onto others suggests an identity of isolation from colleagues. This isolation of individuals does little to support mutual self-esteem which in turn creates a fractured profession, poorly equipped to constructively review practice. R4 (TS2) feels that he would learn more from working with his colleagues but feels the 'teaching system' does not accommodate such working together.

I constantly tell parents that the kids will learn more from each other than they will from teachers and teachers are the same, we learn more from fellow teachers than we give credit for, but sure it's not something I suppose that our teaching system helps.
(Interview TS2, R4)

The isolation witnessed throughout the research was based on a variety of constructs which are now discussed.

9.3.1 Isolation due to age and perceptions of confidence

There was considerable evidence of teachers viewing each other through the lenses of their personal constructs of "older"; younger'; 'more qualified'; 'a fool' (implying over enthusiastic); 'superior' etc. These various definitions of others caused people to assign themselves to 'boxes' from whence they found it difficult to find common ground. It is argued here that such identification into discrete, mutually exclusive categories is detrimental to collaborative relationships. Older teachers' identity as professionals may be diminished by what they perceive as better trained, younger teachers. Younger teachers may feel inhibited about revealing lack of confidence in the light of this perception by their older colleagues. The isolation caused by fears of appearing incompetent to one's colleagues was very evident throughout both trials of the WSIS CPD programme. The perception of colleagues as 'older' or 'younger' impacted on teachers' identities. Those older teachers, deemed by their younger colleagues to be out of touch, used this image of themselves to justify non-implementation of the reform and non-participation in CPD. Such non-implementation confirmed younger teachers' perceptions of older teachers as less competent. Older teachers indicated a perception that younger teachers, perceived to be 'well-prepared', should be teaching their science classes for them.

> *Older teachers need a lot of support and encouragement in this area - much more than the more competent younger teachers whose training is more relevant to this area.*
> (Res NNA 317)

In reality, it was found that these younger teachers are hesitant to destroy this 'subjectively interpreted identity' by admitting their lack of confidence around the subject. R12, a young teacher just graduated from training college during her interview began by stating how confident she was and how well trained she had been to teach science. As the interview progressed and her self-proclaimed 'confidence' to teach science was interrogated more deeply, R12 eventually admitted that in fact science was her weak area and the one she would need to address. R12 ends the interview by being very frank about her lack of confidence teaching science:

> *It's a subject that honestly I am fairly apprehensive about teaching-wise and it's not an insult to science, it's just I feel a lot of teachers have an area.....well I feel my weakness would be science. So it's not that I'm allergic to science or anything it's just that it's an area that I feel it's probably my weakest across the curriculum and as I said earlier it's from my own experience of it too. And it's not that I don't want to teach it or that I don't see the point of it, it's just that's the way it is. I suppose in time when I am teaching it and maybe with these in-service training and summer courses and things, if I was to say where I should try to pick up on a subject that I feel I really need to improve on, it would be science. Straight up.*
> (Interview TS2, R12)

This provides evidence of the pressure felt by young teachers to express a confidence to teach science they do not always feel. They, like some older teachers, are vulnerable about admitting their lack of confidence. A similar level of low confidence leaving college was expressed by most of the teachers in both Trial Sites with no distinction between the younger and older members of staff in spite of their very different experiences at training college.

This interview also reflects the ambiguity that was detected in some of the postal interviews. Teachers asked about their overall confidence teaching science declared themselves to be confident. However when this self-proclaimed confidence was compared to their confidence teaching other subjects on the curriculum it is clear that it is much lower for science than for any other subject. When confidence for individual items from each of three strands of the science curriculum was computed the confidence score fell by another 20% (See Chapter 5, Table 5.30). R12 (TS2)

> *R1 (TS2) graduated in 1994 did chemistry for leaving cert. but didn't remember doing any science in (College of Education) She felt it was mostly environmental work.*
> *(Journal entry, November 16th, 2008)*

> *R10 (TS2) left (College of Education) 3 years ago and says she had forgotten that she had done any science in college until I mentioned (lecturer).*
> (Journal Entry, November 21st, 2008)
> *M12 (TS1) is about 25. He felt training college offered nothing memorable in his development as a teacher of science. He remembers it as coming under the umbrella of SESE and taught by (lecturer) but nothing much else. M12 is a young teacher possibly 2 or 3 years out of college at most!! He studied physics at honours leaving cert. level and feels he knows nothing about it. He learned definitions and the experiments were strictly for exam purposes - nothing relevant or memorable*.
> (Journal entry, May 2008)

The main difference that the younger teachers' preparation to teach science at college made was that it rendered them less able to admit their lack of confidence. Most of the older teachers had received no preparation to teach science at training college and therefore did not feel so abashed at admitting their lack of confidence**.** Perceptions of one's colleagues as being more or less proficient than oneself may damage one's identity as a competent teacher. Feelings of inadequacy, in turn, obstruct opportunities to express respect for colleagues' capacity and goals. Where teachers worked in isolation from their colleagues, it was observed that mistrust and competitive practices decreased opportunities for learning. Teachers tended to disrespect the contribution of a teacher whom they perceived to be less competent.

Many teachers expressed the opinion that their colleagues (sometimes older than themselves) were more in need of professional development than they themselves were.

> *I was fortunate to have trained when there was a huge emphasis on science in the new Curriculum however my colleagues have had to start at the beginning.*
> (Res NNA 174)

It is possible that this perception of colleagues' lack of proficiency could lead to inconsistent provision across class levels thus causing tensions if some teachers were to be targeted as in need of professional development aka 'remedial' help as in the response quoted below.

> *Whole staff training needed.*
> *Concerned about fact that only some teachers do science so children's knowledge is poor... how are "new" & "sub" teachers briefed on "science curriculum in the school."*
> (Res NNA 146)

These perceptions of difference need not reinforce isolationist practice but could be used as a place from which to begin the transformation to collaboration.

9.4 Replacing Isolationism with Collaboration

The 1999 curriculum is significantly different from the 1971 curriculum and, each subject as now presented has multiple strands, each of which require knowledge of new methodologies as well as new subject-matter. From the NNA data, it is clear that for many teachers "sustaining a positive sense of effectiveness to subject, pupils, relationships and roles" (Day et al 2006, p.614) became increasingly difficult as they struggled to address demands of new curriculum and for some their enthusiasm for innovation has suffered. About *half* of all respondents to the NNA referred to 'overload' or 'workload'.

> *Overloaded curriculum and DES Inspectorate or administration has reduced effective teaching time in the classroom*.
> (Res NNA 294)

> *Very little incentive for teachers to undertake extra courses - time/ curriculum overload in recent years has discouraged teachers in this area.*
> (Res NNA 289)

Real concerns with what many teachers perceive as their primary duty - to ensure a sufficiently high standard in literacy and numeracy - were also evident.

> *Science is not a top priority on a teacher's list when there is such a full programme to be taught. Difficulty in trying to cater for all children. Teacher's workload! The hard task of trying to make sure all children can read, write and add puts science in the backseat!*
> (Res NNA 407)

Within any one school, it is possible to have several individuals striving to educate themselves, purchase and organise equipment, prepare lesson plans for the same learning objective while also responding to the multiple demands made by various stakeholders. Each teacher is replicating work going on elsewhere within the same school. The impact of such gargantuan effort has been shown by the VITAE research (Day et al 2006, p.614) to have serious repercussions for stress levels and retention of staff. The following section summarises how I began the process of changing the culture of our schools from one of isolation to collaboration.

9.4.1 Laying the foundations for collaboration - building individual capacity

If teachers are to be in a position to identify weaknesses in their practice they need to engage in very challenging dialogue with their colleagues. In order for challenging dialogue to take place, it is necessary for teachers as individuals to have a very stable sense of self-worth. The process of moving from isolation to collaboration in TS1 and TS2, therefore, began with building up the professional identity of individual teachers as competent, respected individuals. This was done by first of all speaking openly to the entire staff about the findings in the literature and the NNA regarding the uneven treatment of science in the colleges of education and the acknowledgement that the provision of support by the DES was, of itself, insufficient in the light of the degree of need regarding science. In this manner, it was hoped to assuage any sense of individual responsibility for the lack of implementation and to open up the conversation about the needs of teachers generally. When the teachers realised that they were not the only ones who felt under-prepared they were willing to discuss the kinds of support they felt they needed to improve their practice. They were empowered through a year-long programme of support to reconstruct their identities to include responsibility for their own development and the development of the profession. Section 9.5 summarises the reconstruction of identities evidenced.

9.5 Identity Review

Teachers' identities were seen to be reviewed and reconstructed over the course of the programme. The literature on teacher identity/self supports the notion that one's 'identity' is not a fixed state of being but is in fact subject to change in response to "the broader social conditions in which teachers live and work, and the personal and professional elements of teachers' lives" (e.g. Goffman1959; Erikson 1959; Ball 1972 and Nias 1989 in Day et al, 2006, p.602-603). The changes to teacher identity witnessed over the two trials of the WSIS programme came about as a result of changes in how the teachers related to themselves, their colleagues, me, the principal, parents, the children and the subject of science. Teachers not only experienced an identity review individually but also collectively as a staff. The changes in identity witnessed included the following:

- Teachers moved from being apathetic about science to being ‘interested’;
- Teachers felt more confident teaching science;
- Teachers had more regard for colleagues’ contributions to their learning;
- Some teachers’ identities changed from being ‘receivers’ to leaders of CPD;
- Teachers’ perception of staff capacity to address needs improved;
- Principals’ perception of staff capacity improved.

Each of these changes is now discussed.

9.5.1 Attitudes towards science

Some teachers showed evidence of moving from a position of feeling very alienated from science and its teaching to a point where they felt enthused about the subject and open to learning more.

> *I think particularly for the people who didn’t have the confidence, that they have become equipped with the confidence as a result now.*
> (TS1, P1)

This principal’s opinion is confirmed by a class teacher from his own school:

> *…it has made me see, especially in the areas where I wouldn’t be strong, like in Physics and Chemistry, that it’s a lot easier than I thought it was, because I’m looking at it from a different point of view as an adult, ‘oh god this is terribly confusing’… I did not know how to simplify it for myself or for them for Physics and Chemistry, and I think that definitely made a difference to my confidence.*
> (TS1, M11)

Another teacher from TS2, R10, had a similar experience of becoming more confident about science through working on this model of CPD. Her attitude has also changed as she now sees science as 'interesting'.

> *I think it definitely will, just overall my knowledge has improved; I'm more confident, even if I get a higher class now, I think I'd be quite confident teaching it. And it's seeing how it's not that… there is quite a negative attitude among teachers towards science in the class. I'd be more willing now to do a lot more science….I'd definitely do it again, it's interesting.*
> (Interview TS2, R10)

R10's feelings are echoed by R6 who expresses the opinion that "*everyone seems much happier to teach science and more confident about it.*" (Interview, TS2, R6). Even the single 'negative' teacher in TS2 who remained on the periphery of the project throughout, and tried to retain her stance of disengagement, showed signs of being increasingly engaged with what was happening to the staff and children in relation to science. She was one of the most enthusiastic participants in the Science Day which was the culmination of the year's work. Increased interest and confidence teaching science were not the only changes witnessed however. Some teachers also changed from being dependent on external providers of professional development to viewing themselves as potential leaders of CPD.

9.5.2 Improved individual capacity

Over the trial of the WSIS programme, some teachers moved from viewing themselves as recipients of 'in-service' to potential facilitators of CPD for their own staff.

> *Well I certainly would help if I was needed to plan any lessons for any teacher or for the different levels throughout the school, I would, no problem.*
> (Interview TS2, R9*)*

The belief that teachers have the capacity to lead one another in CPD gained momentum over the course of the programme. This created a sense of autonomy and enhanced teachers' identity as problem-solvers, as opposed to being targets of unwanted innovations.

> *N(Leader): Do you think you could apply this model to another subject?*
> *R5: Yeah definitely, because it has just huge benefits, you always have someone in school who's got a certain area where they're good at, whereas others might not feel as confident, so to share that around so that everyone feels more confident about it.*
> (TS2, R5)

M2 (TS1) felt that the model was easily replicated by a staff member, thus indicating a change in her perception of herself and her colleagues from recipients to providers of support.

> *N: Is it something that you could work again in the staff?*
> *M2: I suppose we're all doing lessons every day anyway, so even if it was the case of getting one teacher in to have a look at you and you look at them, you know I suppose in that way, we're doing it every week anyway it shouldn't be an extra workload in that way.*
> (Interview TS1, M2)

Similarly R7 felt that staff capacity was increased when the entire staff was learning together.

> *Well I suppose the fact that we're all learning together, everyone supports each other and makes it easier to do.*
> (Interview, TS2 R7)

Not only did teachers experience change in themselves but they also changed in the way they regarded their colleagues.

9.5.3 Increased value in colleagues' contributions

When teachers had the opportunity to work with colleagues they were seen to re-evaluate their estimation of colleagues' contributions to the educational endeavour of the school and came to the realisation that it was possible to learn from them.

> *I suppose different teachers come at it from different angles. They ask questions that I wouldn't even have thought of. Different approaches I suppose.*
> (Interview TS2 R7)

A new perspective on CPD emerged during the course of the trials, which I termed the 'Needs-Response DIY perspective'. This perspective saw an increased level of self-identification of needs leading to the staff working together to identify possible solutions and directing the development of the programme in the way that would best address those needs. This perspective was seen to emerge towards the end of both trials and indicated a new agency among teachers in addressing their needs. Increased self-esteem created greater *openness* with colleagues.

9.5.4 Openness

The nature of the relationship between participants was found to support or inhibit teachers' sense of themselves as learners. R2 (TS2) was often the first participant to ask questions, even though he was laughed at and ridiculed at times for the questions he asked. The role of 'class fool', which he assumed, allowed others to feel in a position to ask questions and discuss concepts which they found difficult. He created a 'safe' environment in which to reveal misconceptions.

> *Probably it has to do with the fact that I've been teaching for nearly the best part of thirty years....It doesn't bother me to make mistakes or to just say, "I don't know, what are you talking about? Will you just tell me what an atom is and get it over with.*
> (Interview TS2, R2)

R2's openness about his lack of understanding supported other teachers' sense of themselves as learners of science. Not only was R2 enthusiastic about acquiring new knowledge, but, by the end of the year he saw himself as having the capacity to bring about change in the staff through his personal learning:

> *…but if I was to do a topic next year that I found fairly difficult, I would like to give a talk on it. Study it and then give a talk on what I know to the staff, and if other teachers could do that as well, say once a month a teacher would give a talk on something scientific.*
> (Interview TS2, R2)

At the end of the year's trial, R2 seemed to be more confident that the staff had the capacity within itself to address its own shortcomings, which are now not viewed with shame, but rather as a motivation to seek a solution.

> *And if you could have a science club where four or five teachers would come together and work together, there's great potential. Or you could even invite people in; get someone to talk to you about something if you were unsure.*
> (Interview TS2, R2)

R2's belief in his colleague's ability to support each others' development as science teachers enhanced teachers' identity formation as 'agents of change'. The esteem of one's colleagues, particularly that of one's principal, fostered teachers' sense of self-worth and contributed to staff capacity.

9.5.5 Principals' perception of staff capacity

The principal of TS2 started to consider her own potential as a leader of CPD within the school. She also acknowledged her revised opinion that any member of staff could potentially lead a programme of change. In the interview data there is evidence of a change in her attitude towards people's potential as agents of change.

> *N: And about the support maintaining the current levels on confidence?*
> *P2: Yea, I was saying a leader would keep it going, I was thinking about that myself, could I do it, would it possibly be better coming from the staff?*
> (Interview TS2, P2)

The principal identified her improved perception of the staff as the main lesson she had learned from the project.

> *It has really made me even more aware of the potential of the staff…*
> (Interview TS2, P2)

This represented a significant change in attitude towards her staff. 'Bringing staff on board' was a major issue for this principal, as it is for many principals, who struggle to engage staff with their personal vision for their schools.

> *…I now realise that if the opportunities are created, you can bring staff on board and I know this will probably have impact on staff members in different ways but overall it had a very positive effect on the staff.*
> (Interview TS2, P2)

This change in the principal's evaluation of 'the potential of the staff' was noted by the teachers.

> *I saw her looking at me with surprise when I was teaching science and she was really listening when I was conducting the discussion at the end. I really feel I have gone up in her estimation. I think she did not think I had much to offer. It's been very good for me to try something different and it has really improved my status on the staff.*
> (Interview TS2, R3)

That the principal noticed and remarked on this teacher's involvement was confirmed by remarks made by the principal during the interview stage.

> *And people worked together, I thought that was very positive. The thing I liked about it was the learning support teachers were able to*

get involved as well and I think that maybe they all gelled, and I think that had a very positive impact on the staff…
(TS2, P2)

Using the Learning Support and Resource teachers to work alongside class teachers to deliver subjects other than literacy and numeracy was a new departure for this school. The principal felt this contributed to increasing the capacity of the staff as it had facilitated a re-evaluation of the contribution of these staff members to the school effort by their colleagues. Her opinion that "they all gelled" indicates the affective shift which I witnessed among the staff members. The principal's positive response to teachers' efforts contributed in no small measure to the "morale" of the staff (Humphreys 2000, p. 148)

The principal felt that having had the experience of working successfully together to bring about change, the staff would be more inclined to do it again.

So I think you know that happened and I think people probably now would be less intimidated, you know if a group were to get together again, they might say, look, will we try something, you know …'look we tried this last year, but we tried for a time' but it happened once so I think teachers would probably feel a lot more comfortable with trying something again.
(Interview TS2, P2)

The change in the principal's perceptions of some of the staff served to strengthen the individual capacity of teachers whose response was to work even harder to maintain that positive evaluation of their contribution to the school effort to change.

9.6 Creating a Culture of Collaborative Relationships

How does one replace a culture of 'exclusion' and 'isolation' with collaboration? The literature on "Learning Communities" is full of exhortations to be collaborative and to encourage collegiality (e.g. Frankham and Howes 2006, p.618). Unfortunately there is no blue print which shows exactly what such a ‘collaborative’ culture might look like or indeed what the nature of the relationships which comprise such a culture might be. I began this research with a passion for science but only vague, unformed notions about how to translate that passion into change.

Changes in how teachers view themselves, as discussed in Section 9.2, were accounted for by the participants themselves, as a result of changes in how the participants *related* to one another during the programme. These changes were “engineered” by adjusting the kinds of “classroom experiences and organisational culture” (Day et al. 2006) experienced by teachers. Efforts were made to provide teachers with experiences which would build their confidence as teachers of science and as learners. Simultaneously the organisational culture was adjusted gradually so that teachers had increasing opportunities to work together to improve their practice. During this research an effort to promote collaboration was made by enhancing the perceived value of each member of the school community. Individual capacity was developed by providing differentiated provision to individuals. This was determined by basing intervention on individual and school needs analyses and not on the age, constructs of perceived proficiency or role within the community. Individuals were thus empowered to engage with other stakeholders. Figure 9.1 illustrates the various relationships which were felt to impact on the emerging/changing identities of individual teachers. As each relationship evolved, responding alterations in teacher identity were set in motion. The process was idiosyncratic for each participant.

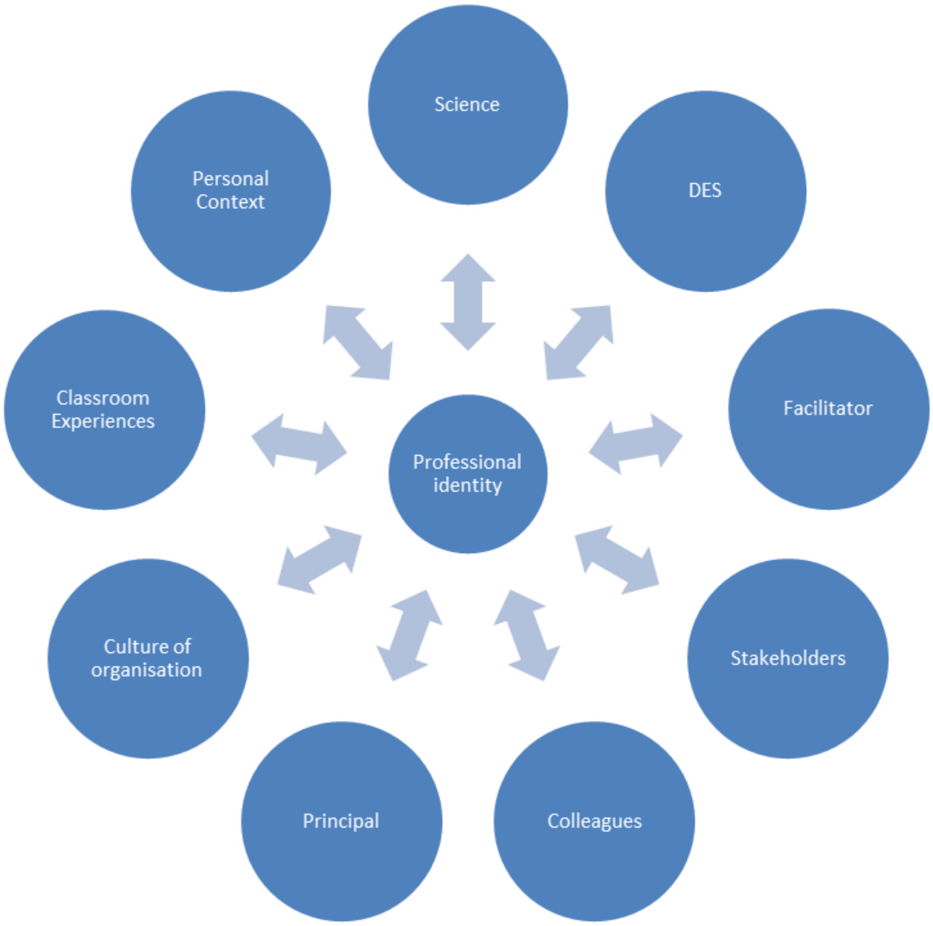


Figure 9.1 Relationships found to impact on Teachers' Professional Identity

Teachers' increased confidence allowed them to gradually become more able to participate in conversations with their colleagues and parents about the school's provision of science. This led to the adoption of a shared vision of science in the schools and to teachers looking to their colleagues for a collective approach to addressing this vision.

9.7 Summary

This chapter began by suggesting that the reason so many reform efforts are doomed to failure is possibly because they rely too much on the effort and motivation of individuals. By contrast, the more successful international models of professional development were shown in Chapter 3 to be premised on a socio-constructive model. This was validated in the data from the NNA in Chapter 8, Section 8.2 which showed that Irish teachers endorse socio-constructive principles of CPD where responsibility for reform is shared collectively. In order to be able to contribute to a shared approach to reform, teachers need to have a strong sense of their individual capacity to contribute to critical debate and mutual problem solving.

I attempted to illustrate that the context of teachers' lives contributes to their identity as professionals. The significant relationships in their working lives with the DES, the principal and their colleagues have been shown to either support an identity which is powerful and imbued with a sense of shared responsibility for the development of the profession or an identity which feels isolated, powerless and individually overwhelmed by the enormity of the effort to reform. The chapter outlined the kinds of identity reconstruction that were witnessed over the period of the trials of the WSIS programme. These new identities included: increased agency; improved attitudes towards science; improved individual capacity; increased value in colleagues' contributions; improved principal's perception of staff capacity; increased ability to participate in the conversation about science in the school and about the school's implementation of the 1999 curriculum.

As teachers increased in confidence they were better able to engage with other stakeholders and suggest ways of addressing their perceived needs in the area of science, i.e. increased individual capacity empowered teachers to adopt a collective approach to their mutual problem of implementing the 1999 science curriculum. Teachers' increased ability to engage with their colleagues regarding the science provision within the school increased the amount of positive feedback they were likely to receive from their peers. This boosted their new-found confidence, not only in teaching science but also in their ability to demonstrate agency and to contribute to the school's collective efforts. My interventions, therefore, set up a symbiotic relationship between individuals and the school which boosted the capacity of both. Chapter 10 describes how opportunities were created to foster relationships supportive of increased individual and collective agency within the trial schools.

CHAPTER 10

BUILDING COLLECTIVE CAPACITY

10.1 Introduction

Chapter 9 described how my interventions in the trial schools set in motion a process of identity reconstruction among participants. I then sought to develop relationships within the schools which would lead to (a) a commitment to the school goal of improving the provision of science and (b) a collaborative way of working towards the fulfilment of that goal. The approach adopted consisted of:

1. Increasing individual capacity by increasing confidence and self-esteem;
2. Creating opportunities for teachers to talk together by giving them a common language and by having the same focus topic throughout the school;
3. Creating interdependence among teachers by introducing Team-Teaching.

Figure10.1 attempts to represent how the relationships between participants contributed to increasing commitment to the common goal of improved science.

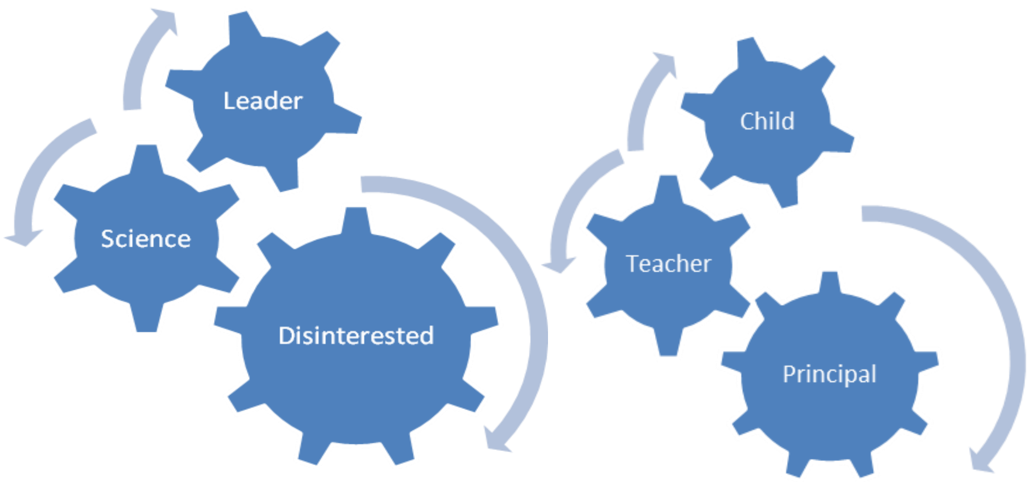


Figure 10.1 Interlocking Relationships of a School Community

This chapter begins by considering what appears to be a common problem for principals - getting teachers to buy into their vision for their schools. I then consider the role of dialogue in developing relationships in the school community. The chapter concludes by considering how increased interdependence among the various stakeholders laid the foundation for a more collaborative way of working towards achieving improved science in an entire school.

10.2 The Elusive Common Vision

The principal of TS1, along with the members of the staff who had participated in the UCC diploma in primary science, wanted to improve the provision of science across the entire staff but did not know how to go about it. Similarly, the principal in TS2 had a personal interest in science and was aware of the teachers' needs but was unsure (a) how to proceed in terms of alerting teachers to her perception of their need in the area and (b) how to address this need.

The value of a common vision to the success of in-school CPD programmes is well accepted in the literature (Mullen and Hutinger, 2008 p.3). However, many principals expressed their difficulty engaging staff with their vision for the school.

> *Science is being seen as an extra burden by many teachers who need more support, help and information about its teaching. What a pity!*
> (Res NNA 447)

The experiences at both Trial Sites show how dialogue might enable principals/ leaders to begin the process of engaging teachers with their vision and forging the kinds of relationships which would support the social interaction necessary to construct knowledge (Applefield, 2000/2001, p.35-53 discussed in Chapter 3).

The entire WSIS CPD model hinges on dialogue and I believe the culture of TS2 would not have undergone the metamorphosis it did, had the discussion and reflection been confined to individuals with the researcher. It was essential for the success of the project that conversations about the project involved as many stake-holders as possible. All the respondents to the NNA and teachers at both Trial Sites indicated that the opportunity to discuss their teaching and learning was something which they valued highly. P1 was very clear about the need for reflective dialogue but also about the major difficulties this posed for him as the manager of the school.

> *If those two or three teachers could meet once every few weeks to kind of discuss progress, to plan, it would enhance their professional development and what they're doing but* ***I don't think there's time in our school day to allow for that and we're not given time by the department to do it..(****it's something that's missing really)****...from the system yeah****.*
> (Interview TS1, P1)

P1's commitment to reflection was, however, ambiguous as he did not open up the conversation about how time could be found for such reflective dialogue. He placed the responsibility for the non-allocation of this time with the 'department' or the 'system'. This may be a manifestation of the disenfranchisement associated with DES mandated CPD (Chapter 9, sections 9.1 and 9.2) i.e. the lack of agency addressing perceived problems. Every teacher at TS1 bemoaned the limited amount of time available to engage in reflective conversations. It became obvious from the lack of negotiation in TS1 that it would prove impossible to get more than one or two teachers together at any one time. This meant that larger discussion groups could only be managed outside of school hours. Securing commitment from teachers to engage in this reflective discussion outside of school hours was an obstacle which I did not succeed in overcoming. When asked if she has enough time to discuss the project with her colleagues, M6 responded...

> *No, I really only discussed it with you, I didn't… and M5, that was it.*
> *(Interview, TS1, M6)*

Although I had greater success facilitating discussion at TS2, most interviewees still felt they would have liked more time to reflect on their work with their colleagues.

> *But like I mean, I did get a chance to talk to others about it in the small group meetings, definitely we got a chance to talk about it but it would be nice if there was kind of more time.*
> (Interview TS2, R6)

In one interview, R2 indicates his perception that increased dialogue with colleagues would not only benefit teachers but would also impact on student outcomes. This reflects a move away from individual to increasingly collective responsibility for the learning in the school.

> *In retrospect now, I would have given ten minutes at the end of every lesson for each teacher's input and what teachers observed and it would be good for other teachers maybe as well because you'd be able to write down if some children went from my table to the next table, what they brought from my table to that table.*
> (Interview TS2, R2)

R2 in this interview was actively attempting to find a way to use discussion to build collective capacity. In fact, this is the methodology which we ultimately employed for all Team-Teaching sessions. While a parent or SNA supervised the children's recording or tidying up after the lesson, the group of teachers met to discuss their impressions of the learning. One teacher recorded this review and relayed the information back to the planning group which used the data thus gathered to inform the next planning session. While there was consensus about the value of dialogue in supporting teachers to change, the nature of that dialogue took different forms for different groups.

10.2.1 Coaching vs. mentoring

“Coaching is usually focussed professional dialogue designed to aid the coachee in developing specific professional skills to enhance their teaching repertoire” whereas mentoring is usually associated with “significant career events” where “the mentor is almost always someone more senior in the organisation”(Lofthouse, Leat and Towler, 2010, p.7).

Prior to embarking on trialling the model, I had thought that coaching would form a central support of the entire project. With this in mind I trained as a coach in the National Science Centre at York University in the UK. However as the trials of the WSIS model proceeded, this assumption had to be reviewed as it became obvious that the majority of the teachers I encountered were not yet ready for coaching but, in fact, needed to be mentored. The primary difficulty was that teachers were not yet in a position to ‘create measurable goals’ (van Nieuwerburgh, 2012) in the area of primary science. The teachers whom I encountered had insufficient scientific knowledge and initially were not very motivated to improve either their knowledge or level of implementation of science. All but the three teachers, M9, M7 and M11 in TS1, who were already participating in the UCC diploma, were unconcerned about their inadequate provision of science. This is not that unusual as the following comments from respondents to the NNA suggests.

> *Science is only one of 13 subjects I teach. I don't need to be a scientific expert to teach it so general teaching-related in-service would suit me best.*
> (Res NNA, 258)

This reflects what seemed to have been a common lack of appreciation of the depth of knowledge and understanding required to teach science and was echoed by the many respondents who claimed to be well able to teach science to the junior classes but not to the senior classes.

> *Feel quite under-qualified particularly when teaching older classes experiments*.
> (Res NNA 60)

By contrast, those with a background in science are more aware of the demands placed on teachers without such a background.

> *Teachers who have been trained before the new curriculum have been expected to absorb the same amount of knowledge as their colleagues in a very short space of time. Having sat in science lectures myself and having had plenty of time to prepare to teach science as a subject I can see the difficulty that these teachers face after attending a 'crash-course' on how to teach each strand to children.*
> (Res NNA 174)

The Irish primary teachers encountered during this project could be described as being at a pre-service stage of ability with regard to science teaching compared to their level of proficiency in any other subject.

> *On a personal level I would prefer if someone else on the staff did the course as I feel science is not my strongest subject.*
> (Res NNA 402)

It was seen in Chapter 6 that science is the subject which teachers, almost unanimously, feel least confident teaching. Many of the teachers interviewed during the trial of the CPD model confessed to "avoiding it altogether" when possible.

> *It is probably one of the subjects a lot of teachers neglect (from hearsay, comments from colleagues).*
> (Res NNA, 271)

Where obliged to implement it, many would use what Goodnough (2008) terms "low-risk approaches" to its teaching i.e. workbook-based, transmission mode lessons which did not include any effort to implement constructivist philosophies of learning or investigative/enquiry lessons.

Due to the inexperience of the majority of teachers in the two pilot schools with regard to teaching science and the absence of both scientific understanding and pedagogical content knowledge, it was considered that to begin with, mentoring might be of more benefit to these teachers. The teachers were novices in preparing and teaching science lessons and needed far more scaffolding than had been anticipated. The primary difficulty arose because they did not have a sound understanding of the target concepts (Forces and Materials) and did not have a sense of how best to develop those concepts in the children. They found it difficult to assess children’s prior understanding of the concept as they themselves were unsure what it was they were looking for. They needed support in designing appropriate assessment tasks and in interpreting these. Eventually I designed a check-list in order to facilitate their efforts to profile their classes’ level of understanding (See Appendix XXVI). They lacked ideas for lessons initially and needed a lot of support designing lessons. The first use of dialogue in the WSIS CPD programme, therefore, consisted of a series of mentoring conversations with teachers. I then attempted to move the conversation forward to encourage teachers to reflect on their progress.

10.2.2 Reflection

It was observed that many teachers interpreted ‘Reflection’ as a need to find something negative about the lesson to discuss. R9’s comment "But sure you see yourself in a way, in the classroom what went wrong...." indicates this common misunderstanding of assessment. When a particularly good lesson had been experienced teachers enjoyed recalling it for each other but more often than not the emphasis would be on the difficulties which had arisen. This preoccupation with the negative is evident in R7’s comments.

We would have always said, this didn't work if it didn't work...We did analyse what went wrong, but I think we didn't analyse what went well.
(Interview TS2, R7)

This point which R7 (TS2) makes is important because it is one of the key lessons of the entire project - developing and sustaining the self-esteem of teachers. It seems that it is common practice to highlight the negative aspects of practice whereas it is not as acceptable to publicise the successes. If successes are not celebrated the whole endeavour can become an endless cycle of demeaning negativity. Because of the use of video recording it was possible for us to review lessons together and identify the positive aspects, of which there were many. Teachers were often so absorbed in getting through a lesson that they lost sight of the learning that had taken place.

You know it's nice to be able to look back over the lessons; like you'd hate looking at yourself ...but I thought the lesson went well in that I think I achieved the majority of my objectives-...
(Interview TS1, M9)

This need for feedback is difficult to meet where the organisational structure consists of individuals working in isolation from one another with few opportunities to meet. I attempted to create opportunities for teachers to review work in groups as well as individually.

10.2.3 Small group vs. individual reflection

Retrospectively, I believe that an experience of both individual and group reflection is essential to getting maximum benefit from the WSIS CPD model, as it gave rise to both "self and peer confrontation" (Leitch and Day, 2001, p.257). It was observed that the more time teachers spent in group reflection, the more likely they were to individually seek out help and to commit personal time to reflection.

We did, we did quite a bit of discussion now in fairness. Either with you or in the small groups ourselves and there was plenty of notes

available to us as well so I would have said there was plenty of time and there were staff meetings as well.
(Interview TS2, R4)

The trials of the WSIS programme indicate that individual and group reflection opportunities are symbiotic, in that group reflection served as a stimulus for individual learning, and increased proficiency at an individual level increased the capacity of the group.

10.2.4 Composition of groups

Initially the groups at both schools were based on class level groupings. R4 emphasised the importance of the smaller group meetings as these were more focussed on individual needs.

> *I'd say the small groups* (were better) *because with them you're planning towards your own level as well so probably better to be sticking within the… you know, 3rd, 4th, 5th, 6th and so on because I don't know would you know, it's probably more time consuming with the whole group of us as opposed to being fairly specific and working towards our own levels.*
> (Interview TS, R4)

These comments indicate the awareness of all teachers that the time devoted to CPD be as efficient, productive and practice-specific as possible. R6 (TS2) concurs that she preferred the smaller, more intimate meetings as she found them more tailored to her own specific needs.

> *I suppose the Team-Teaching and the small groups were the most beneficial because the small group was very focused on what I would be doing with my class level and then the Team-Teaching was just superb for the kids, you know with management and they all got to do so much more than they normally would in one class.*
> (Interview TS2, R6)

The other point raised by R2 and R4 was that in terms of developing scientific knowledge**.** It was easier to ask questions to clarify your understanding in the small groups as opposed to the whole staff setting.

> *Yea because, I think when you learn anything, I think when you're in a big group, you can tune out very easily like as well, so it's a lot more effective in a small group....Yeah, I suppose it's easier to ask questions I suppose too in a smaller group rather than a bigger group. It's like teacher-pupil ratio.*
> (Interview TS2, R4)

Teachers themselves decided the composition of the groups. Because the same topic was being taught throughout the school at the same time, it did not matter which group anyone 'belonged to'. Teachers therefore met with people they felt comfortable with. Meeting in these small groups spawned another form of discussion, arguably the most valuable of all that had taken place during the project – informal discussion. Teachers became aware of differences of opinion regarding the scientific explanations through the informal discussions which followed the group meetings with me. Often groups of teachers would ask me to stay behind after school to talk through some of their differing misconceptions. The increasing ownership which teachers took of their learning spawned informal conversation around the topic of their learning.

10.2.5 Informal discussion

Information was distributed during this project in a variety of ways but the indicator of the success of the project, I believe, is the extent to which the project became the subject of personal discussion. It is this on-going discussion that took place in all kinds of informal settings which sustained the project in TS2. This view of the contribution of informal dialogue is supported in the literature.

> According to socio-constructivistic learning theories (Duit and Treagust, 1998), knowledge emerges by collaborative search of problem solutions in communities with distributed information among its members.
> (Bell et al. 2010, p.351)

Science and the WSIS CPD programme transcended the boundaries of the project and became an acceptable topic of discussion whenever colleagues met. This indicated the degree to which teachers had identified with the goals of the project and assumed them as their own. The level to which science had begun to dominate topics of conversation in personal time is reflected in R8's comment when asked if she had enough time to discuss the project with colleagues. Her response was:

> *There was an awful lot of it all right* **(talk about science**), *see again when science isn't really my thing, it wouldn't be something I'd be very excited about doing, whereas if it was geography I would be delighted to have that going all year, or history, I love history as well, for somebody who likes science, I'm sure it didn't bother them at all but* ***there was too much talk about it.***
> (Interview TS2, R8)

While R8 was initially antagonistic towards the programme, she was carried by the enthusiasm of the rest of the staff and continued to be informed about what was going on because of the transfer of the topic into group conversations which took place in informal and unexpected settings.

The strength of the WSIS model lay in this shared experience and it was an element almost impossible to plan for, as it happened in people's own time and at their own instigation. What could be engineered was the confidence of individuals to engage in such informal discussion of professional goals.

10.2.6 Enlarging the school community

From the literature it was considered that a model of professional development had the best chance of success if as many stakeholders as possible could be included in the effort (Borman et al. 2005). My awareness of the untapped potential contribution of parents to the educational process in Ireland led me to offer evening classes in science education to parents and to invite them to participate in the delivery of lessons. This was done in an effort to broaden the range of people in the school community who would be aware of and supportive of the drive to improve science provision in the school. It was felt that when parents were aware of the efforts of the teachers, and were empowered through their own education to initiate and sustain discussion of the project with both the children and teachers, this discussion could be a source of support to teachers. Similar sentiments attended my invitation to the auxiliary staff in the school to attend the whole staff science education days. It is considered that the extent to which the professional development in TS2 was inclusive accounts for the very positive feedback from all parties concerned.

> *This was my first time being involved in an educational programme in the school. It was great to get a better understanding of what the children were learning in school. It meant we could look stuff up at home - I loved the experiments. I had never done science in school so I found it really interesting.*
> (Interview TS2, Parent)

Similar efforts to involve parents in TS1 were strongly resisted by the principal, which may be attributable to the tradition of an uneasy relationship between teachers and parents (Byrne and Smyth 2011, p.2) "Active participation" (Government of Ireland1995, p. 4) of parents became very acceptable during the trial of the WSIS model of CPD in TS2 and, by the end of the year, parents were teaching science lessons alongside class teachers. The potential of including parents in a more meaningful way in school- life became more apparent to the principal and approaches were made to her by parents to extend this innovative way of working together.

> *And actually one parent came to me there now the other day and she was asking me now could we run a similar project for Gaeilge and she could help, she asked me, well I do think that was a spin off from your project.* ***I see now what an enormous asset parents could be to the school and even in terms of supporting our own professional development.***
> (Interview TS2, P2)

The decision to allow parents a role in the evaluation of teachers (Murray 2010, p.2) indicates a lack of awareness about the need to cultivate supportive relationships of trust among all parties. The evidence of this research suggests that a more productive way of fostering positive, supportive relationships between teachers and parents would include involving parents in a more active role in the education of their children.

Broadening the forum for discussion and reflection was seen to be a valuable process by which relationships among stakeholders i.e. teachers, SNAs, parents, local businesses (the hardware stores!) were improved. It became impossible to avoid the topic of science as everybody was talking about it!

In order to strengthen these relationships, I attempted to devise a means of increasing the level of interdependence among participants by which I hoped to foster "true collaborative ways of working" Bell and Gilbert (1996, p.35). When teachers were relying on others to teach a concept which was fundamental to understanding their own target concept, teachers had to be sure not only of their own understanding but also of their colleagues' understanding. This meant that each individual had a vested interest in their colleagues' development. Section 10.3 recounts the steps taken to create interdependence among the participants in TS2.

10.3 Creating Interdependence

Many months were spent helping teachers, either individually or in small groups, to plan and teach science lessons. This preparatory work involved giving teachers an experience of success at an individual level thus increasing confidence. Increased confidence allowed teachers to engage in conversations about the process and so strengthened the relationships among the various stakeholders. Having witnessed the difficulties experienced by teachers in TS2 trying to organise and conduct science lessons in isolation, it was considered essential to find a way whereby teachers could mutually support one another to provide improved science lessons.

From the needs analysis and my own observations, teachers seemed to feel isolated in terms of access to equipment; sorting out the resources and materials necessary for science lessons; trying to understand the target concepts which, prior to the WSIS programme they had to research for themselves; trying to implement a 'constructivist' methodology and potential difficulties with managing investigative work in the classroom. Extended contact with teachers further illuminated the areas of science education which were problematical for them.

Steps were taken to address teachers' expressed needs by:

1. Guaranteeing teachers that I would take responsibility for organising all equipment needed; photocopying, resources etc. and eventually support teachers to jointly find a way to eliminate this source of stress;
2. Providing specific training for everyone in the identified target concepts i.e. Forces and Materials;
3. Providing individual support for individual teachers' understanding and confidence with 'constructivist' methodologies through a system of modelling, mentoring and/or coaching;
4. Providing opportunities for teachers to meet to share their successes and difficulties;
5. Providing specific training for parents in the target concept;
6. Creating opportunities for parents to support teachers' provision of science education;
7. Working alongside teachers as an equal contributor.

After nearly two terms in the school, work was still being duplicated throughout the school and teachers were still doing a lot of individual accessing of equipment, resources and work sheets. Teachers, although involved in jointly teaching science lessons (usually in pairs or threes), were still only teaching at their own level of the school and had not moved out of their comfort zone. In order to create opportunities for increased collaboration across all levels of the school, it was felt necessary to manipulate situations of interdependence among the entire staff. To this end a system of 'Team-Teaching' was introduced to the school for the final term.

10.3.1 Team-Teaching

Team-Teaching involved lessons being taught jointly by five adults (teachers, parents or SNAs). Each of the five facilitators had sole responsibility for one sub-section of the entire lesson. All five, however, were responsible for the lesson as a whole. It was essential to the group effort that each teacher clearly understood his/her target concept or sub-concept and how it contributed to the target concept. This led to group commitment to supporting each other's learning. The 'Team-Teaching' lessons would not have worked if there was a weak link in the chain of mini-lessons which comprised the whole lesson. Reaching the point where teachers could work through their understanding with their colleagues and seek help from them involved a year's work.

Through the creation of lessons which involved multiple participants working together to contribute, equally strengthened relationships among the participants. It is to these relationships that teachers attribute the changes in how they viewed themselves and other members of the learning community. This conclusion is supported by the findings of Fiszer (2004) who claims that "in a dynamic environment where there is purposeful conversation regarding professional practice, a bond is built that is greater than the single efforts of any individual. Yet this synergy needs to originate in a trusting environment" (Fiszer 2004, p.31). Section 10.3.2 describes how this "trusting environment" was cultivated in the school prior to establishing 'Team-Teaching' in TS2. Firstly I reflect on how trust in the facilitator was cultivated.

10.3.2 Fostering trust in the facilitator

The necessity of establishing a relationship of trust with participants was not something which I had articulated prior to beginning the programme and, it was only as the programme progressed, that I became aware of the absolute necessity of such trust for the programme to succeed.

> *I realise now looking back that it was a year's journey to this point where I can, almost at the drop of a hat, say to a teacher – "are you free at 11.30am to help out?" It took a lot of work to build up **the trust and the relationship** where I can say that without intimidating or alienating them,*
> (Journal entry, 28th May, 2009)

This was one of the most important lessons learned over the year and it can be considered valid as I was not consciously aware of the need to establish the correct relationship at the outset. I had to work initially to be accepted as a member of the staff. This was done predominantly in a social way and, I initially earned respect by getting to know my colleagues on a personal level, and taking an interest in their lives.

I had to develop a relationship with the staff where they could trust me not to undermine their identities as competent professionals. The fact that every step of the project was negotiated and re-negotiated with all interested parties, and that no coercion of any kind was used, combined to create a relationship of mutual respect and trust. The staff was not manipulated by the researcher, however, a process evolved in a natural and unforced way from my membership of the staff which allowed teachers to commit to the goals of the project.

> *Well this is it I suppose; they came on board - maybe some people were very enthusiastic from the outset but, well it kind of grew on other people. I just think you won over the staff.*
> (Interview TS2, P2)

Once trust had been established it was possible to work towards developing "mutual understanding of specific goals" (DfES, 2003). Participation in a whole school programme where everyone worked on the same theme at the same time opened people's minds to the potential to learn from each other and also to teach each other. R7, in reviewing the merits of working with the entire staff at one time felt that the 'whole school' nature of the programme helped to get people 'excited' about the programme and facilitated new ways of relating to one another.

> *N: Was it too ambitious to attempt to get the whole staff involved?*
> *R7: No, and I think you succeeded very well, I think the whole staff did get involved and everyone was excited about it as well.*
> *...I think the way the whole staff were so involved with the Team-Teaching as well that it gave us the chance to get to know each other, if only half the staff were involved, then we wouldn't have had the same relationship.*
> (Interview TS2, R7)

It became much more acceptable for teachers to go into other classrooms and to participate in teaching other teachers' classes. Teachers became less 'territorial'.

> *It was a good idea I suppose from the fact that you could go into another class and kind of see what they're doing or how much further up they've gone on.*
> (Interview TS1, M8)

Some of the benefits of collaborative work expressed were as follows:

> *Yes,* ***you have more in common with the staff*** *and there's* ***more to talk about****, you know? It's just something that you know* ***you can share as a staff and it's good for planning as well.***
> (Interview TS2, R5 emphases added)

Teachers came to realise how much they had in common and that they had underestimated some of their colleagues and their potential to contribute to the school endeavour.

> *Actually I think what helped most was watching other teachers teach. Do you know to bring that back, because I suppose, I haven't formed as a teacher properly yet. I suppose getting hints from everyone, how to do such a thing and…*
> (Interview TS2, R7)

It was clear from my experience as a member of the staff at TS2 that the prevailing work culture was that of disparate individuals working in isolation from one another. Team-Teaching opened participants' minds to the potential of a more collaborative way of working.

10.3.3 Staff as a network

A sharing of expertise was found to be effective because each member of the staff of TS2 could demonstrate his/her strengths and thus experience the affirmation of colleagues. This created an atmosphere of mutual respect and allowed each one to feel valued for their unique contribution to the entire school. This created an atmosphere of mutual respect and allowed each one to feel valued for their unique contribution to the entire school. It also created openness to learning from one another and facilitated frank discussion of difficulties encountered.

> *You do learn a lot, even just by… like it would kind of help you for teaching every day, not just for science, just like classroom control, and group work and watching other people deal with that kind of thing.*
> (Interview TS1, M12)

Teachers generally are aware of the potential to learn from colleagues as is seen in responses to the NNA, but this enthusiasm is insufficiently exploited.

> *Greatest benefit was meeting & talking to other teachers.*
> (Res NNA 67)

Similarly a sense of sharing similar difficulties can be supportive when everyone is felt to be sharing the same problem which could potentially lead to a shared seeking of solutions.

> *All teachers in our school have difficulty implementing science curriculum due to large numbers and lack of space and overcrowding.*
> (Res NNA 23)

Sourcing ideas, accessing, storing and managing equipment as well as managing a practical class was 'too daunting' for individual teachers from TS2.

> *Whereas if you were trying to do it on your own, it's too daunting, I think it would nearly turn you off doing it. Because there's so much to do and you get tired from it very easily.*
> *(Interview TS2, R6)*

When teachers were supported to work together to solve mutual problems, perceptions of one another changed and people became more aware of their colleagues' contributions.

> *...we learn more from fellow teachers than we give credit for, but sure it's not something I suppose that our teaching system helps.*
> (Interview TS2, R4)

The dynamic among the staff at TS2 was observed to experience a significant shift in focus away from individual work to a shared approach to learning and teaching. Section 10.3.4 outlines how the principal viewed this change.

10.3.4 Principal's perspective on how dynamic among staff changed

It would appear from responses to the NNA that principals in Ireland tend to lead from above rather than from within, by distancing themselves from the need for CPD (See Chapter 9). The principal at TS2 acknowledged during interview that she perceived the leadership model of the WSIS programme (which was based on encouraging teachers to assume leadership) to be more effective than her efforts to lead on her own.

She came to an appreciation of the importance of listening to people when trying to engage teachers with her aspirations. Prior to, and at the early stages of the project, P2 at times resorted to coercion which met with considerable resistance. It was not that teachers did not engage with her vision, but rather they resented the manner in which it was imposed rather than negotiated.

> *I suppose then, the biggest challenge then is to get the balance, between on the one hand, having the vision and having a picture in your head of where you want to go and then being realistic then about what is possible and it's all about getting people on board.*
> (Interview TS2, P2)

In this statement it is clear that P2 is trying to analyse what made the project work. She seems to be coming to the realisation that it is insufficient for her to have a vision without taking into consideration teachers' views of this vision. This change in approach is evidence that the principal herself experienced change through the programme.

> *Yeah, I was saying a leader would keep it going, I was thinking about that myself, could I do it, would it possibly be better coming from the staff?...I think it might.*
> (Interview S2, P2)

It appears from the principal's interview that she is aware of a change in the way people relate to one another on the staff and refers to the 'morale' of the staff. I would rather call it the relationship between individuals which eventually provided the basis for a negotiation of a 'vision' which balanced the principal's needs and the staff's needs.

> *Yea, I think that maybe too the fact it definitely did change the, well I won't say the morale of the staff, but do you know the way people who wouldn't have been used to working together. You know, the whole idea of four teachers coming in and five teachers coming into one class, is just, I mean maybe two, but not five, to do something.*
> (Interview TS2, P2)

When asked about what she has learned from the project it is clear that her perception of the staff has changed.

> *I suppose two things, it has really made me even more aware of the* ***potential of the staff*** *and if the opportunities are created, that* ***you can bring staff on board****.*
> (Interview TS2, P2)

P2 has reflected on the factors which allowed the potential of the staff to be revealed and she assigns credit for the change to the personality of the leader:

> *I know this will probably have impact on staff members in different ways but overall it had a very positive effect on the staff but I do still think a lot of that is down to you. It's just the person that you are and you have a wonderful way, you're a wonderful people person, not domineering because I don't think that would've worked. And that's the thing about any project, any initiative that you start,* ***it's getting people to buy in.***
> (Interview TS2, P2)

It is not however accepted that 'personality' is the determining factor in 'getting people to buy in'. Rather it is the nature of the relationships among all participants which facilitated the creation of a 'mutual vision'. When participants were given ownership of their own learning which was directly related to their professional needs, they responded by assuming responsibility for the process and outcome of the learning.

P2 attempts to define the nature of the relationship between the facilitator and the teachers in her use of the term "people person". She also used phrases such as "bringing people on board"; "not domineering"; "getting people to buy in"; "didn't force anybody". These all reflect the nature of the relationship which she perceives as being the defining driver of the programme - one of mutual respect with both partners of the relationship equally "powerful".

> *And I just thought you yourself were a wonderful model of leadership, I say that in all sincerity…, you were so practical, so down to earth, you just seemed to have that enthusiasm, that love of teaching and learning and that was wonderful but I definitely felt that as a model you were a wonderful role model for leadership, at anything really, you came into it, you didn't force anybody.*
> (Interview TS2, P2)

The principal has mistakenly attributed the success of the programme to the personality of the facilitator rather than to the equal distribution of leadership and responsibility. Like Frankham and Howes (2006), I "argue that it was in working at and through relationships that I began to play a part in developments in this school". I had credibility due to prior experience as a primary school teacher and my obligation to teach in the school alongside the other members of staff. The relationship was non-threatening because I was a member of staff and therefore "part of the culture and the changing culture of the school" (Frankham and Howes 2006, p. 620).

While it is to the group dynamic that I attribute whatever positive results were achieved, I acknowledge that my "interventions were a crucial element in the action of the action research" (Frankham and Howes 2006, p.623).

10.4 Relationship Building

Teachers who participated in the WSIS programme were seen to review their 'identities' and how they viewed their colleagues over the course of the programme. The process was predicated on securing commitment to 'a common vision' which meant that the initiation process took considerably longer than anticipated. Retrospectively, allowing time for people to choose (a) whether or not to participate (b) the focus-topic and (c) the nature of the support required, all acknowledged people's desire "to be able to run their own lives, to make choices unrestrictedly…without coercion" (Wubbolding 1991, p.20), and contributed to the participants' relationship with me and the project. The following factors facilitated the development of the trust necessary for teachers to engage fully with the programme.

10.4.1 Differentiation

Each individual had the personal freedom to opt in or out. Each individual could choose whom they worked with, where and when. Everything, apart from the whole staff education programme and meetings, was negotiable. All suggestions and contributions were publicly acknowledged and valued - even those with negative connotations. When something was not successful I took responsibility. This openness led to a very real trust of one another and allowed teachers to share their aspirations with one another. Once this sharing of needs and aspirations became established, allegiance to the project became normalised.

> *I think I can count on what I have done so far as preparing the ground by developing my relationship and acquiring their trust – it would be a natural progression to now intensify that relationship and try to prove that the coaching relationship is a viable way to develop people's capabilities within the school day*.
> (Journal entry, March 2009)

Teachers no longer sought me out discretely but felt sufficiently safe to speak openly about how they were experiencing the project.

> *Today was quite a productive one and my relationship with the teachers is improving all the time with each successful lesson as the teachers are happy to see me coming with ideas and they are willing to come to talk to me which is wonderful.*
> (Journal entry, January 2009)

It was no longer a matter of shame to be seen staying behind after school to get advice on an upcoming lesson.

> *R7 has been squirreling away very independently...She is also happier to work more independently once she has sorted out ideas with me. She had an informal coaching session with me while standing in my room. We were on our way home!!*
> (Journal Entry, January 2009)

Teachers changed from being protective of their social time together to offering it as an opportune time to meet with individuals or groups.

> *R7asked me several times this week to give her some time to prepare final lessons on Forces and R5 likewise. They are anxious to do it together which is good and eventually we had to plan for a before-school session – only time to suit us all.*
> (Journal Entry, March 2009)

Those who happened upon these meetings shared enthusiastically in the work. I facilitated anyone who sought to meet me regarding time, place and constituents of groups. This flexibility allowed teachers to tailor the meetings to their own needs. What was common to all meetings, however, was the trusting relationship.

> *I see now that it is unreasonable to expect an experienced teacher to perform (as they would see it) for a stranger, particularly in a subject with which they are not confident. Time spent developing relationships is a factor I had not considered before, but see now that trust is essential to this model, and it takes time to develop this trust. Also the old adage of "success breeds success" is evident as the teachers are hungry for more ideas as their classes go well and they themselves grow in confidence.*
> (Journal Entry, February 2009)

Essential to the development of trust was providing equal access to all support systems available.

10.4.2 Equality of access

The futility of accessing individual professional development without any means to share this education with one's colleagues was reiterated many times throughout the research. The view that everyone should receive 'equal training' is confirmed by the following respondents to the NNA.

> *I'm sure many teachers have missed training due to illness/mat leave etc. There should be a catch up system in place. Also some courses have only been available to one teacher per sch. Every teacher needs equal training.*
> (Res NNA 382)

Teachers involved in the trial of the model in TS2 valued the whole school approach because everyone received the same opportunities:

> *I think the big mistake you would make is if* ***you*** *decide who should be able to participate...the way you presented it and the way you made it so attractive, you gave everybody the opportunity to take part.*
> (Interview TS2, R2)

When everybody was offered the same opportunity teachers' perceptions of the leader as a facilitator rather than as an 'auditor' were enhanced. To select individuals would have been perceived as a value judgement..."*Every teacher needs equal training"* (Res NNA 382)... and the support from their colleagues would have been less effective.

> *Being able to come back and discuss progress would be motivating.*
> (Res NNA 326)

This motivational factor signals the value of targeting the entire school over an extended period. Engaging as many people as possible in pursuit of a mutual goal and, by providing the same degree of support to all, created a cycle of 'conversations' which in turn provided motivation for the disengaged to opt in. It is, I propose, these conversations which bridged the 'gaps' between various groups of people. Because we chose to pursue the same topic throughout the whole school at the same time, and because all participants had the same opportunities to improve their practice, people had much more in common. People talked about how they found the whole-school workshops; how they found teaching with me; what they thought of the lessons I modelled, etc. Teachers were going through a shared process, albeit in slightly different ways and this provided fertile ground for subject-specific conversations.

10.5 Summary

If the WSIS CPD model can claim any success, it must be attributed to its 'Whole-School' nature. The locus of power changed over the year from the researcher/principal to individual participants working together as a team. What facilitated this shift? Teachers whose ability and capacity were acknowledged, and who were given control over the nature of the support they received, were empowered to review their own potential as agents of change.

Interdependence among staff members facilitated the reconstruction of culture within the school, where all stakeholders moved from clearly defined roles which had no overlap, to a situation where all stakeholders became co-workers striving equally to achieve a mutual goal. Teachers were facilitated to review their sense of agency because it was possible to achieve this 'power' without conflicting with the need to belong to staff or even 'clique'. A cooperative way of teaching became an accepted way of working with colleagues, making it a safe option for these teachers to opt into the CPD programme and, even go so far as to visualise themselves as leaders of similar programmes.

The fact that much of the work was achieved within the school day meant the programme did not lead to conflict with family needs and therefore freed teachers to make the choice to opt in. There did not exist within the programme any hierarchy, with all teachers' contributions being equally acceptable. Such acknowledgement of the value of individuals' input may have been a boost to teachers' self esteem. The length of time available for the project was considered by participants to have had an influence. This is echoed in the literature (See Chapter 2, Section 2.5.2).

The process of moving from observing a series of modelled lessons to planning, teaching and reviewing a series of lessons with colleagues; taking total responsibility for one fifth of a Station lesson, before finally teaching individual science lessons while engaging in ongoing science education, provided a framework of creating increasing independence in the teachers. Improved relationships among participants led to teachers pairing up, or forming small supportive groups for which they increasingly took responsibility, which allowed a culture of collaboration to become more commonplace. This increase in the assumption of responsibility and leadership was a consequence of membership of collegial learning communities (See Chapter 2, Section 2.5.2).

The broadening of the school community to include SNAs, parents and interested businesses served to increase the support available for the change effort by widening the forum for discussion (See Chapter 3, Section 3.6.3). This represents a major shift in CPD which has traditionally been concerned only with one's individual development, to a situation whereby individuals had a vested interest in the professional development of their colleagues. The interconnection between individual development and the development of one's colleagues set up a symbiotic relationship which drove collaborative ways of working.

Chapter 11 now considers some processes of the WSIS model which presented difficulties and reviews how these challenges were met.

CHAPTER 11

CHALLENGING PROCESSES

11.1 Introduction

Chapters 8, 9 and 10 summarised those factors which were deemed to have contributed to the success of the WSIS model, namely the context- responsive nature of the model; the building of individual capacity and the building of collective capacity of the schools in which it was trialled. I now propose to discuss the factors which presented difficulties and how I worked within the confines of those difficulties. The inhibiting factors identified were leadership issues; negative attitudes towards the use of observation and the abiding issue of time.

11.2 Leadership

Because the WSIS model was a school-based programme, the leadership of the principal determined how the teachers experienced the programme. Whether or not teachers had the opportunity to enter into dialogue with other participants, the amount of time allocated for CPD activities and whether or not participants had an opportunity to observe other teachers, all depended on the extent of the principal's commitment to this particular model of CPD. The experience of the CPD model varied greatly in the two sites, predominantly due to the responses of P1 and P2.

11.2.1 The principal's leadership

At TS1, it is felt that P1 retained the locus of control throughout the trial and was reluctant to renegotiate his initial stance on the issues of time, structure, observation and dialogue. Opportunities for teachers to self-manage their engagement in the programme were limited. Conversely, P2 was open to changes in direction and facilitated teachers taking increasing responsibility for the direction and nature of the programme. The resulting programmes in each were as divergent as their respective principals. At TS1, the CPD model remained very much in 'transmission mode', with the facilitator and individual teachers co-constructing lesson plans which were implemented with much less group discussion around lessons than in TS2. Teachers had less opportunity to observe their colleagues teaching. Teachers in TS1 did not get to teach classes other than their own. The restrictions imposed by P1 on the time available, and the number and constituents of study-groups, served to limit the nature of possible dialogue. No opportunities were provided for the whole staff to meet. Parents were not invited to participate in any work on the school site. The local community got involved in the technology project as the local hardware shop provided advice on the materials to be used and on the design of the class go-karts (each class made one so that those children who did not benefit from parental support at home were still able to avail of this application of the knowledge of Forces gained in science classes).

Initially, the principal of TS2 would have presented as quite similar to P1 in terms of leadership style, in that there was limited opportunity for negotiation. There was limited consultation about innovations but, by the principal's own admission, teachers were accustomed to having projects foisted on them.

> *At the start when you came in, you just felt that some staff were thinking "Not another project"…. You know, 'she's just landed this on us now again' you know...*
> (Interview TS2, P2)

However, P2 unreservedly supported the goal to improve science provision in the school and was open to all suggestions to achieve that aim. She acted as a conduit between me and the Board of Management who sanctioned use of school time for whole school CPD activities. She was tolerant of the ever changing nature of the programme and teachers' increasing levels of autonomy in dictating how they experienced the programme. This openness to change and distributed leadership was not however evident at the beginning of the year and, it is believed that the principal's approach to the staff and their development changed through her experience of the project.

11.2.2 The principal-staff relationship

The principal of TS2, where I was based for an entire school year, was observed to reflect on and review her style of management in the light of the WSIS programme.

> *I suppose my own position as administrative principal, you know, that I was there, because I know it's just coordinating people and getting people, telling people to go and do something, sometimes at very sharp notice; or something else comes up and you've got to change and somebody else has to do some of that…*
> (Interview TS2, P2, June 2009)

The language the principal uses to describe her role, *"Co-ordinating people; getting people; telling people to go; at very sharp notice*"; *"I was co-ordinating the whole thing"* reflects the difficulties of keeping everyone's needs in balance (See Chapter 2, Section 2.5.6).

At the time of the trial of WSIS, P2 had been principal for eleven years. She spoke about the difficulties she encounters in her role as principal

> *You notice every day there's something new, new challenges every day so I mean that's one of the things that you just never know. You might plan so much that you're going to do x, y and z tomorrow but when you come in then something else turns up.*
> (Interview TS2, P2)

P2 acknowledged that she perceived the position to be "all about people" (Journal Entry, May 28th, 2009). P2 had shown leadership in relation to science by participating in the UCC diploma course and was committed to providing access to CPD for the staff. She aligned herself with her staff as a fellow learner by participating as an equal in all whole school activities associated with the WSIS professional development. It is clear however, from her interview, that P2 struggles to strike the balance between negotiation and coercion. She is conscious that the staff does not always share her vision for the school. Whenever the principal of TS2 sought to force the direction of the project, the resistance and resentment was such that it became necessary to sideline her involvement, so that she did not inadvertently undermine the entire project.

> *P2 was supposed to ask xxx to come today and when she didn't turn up, P2 took it upon herself to* **order** *the 2 infant teachers to come to my rescue even though I had already requested and received help. They were resentful of the manner in which she ordered them to participate...People, once they feel they are being coerced, will rebel and could quickly lose enthusiasm.*
> (Journal Entry TS2 May 28th, 2009)

The principal later lamented her lack of "people skills" in interview when she wondered aloud how it had been possible to get people "to buy in". As the project progressed she pondered the "potential of the staff":

> *I suppose two things, it has really made me even more aware of the* ***potential of the staff****...: That* ***if the opportunities are created****, that* ***you can bring staff on board*** *and you know I know this will probably have impact on staff members in different ways but overall it had a very positive effect on the staff ...And* ***that's the thing about any project, any initiative that you undertake, it's getting people to buy in.***
> (Interview TS2, P2 emphases added)

P2 suggested that the “ripple effect” of the project was influential in getting people on board i.e. that so many teachers, normally cynical about her attempts at innovation, became enthusiastic.

> *No, I just think it worked very well, I could see, I said it,* ***the ripple effect.... And people worked together, I thought that was very positive, the thing I liked about it was that the learning support teachers were able to get involved as well and I think that they gelled with the other teachers, and I think that had a very positive impact on the staff.***
> (Interview TS2, P2)

What exactly was the “ripple effect”?

11.2.3 Distributed leadership

P2 gradually facilitated teachers assuming increasing control over their own professional development, by sanctioning release time for meetings and by allowing them to choose which professional activities to avail of etc. This manner of relating to the staff facilitated a growth of responsibility among staff members. The gradual transfer of leadership away from the principal to the teachers served to empower the teachers as discussed in Chapter 2, Section 2.5.6. It became increasingly evident that the leadership which came from the staff rather than the top (principal or leader) was instrumental in encouraging non-participants to become involved and sustained the momentum of the project beyond the initial stages. Increased autonomy and affirmation from colleagues persuaded teachers to remain involved and contribute to the whole school effort to improve science provision. While Borman et al. (2005) found that the principal could potentially negatively affect how teachers experience CPD (Chapter 3, Section 3.6.3), it is clear that reform efforts have little chance of success without adequate leadership.

> *It needs a leader to push people along because I feel, you know it was great this year, you were coming to us and in the end we were actually coming to you as well, you know which was great. Whereas I*

think if we were left to our own devices, I think we could fall back into old habits very easily. I think you need somebody there to keep the enthusiasm going. Without a doubt.
(Interview TS2, R5)

It can be claimed from analysis of the NNA (Chapter 6), that the resolve exists among Irish principals to improve the capacity of their teachers, but how they communicate that resolve to teachers may not have the desired effect of getting teachers on board. Principals need to first of all lead by example. Many principals who responded to the NNA survey distanced themselves from any need for further science CPD.

Personally no but my staff would need ongoing in-service in science to keep up to speed.
(Res NNA 56)

Secondly, principals need to build organisational capacity by giving staff members opportunities to assume leadership. P2 did her utmost to "… make provisions for dialogue" and thus "build organizational capacity" (Mullen and Hutinger 2008, p.283). While her style of management at the start of the programme smacked of coercion, P2 wholeheartedly supported full dialogue among all parties, including parents, and gradually relinquished control to staff members.

By contrast, in TS1 open dialogue was not a feature of the project. Parents were not invited to discuss the project or to avail of the science education which I was offering. The principal of TS1 did not extend an invitation to me to participate in staff discussions concerning the project but rather chose to 'discuss' the project with staff members and communicate decisions to me. While such discretion is understandable when I was not a member of staff in this school, it is however interesting to observe how he managed to retain control - by withholding opportunities for dialogue among all parties.

The second factor which caused some anxiety among participants was the use of observation.

11.3 Observation

From my work on coaching as part of my own professional development and awareness of the *Jugyou Kenkyuu* system (See Chapter 3, Section 3.3), I became interested in the idea of using observation as a tool for professional development. Observation as a CPD process seemed to conjure up very negative connotations for teachers, both in the National Needs Analysis (it was the second least popular CPD process identified, See Chapter 6, Table 6.2), and in the Needs Analyses conducted in both schools. Observation was not clearly defined in the NNA questionnaire and only referred to "the opportunity to observe other teachers." It is presumed that the less than enthusiastic response to observation relates to teachers' fears around being observed themselves. From the interviews conducted at both sites it would appear that these negative feelings are often founded on what was generally a negative experience of observation at pre-service level.

> *It just goes back to teaching practice, everyone's negative criticism, like saying all these negative things about you*.
> (Interview TS2, R10)

Because of the negative associations evoked whenever the concept of observation was suggested, I sought to identify what eventually facilitated its use in both trial schools.

11.3.1 A Culture conducive to observation

It was established at TS1 that a culture of being observed in an informal manner exists in this school due to the high incidence of non-teaching staff in the school.

> *It depends on who you're observing, some people are obviously a little bit uptight about being watched until they kind of relax and forget somebody's watching them, but some people seem, with the advent of SNAs and all this and in-class support and all the rest of it, it's much easier now to go into somebody's classroom and be there because most people are now actually in the past few years, are used to other people in and out of the room anyway.*
> (Interview TS1, M11)

Other teachers felt that watching another person teach could actually diminish one's own confidence.

> *If their lesson goes well, it would maybe bring down your confidence in the sense that you'd be living up to what they did, whereas if they don't do as well, it might be better for you like.*
> (Interview TS1, M6)

From the outset teachers at both sites expressed concern about the use of observation and were intimidated by the prospect of its use. This fear was, I believe, a product of the nature of the relationship that existed between the observer and the observed in prior experiences. R8 from TS2, who remained on the perimeter of the emerging collaborative work on the project, summarises what I believe to be the norm in many schools.

> *I'd hate to go in and be watching R9 teaching science, I mean I know she'd be cringing and I'd be cringing and the whole thing would just be… I think it is beneficial, I think we can all learn an awful lot from each other, but we don't tend to…*
> (Interview TS2, R8)

This sense of discomfort and fear of 'judgment' or 'cynicism' which R8 speaks of, is reflected in P2's remarks about the change in how the staff of TS2 were relating to each other at the end of the year.

> *I think people probably now would be less intimidated…*
> (Interview TS2, P2)

What brought about this dramatic transformation?

11.3.2 Self-observation - the use of technology

Teachers who opted to use the facility of the video camera for the purposes of recording their teaching chose to use the subsequent DVD in a variety of ways to enhance their teaching.

M2 (TS1), who teaches special needs children, used the DVDs of her teaching to critique her own teaching both as an assessment tool and as a teaching tool.

> *I suppose it was nice to see it, to see what went well. Actually things that I thought didn't go well, it didn't seem to show up as much in the DVD, so smaller things that while you were there like, 'oh no, that shouldn't have happened', but in the overall scheme it didn't make you look as bad... Because you could leave the lesson with a bad feeling and when you go back to it and look objectively you might think the overall lesson, yeah that was nice...I mean even small things now like I suppose I have a tendency to ask a question and maybe answer it too quickly straight away for the children so I suppose you learn things like that too - to pause a little bit more after you ask them a question or just allowing them more time…*
> (Interview TS1, M2)

Many teachers who used the recordings in this way had the same experience. Exaggerated memories of less than perfect teaching were put into context when the teacher had the opportunity to review the whole lesson. Because M2 works with special needs children she is accustomed to constantly researching better ways of enhancing their learning and she found the use of recording an excellent tool for this.

> *As they were watching it, I mean because they were looking at themselves, they loved it. So instead of me drilling the word into them all the time, it was themselves teaching themselves.*
> (Interview TS1, M2)

M9 (TS1), one of the more experienced teachers with regard to science, also felt it was great to get a chance to observe herself in action.

> *Do you know what? It's nice to be able to look back over the lessons...I mean, you'd hate looking at yourself but it's great because it just gives you an idea as to what you are doing...Yeah, I thought it*

> *was very beneficial now myself, like it was far from perfect and there were lots of things that I probably would change about it, but I thought it was very interesting.*
> (Interview TS1, M9)

It is clear that M9 has taken pleasure out of watching her own teaching. This in itself is a form of affirmation which is sadly lacking for teachers because they so often teach in isolation. M9 comments later on in her interview that she found herself analysing the structure of her lesson and the length of time she had allocated to different parts of the lesson. She also comments that although she left the lesson feeling disappointed that she had not achieved what she had set out to do, going over the recording she realised all that she *had* succeeded in achieving. The benefit of the recording/observation therefore was not only in deconstructing the lesson but also allowing teachers a chance to enjoy their successes. R10 (TS2) also used the DVD to analyse her own lessons and found it useful.

> *I think it is yeah, because I was there going, okay, I'm saying that too much, I spent too long at the start seeing what they knew already, their previous knowledge. So I probably should have just knew the way they all want to tell you what they know, I should have left less time doing that... Because you're your own worst critic, aren't you? Well I thought it was good now, like I thought it was quite interesting to do it now.*
> (Interview TS2, R10)

R10, like M9 and M2 found that observing themselves teaching (through the use of DVDs) led them to identifying issues they would like to improve, it was also a good source of affirmation.

11.3.3 Modelling

The other format of observation with which people seem comfortable is having a lesson modelled for them. In the absence of practical knowledge around constructivist methods of teaching science combined with weak understanding of the concepts involved, teachers had used 'low risk' teaching methods i.e. prior to the project they relied on a transmission mode of teaching based on class workbooks which do not demand much understanding of concepts or conceptual development. Teachers needed to observe alternative ways of teaching science, in order to build confidence, not alone in their teaching methodology, but also in their understanding of the target concepts. I eventually used modelling to achieve the following:

1. To motivate teachers - I taught lessons which allowed teachers witness the kind of excitement that could be generated amongst children by science;
2. To introduce a pedagogy of science which uses formative assessment to take into account children's ideas and current theories of learning in science;
3. To demonstrate some classroom management skills appropriate to science;
4. To introduce the target scientific concept;
5. To introduce the scientific process and raise awareness of the need for evidence to support ideas and theories;
6. To introduce a technology project related to the target concept to the children as a means of engaging them and their parents in the CPD programme;
7. To initiate an awareness of and enthusiasm for science in the school;
8. To allow teachers to see that teaching science is possible for all teachers.

Modelling did not present the same negative connotations associated with 'observation'. This is probably because the spotlight was not on the observing/learner teacher. Teachers were free to interject and co-teach at any time and many did just that. I would often ask them their opinion and include them in a non-threatening way in the delivery of the lesson, by asking them to help me look at the children's ideas or drawings. This displayed my respect for the teachers' competence and increased their trust in me.

The modelling offered teachers a sense of the direction of the project.

> *I mean the day, that was one of the first lessons in the Science throughout the year, the day you taught my class and I suppose that kind of gives a chance for me to see myself where the whole thing was going and the aim of the project and things like that.*
> (Interview TS2, R9)

When asked which element of the whole project R7 found had most improved her confidence and ability to teach science her answer was very clear.

> *Actually I think what helped most was watching other teachers teach. Do you know to bring that back, because I suppose, I haven't formed as a teacher properly yet. I suppose getting hints from everyone, how to do such a thing and…*
> (Interview TS2, R7)

R4 also feels that this chance to watch other teachers teaching was possibly the most influential aspect of the entire project for him. When questioned at the end of the project about the various components of the project R4 singled out modelling as the particular aspect which had most impact on him and feels he would like to continue to have lessons modelled for him because he "would know where to work from there."

> *Certainly getting lessons modelled was very helpful because you could really get a feel for the structure...Yeah maybe just say if you were starting a new strand you know you might have one model lesson per strand so you'd know where to work from there.*
> (Interview TS2, R4)

R6 also felt the modelling was a positive experience for her.

> *I've got great ideas, things I would never have thought of doing like really engaging with the children first and seeing what they knew. I would've normally just jumped in and started teaching rather than going from what they knew.*
> (Interview TS2, R6)

R5 also felt that the Modelling aspect was worthwhile doing.

> *You know it gave me kind of a chance to actually see a science lesson happening and the way it should be done.*

(Interview TS2, R5)

By modelling the kind of teaching which I hoped teachers would eventually emulate, they witnessed the different kind of learning which resulted, and were motivated by this to attempt to use a similar pedagogical model. The modelling helped launch teachers into teaching. R4 talks about how watching modelling motivated him to try teaching science.

> *Oh it was a huge help, because you could tell just how much the children enjoyed it because there was a real encouragement from you for it and that brought out, it wouldn't be something that I would've particularly been motivated by in the past. You know yourself when you can't be motivated, to try and motivate others to do it…It's nearly impossible. It opened my eyes in a way; I had some really bright people in the class who loved science as well so…*
> (Interview TS2, R4)

This was an unanticipated outcome of the modelling. Once R4 realised how much his class enjoyed science lessons, he determined to up-skill himself in the area of science, having had no science education beyond Junior Certificate level.

11.3.4 Observing the children

Not only did the modelling allow teachers to learn about teaching, it also provided an excellent means of assessing the children's understanding and progress. One of the main reasons for observing in Japan is to ascertain how the children are learning and which experiences best facilitate that learning. Many of the teachers involved in this project, who either watched DVDs of themselves or watched me teaching, found themselves also watching the children and doing this type of analysis or assessment without being instructed to do so.

> *I found it made me think about, where we could go from then on. Do you know if you're teaching yourself, you're trying to think of the next question? I found I picked up more of what the children were*

> *saying when I wasn't teaching, which I know sounds contradictory but…*
> (Interview TS2, R7)

Not only was she learning about different styles of teaching, R7 was also thinking about the pedagogy of the lesson. She was thinking about how she could develop the learning from the lesson she had watched. She also benefitted from having the chance to really listen to the children as opposed to trying to remember her next step in the sequence of the lesson - not an automatic capacity in inexperienced teachers. R2 (TS2) remarks on how modelling imparted an understanding of scientific pedagogy to him in an effective way.

> *It was the structure that you had, you know that you would introduce the topic and you would ask, you always emphasised that people would think about what you just said, you would divide them into groups then you would divide them into pairs, you'd get a pair to work together and it was a whole collaboration of ideas.*
> (Interview TS2, R2)

He also feels that not only was he learning from the teacher modelling but also learned from having the opportunity to listen to the children.

> *You probably learn more from the children because when you're talking about science, they'll give you examples of science at home or experiments they did or something they saw on television, as opposed to Irish, English and math.... Whereas a lot of other subjects we are just imparting knowledge and they suck it up.*
> (Interview TS2, R2)

From modelling, R2 has come to awareness that it is acceptable for the teacher to be involved in personal conceptual construction at the same time. He acknowledges the contribution the children made to his own construction of knowledge.

11.3.5 Being the observed

While teachers were happy to observe teachers and felt that they benefitted from the experience, they were much less likely to volunteer to be the teacher observed and found this more difficult to accept. R2, while a very experienced teacher, still lacked confidence initially about being observed.

> *Yeah at the start all right, I was a bit lacking in confidence a small bit with a new subject but since the last couple of months it's fine.*
> (Interview TS2, R2)

R5, a young but confident teacher, who agreed to be observed did not relish the prospect, but found that the experience was not as bad as anticipated.

> *The first five minutes was tough, but then I forgot all about it, you know I was so involved in the lesson that…*
> (Interview TS2, R5)

R6, another young teacher, similarly places the discomfort into context by saying that it dissipates once the lesson is established

> *But it's fine after five minutes I think. It's just the first five minutes that you're self-conscious.*
> (Interview TS2, R6)

What is clear from these experiences is that these teachers are unaccustomed to receiving positive affirmation for their work. Teachers were so buoyed by their successes that they became increasingly willing to be observed and, to participate in deconstruction of lessons where the emphasis was on the children's learning, rather than on the nature of the teaching. Lessons regarding appropriate pedagogy were acquired in an incidental and therefore non-threatening way. It is believed that if the project was to enter into a second year the teachers' increased self-esteem and improved relationships with their colleagues would allow for even more rigorous and analytical observation of lessons.

Being observed by others eventually became less stressful as one teacher of the team took responsibility for conducting the plenary session with the class at the end of the Team-Teaching lesson while his/her colleagues observed the children and their responses in order to assess their learning. It is felt that more of this process would lead to teachers feeling less self-conscious about being observed by their colleagues.

11.3.6 Fear of criticism

It would seem that it is not the observation per se which fazes teachers but rather a fear of negative feedback.

> *I think it's good to watch other people… so long as if you are going to comment on it, you can at least do so positively, there are people out there, and there are days when you do it yourself, you go in and your lesson is a mess and you can't figure out why. And if you're told the wrong way how you went wrong it could build up a lot of resentment towards, even towards the subject itself, not to mind the person…*
> (Interview TS1, M11)

No teacher mentioned the benefits arising from positive feedback, possibly because they do not anticipate it. This assumption of negative feedback arises from, I would suggest, insufficient positive affirmation in a career of teaching.

R7, a Newly Qualified Teacher (NQT) and in her first year was much less confident about being observed.

> *I hate being watched personally, but it's just something you have to get used to....I think if you trust them, that they'd give constructive criticism but I think you'd have to trust the people in the room not to go out and gossip about you, you know...the relationship between you and the observer.*
> (Interview TS2, R7)

Similar to the difficulties involved in getting teachers to start teaching science lessons themselves, it is my belief that once teachers have had a few positive experiences of being observed and feel it is something that benefits their practice, which most respondents seemed to agree with, observation could eventually be an acceptable element of CPD. In order to maximise the benefit of observation as a process for strengthening relationships and thus self-esteem, it is considered essential that teachers experience observation of both children and teachers from all levels of the school. Why is this wide range of observational experience deemed necessary?

11.3.7 Observing different class-levels of the school

Many teachers throughout the entire project, both in the NNA and in the interviews, spoke about the content knowledge required to teach the junior classes and the senior classes as if it were two different subjects.

> *I have absolutely no foundation in background principles of the strands of science curriculum so I feel totally inadequate in case my senior class will realise I'm only struggling to keep a chapter ahead of them each week.*
> (Res NNA, 177)

M11 (TS1) raises the point that although she has been involved in teaching science for a number of years, it has always been to the same class level, and she would appreciate being able to observe science being taught in different classes.

> *Yea, and I would've liked to have seen as well, you know like, it's mostly I suppose for the senior classes I've worked with in science, I would've liked to have seen some of that with the 2nd class and things like that. I think it would be a great idea.*
> (Interview TS1, M11)

This highlights the benefit of the Whole School approach that was adopted at TS2, where every teacher taught at every level, thus giving teachers a stronger sense of what was happening at every level of the school. This facilitated not only a sense of how a concept was developed up through the primary school years, it also facilitated a familiarity with the different teaching techniques and styles appropriate to different classes. It also gave teachers the chance to develop their own content knowledge by re-visiting the same concept on numerous occasions at increasingly more demanding levels of complexity.

The DES in-service only provided education for the particular class level at which teachers were teaching at the time of the curriculum introduction. This highlights the inadequacy of once-off professional development which has no long-term support built in.

> *When curriculum roll-out happened I was teaching juniors. Now teaching seniors. In all subject-training sessions focus was on your class group at the time. Had little or no contact with senior programme until last year.*
> (Res NNA, 335)

The other danger inherent in preparing teachers to teach only their own class level is the lack of commitment to the scientific development of all children at all levels of the school. Commitment to science is erratic and varies not only from school to school but also from one class teacher to another. This leads to enormous gaps in provision and creates situations where children learn it in one class well, but may have no more science for a number of years and later be taught by somebody whose own content knowledge and confidence is lacking. Respondent 446 to the NNA, who is a principal, is aware of the impact of uneven implementation within his school.

> (*Whole staff training needed) Don't feel clear at present about what to teach but can do the research myself. Concerned about fact that only some teachers do science so children's knowledge is poor. I suggest that trainers/facilitators be qualified from now on. Great knowledge of science not needed. They need to ask very pertinent questions of staff e.g. 1) The rights of children to be taught science 2) What can be done to ensure it is taught with emphasis on a) if NEEDS to be taught right up along the school, not in bits here and there, b) teachers need to collaborate on what skills/topics to be covered each year (class level), c) how are 'new' & 'sub' teachers briefed on science curriculum in the school*.
> (Res NNA, 146)

The fact that the 1971 curriculum only required 5th and 6th classes to study science may be a contributory factor in the 'uneven provision of science' reported by Varley et al., (2008(a)).

11.3.8 Conclusions regarding the use of observation as a CPD process

Many teachers attribute their negative feelings towards observation to negative experiences at pre-service level. However, it was felt by participants in both trials of the WSIS CPD programme that observation, as experienced in this model, made many positive contributions. Observation supported the development of: a collaborative school culture; teachers' motivation to teach science; teachers' awareness of appropriate knowledge and pedagogy for all levels of the school and teachers' confidence teaching science to all class levels of the primary school. It also provided a means of formatively assessing science lessons, particularly with junior and special needs classes.

The third 'inhibiting' factor in the WSIS model of CPD was felt to be time.

11.4 Time

Cognisant of the constraining influence of time on teachers' participation in CPD activities (96% considered it to be the greatest impediment to their participation in CPD, see Chapter 6, Table 6.14), I attempted to investigate possible ways to address this very difficult issue. Firstly, I sought to understand why time was such an emotive issue for teachers.

11.4.1 Personal time vs professional time

It appeared from the qualitative data that teachers are seriously conflicted about the need to balance personal and professional obligations.

> *Family commitments - I have not the time/energy.*
> (Res NNA 9)

A tendency to insulate professional activities from personal time was reflected in responses to the NNA where reluctance to use family time for professional purposes was evidenced.

> *Time is the most important, as any idea that teachers do in-service in the weekend is disgraceful in today's world.*
> (Res NNA 226)

> *Depends on other personal commitments.*
> (Res NNA 266)

This reluctance to dedicate ‘family time’ to professional development, coupled with evidence of the recorded benefits of in-school professional development, persuaded me of the necessity to embed professional development into the time teachers dedicate to their professional lives (Chapter 2, Section 2.5.7). Teachers at both Trial Sites were witnessed to spend, on average, about two hours per day in school involved in non-teaching activities. This time was variously spent in discussion with colleagues, organising the classroom and preparing for the following day’s work, both before and after the official school day. Many teachers spent even more time than this in voluntary school-related but non-teaching activities. It was clear that teachers’ jealously guarded this time and their autonomy in deciding how this time might be used.

Incorporating professional development into the repertoire of what teachers consider to be valid uses of this voluntary time involved changing teachers’ perceptions of professional development. Those teachers who held the ‘investment’ or ‘deficit’ attitude towards professional development were likely to resist use of their volunteered time for CPD purposes (Chapter 8, Section 8.3). However, those who embraced the attitudes of ‘Life-long learner’ or ‘D.I.Y’ were more amenable to exploiting every available opportunity to reflect on their practice.

11.4.2 Time for reflection

The experience at Trial Sites 1 and 2 indicates that, in spite of major efforts to eliminate conflict between an individual's personal and professional time commitments, time remained a constant source of friction throughout the trials of the programme.

> Time compounds the problem of innovation and confounds the implementation of change.
> (Hargreaves, 1994, p. 32)

The issue of time for CPD impacted on how the WSIS model was experienced and was raised continuously throughout the research by all stakeholders. It is clear, from the comments made by teachers at both sites and the NNA respondents, that sustained conversation about practice is valued highly and that teachers would appreciate more time to engage in reflection both with colleagues and a "knowledgeable other" (Chapter 6, Table 6.2). How the time was actually used was a reflection of people's priorities.

11.4.3 Use of time

The difficulty of finding a balance between evaluating lessons and preparing teachers to teach the next lesson in the series arose in many of the interviews because many seemed to be "...in a hurry to know, to have answers, to plan and to solve" (Leitch and Day 2001, pp.248-249).

> *I suppose, like sometimes alright maybe it could have been cut short but in general it was okay... Yea the evaluation was afterwards, as you say like planning lessons took more time.*
> (Interview TS2, R9)

It became obvious that, although teachers valued the opportunity to reflect on lessons taught, such reflection was always secondary to the need to plan for the next lesson.

It is believed that if teachers were required to teach the same lesson a second time as is done in Japan in the use of the *Jugyou Kenkyuu* method of professional development, which was the original premise of the WSIS model, they would be more motivated to review and amend lessons. It is believed that this would be a better learning experience for teachers.

I did not attempt to use the *Jugyou Kenkyuu* method of professional development in TS2 as it became obvious, that the teachers were not yet sufficiently confident to model lessons for each other. It is considered that it might be possible to include such a method in a second phase of the WSIS CPD model.

The teachers' inclination to spend the time available learning science and preparing lessons rather than reflecting on past lessons, reflects lack of confidence in their own scientific knowledge, and a desire for teaching ideas as expressed by 98% of NNA respondents (See Chapter 6, Table 6.2). If the leader of the CPD model were somebody who was a permanent member of staff, this sense of rushing forward to the next stage may not have been as evident, nonetheless, as M11 (TS1) said:

> *...the fact that we're doing this as a sort of an experiment if you like, the whole thing's an experiment, I think it's great, we're getting a sort of a taste of what the possibilities are.*
> (Interview TS1, M11)

The sense that people were very anxious to make the most of the professional development opportunity presented to them in the release time is evident in P1's comments:

> *I suppose people are very accommodating and like it's a type of school where people would see the benefit as opposed to the disadvantage so the benefit is to their own professional development outweighing the inconvenience of having to get somebody to cover for the half hour that you needed them so I think from that point of view like, you have to look at the bigger picture as opposed to that particular difficulty. But I suppose they're just the issues of trying to*

> *find time within the school day to do it.*
> (Interview TS1, P1)

How can the necessary child-free time be secured for staff to enjoy the opportunity to co-solve problems of practice?

11.4.4 Need for dedicated child-free time

The evidence gleaned from the experience of the WSIS model indicates that, while teachers subjectively perceive the issue of time as problematic, in fact they allocate considerably more time to their professional lives than they are actually mandated to do.

The issue was discussed at length at the interview stage with P2. It was mutually observed that teachers already commit a lot of time to non-teaching professional activities, not alone during the school year, but also during the holiday periods. The issue of Extra Personal Vacation (EPV) days and their value to teachers was also discussed. Three EPV days are currently awarded to teachers in lieu of twenty hours spent by them on summer courses. It was mooted during the interview stage by a number of teachers that the same reward could be offered for twenty hours spent on professional development activities which take place during the school year. A suggestion was that teachers could spend one to two hours during the school week, outside of teaching time, on CPD activities. This time could possibly be used for whole staff education on a topic, reflection on lessons undertaken or for peer-coaching. The permutations of such a model are infinite but it would only work if the entire staff were willing to commit to a common focus for whole staff development. Such a model would not preclude teachers from pursuing other individual forms of professional development.

If teachers were in a position to earn their EPV days by engaging in CPD within the school year, there is evidence to suggest that such CPD would be both more attractive to participants and more likely to bring about the required change. Allowing teachers to decide how to use the time would increase teachers' sense of agency and retain their much-valued sense of autonomy.

11.5 Summary

Evidence from the literature and the data collected indicated that, those forms of CPD deemed to be effective, were likely to be premised on socio-constructive theories of learning (Chapter 3, Section 3.8; Chapter 6, Table 6.2; Chapter 8, Section 8.2). However, it was observed from the NNA data that teaching in Ireland, by its structures, tended to support individualism rather than collaboration. It was posited in Chapters 9 and 10 that innovation would be more likely to succeed if responsibility for it were collectively shared. In order to assume such collective responsibility it was felt that teachers needed to be confident. Confidence was developed by giving teachers many 'mastery experiences' and by improving relationships among stakeholders through dialogue, observation, leadership and dedicated time. This chapter considered the difficulties which emerged with those processes and outlined how those difficulties were dealt with.

Initial negative associations with the use of observation necessitated extended opportunities to use observation in a variety of ways which were supportive of teachers' efforts to change. While there was unanimous agreement about the necessity of opportunities to share both positive and negative experiences with colleagues and experts, an enduring problem common to all participants and both sites was securing the time for this discussion.

Whether or not time was provided for CPD activities; whether teachers were given opportunities to take control of their learning; whether or not the learning community was expanded by welcoming the input of parents and non-teaching staff, all depended on the style of leadership provided. This leadership determined the degree to which the culture of the school embraced the concept of collaborative problem-solving to critically examine and address its provision of science. The complex and demanding role of the principal is acknowledged, but the apparent reluctance of many principals to engage as an equal learning partner in CPD is considered detrimental to the establishment of a collaborative culture. Leadership from within the ranks of the staff was found to be supportive of teachers' efforts to change, particularly in TS2.

CHAPTER 12

CONCLUSIONS AND RECOMMENDATIONS

12.1 Introduction

This research set out to answer the question: **How do we improve the provision of science education in Irish primary schools?** In an attempt to answer that question data were gathered from three samples of the national population of Irish primary teachers. That data, together with empirical evidence gleaned from the literature, were used to design a model of professional development. This model of professional development was trialled in two different schools for two different periods. Data were collected from personnel at both of these schools, both prior to and after the trials.

In this chapter, I begin by giving an overview of the empirical evidence arising from this research, which addressed two issues. The first set of data refers to the science profile of Irish primary teachers - their personal science education, their confidence teaching science and their attitudes towards science. The second refers to their perceptions of CPD. I then present a summary of the Whole-School, In-School (WSIS) model of CPD, which was premised on this empirical data as well as the literature (Chapters 2 and 3). I follow this with a methodological critique of the overall research study before proceeding to outline my conclusions and recommendations arising from the findings.

12.2 The Challenge

One of my remits was to address the issue of perceived lack of confidence teaching science among primary teachers. The problem which I faced in attempting to address this lack of confidence was double-edged. While the reasons offered for non-participation in relevant professional development included time, work-load, finance and accessibility, it seemed that attitudes towards CPD also impacted on participation rates. Of the 467 respondents only about 10% indicated that they perceived themselves as life- long learners. About one third of all respondents indicated that apathy was a significant impediment to their participation in CPD, a figure which rose to 40% among the youngest age group. This is supported by the work of O'Donovan (2013, p.124-125). The challenge was therefore significant. The problem was not only about designing the most effective model of CPD, it also required addressing attitudes towards science in particular, and attitudes towards professional development in general. Section 12.3 summarises the science profile of Irish primary teachers derived from the empirical evidence of this research.

12.3 Empirical Evidence Regarding the Science Profile of Irish Primary Teachers

The data generated by the NNA survey, corroborated through interviews, suggest that teachers felt the generic professional development provided prior to the introduction of the science curriculum in 2003 was inappropriate for their individual needs. This evidence is supported by Kshir's (1999) conclusion that any attempt at innovation must begin by assessing the *individual* needs of teachers.

12.3.1 Efficacy of DES mandated in-service

Teachers were provided with two separate day-courses as well as a day dedicated to school planning in preparation to teach the science curriculum. Some teachers also benefitted from 'Cuiditheoirí' (in-class support). While 86% appreciated the attempts to be up-skilled, almost all NNA respondents indicated that they felt insufficiently supported to adopt the new curriculum successfully. Varley et al. acknowledge that "progression in these skills (those associated with the primary science curriculum) was not a particular feature of the in-service provided at the time" (2008(a), p.23). Respondents who elaborated on the reasons for their dissatisfaction indicated a sense of being overwhelmed. This is not surprising given the breadth of the science curriculum. The significant factors impacting on confidence teaching science and, confirmed by the empirical evidence generated by the NNA, are outlined below.

12.3.2 Link between subject mastery and confidence

All respondents were found to be less confident teaching science than any other subject on the curriculum with 70% saying they needed professional development in the area of science. The chi-square test for independence indicated that there was a significant association between perceived confidence teaching the individual strands and study of the related subjects of chemistry, physics and biology at Leaving Certificate level (Chapter 5, Section 5.6). 63% expressed little or no confidence teaching the Materials strand and the same percentage lacked confidence teaching the Energy and Forces strand. By comparison, 69% expressed confidence teaching topics from the Living Things strand. I suggest that these findings may be considered as being representative of the national population as these results were mirrored in both Trial Sites, with both schools prioritising help in the Energy and Forces and Materials strands.

The low confidence expressed by teachers (Chapter 5, Table 5.30 and section 5.6) suggests that teachers do not have adequate subject knowledge in order to develop their pedagogical content knowledge - that knowledge which enables a teacher to break down the concept into what M11 in TS1 referred to as “the baby steps”. This link between lack of confidence teaching science and inadequate subject mastery, has also been identified by Schoon and Boon (1998) among primary teachers and among newly qualified secondary science teachers by Haigh and Anthony (2012, p.653-654); Ireson and Twidle (2004); Goodwin (2003) and Kikas (2004). If post-primary science teachers who benefit from a degree course in science share some of their students’ misconceptions (Kennedy, 2004), it is no surprise to find that primary teachers should experience self-doubt. What is the typical science education of primary teachers?

12.3.3 Science education of respondents

The typical level of science education of NNA respondents was Junior Certificate science and one Leaving Certificate science subject. This Leaving Certificate subject was more than likely to be biology (52%) compared to 30% who had studied chemistry and 18% who had studied physics (Chapter 5, Section 5.4). 10% of all respondents to the NNA had studied no science at post-primary level and 20% had only studied it to Junior Certificate level. Even those participants at TS1 and TS2 who had studied physics or chemistry to honours Leaving Certificate level bemoaned their lack of understanding of concepts and referred to the ‘rote’ learning of definitions experienced at post-primary level. This is supported by the findings of Kennedy regarding Irish post-primary student science teachers. “A lack of subject knowledge was observed among a significant number of student teachers” (2004, p.293). It is suggested that the cumulative effect of learning for remembering rather than learning for understanding at post-primary and undergraduate levels does not support primary teachers as confident teachers of science. This means that nearly one third of all respondents had little or no science education prior to college entry. There was no evidence from the data that the uneven science education of under-graduates was addressed in the Colleges of Education.

12.3.4 Satisfaction with preparation in Colleges of Education to teach science

Teachers’ level of satisfaction with their preparation to teach science in the Colleges of Education was quite low. Only 12% of respondents to the NNA perceived their preparation in the Colleges of Education as adequate. More recently qualified teachers were more likely to express satisfaction with their preparation. 37% of the youngest cohort felt well prepared compared to 12% of the 31 to 40 year age group. This level of satisfaction dropped to 4% for the 41 to 50 year olds and 5% for the over 51 year olds. This perception of good preparation among newly qualified teachers was not borne out by practice as witnessed by more experienced teachers. This was corroborated at the two trial schools where the younger participants admitted to feeling under-prepared to teach science. 95% of all respondents over 40 years of age considered their preparation to teach science as inadequate or non-existent. In a population where 65% of the teaching population are 40 years or over, this is a matter of some concern. There was some evidence of a link between good experience of science at under-graduate level and engagement with further professional development (Chapter 5, Table 5.19).

Inadequate subject mastery has also led to the misapprehension that teaching science to the lower classes in primary schools and special needs children is more feasible. This opinion was frequently expressed in the NNA and clarified at the two Trial Sites. Participants at the Trial Sites explained this perception by saying that these children would be less likely to challenge the teachers' understanding of the concepts. This indicates a misunderstanding about science. The concepts are the same regardless of the level at which they are taught. A teacher must have sound conceptual understanding if they are to be in a position to develop appropriate pedagogy.

In order to clarify respondents' attitudes towards science I sought to establish the amount of time spent by teachers on science-related activities.

12.3.5 Amount of time spent teaching science

38% of NNA respondents admitted to not availing of the allotted time for science each week. There was some evidence of teachers avoiding the subject. Many of the teachers at the two trial schools who did avail of the weekly hour allotted, admitted to opting for 'low risk' teaching strategies, with more emphasis on demonstration and use of workbooks, as opposed to investigative or hands-on work for the children. This was particularly true at TS2. This correlates with the findings of Varley et al. (2008 (a) and (b)) whose research revealed that 43% of all children surveyed did not indicate much involvement in practical science activities. One of the main difficulties highlighted by teachers was the amount of time and effort which is required to prepare for, and teach, active science lessons with large class numbers. Typically primary teachers do not have access to assistance teaching science lessons.

In spite of difficulties with understanding the target concepts and difficulties implementing active science lessons, 46% of respondents were deemed to have very positive attitudes towards science (Chapter 5, Table 5.26). The remaining 54%, while less enthusiastic, nonetheless acknowledged the place of science in the primary curriculum. In total 88% of respondents considered science to be just as important as any other subject on the curriculum. This statistic, together with the 70% who expressed a need for further education in science, justifies a conclusion that Irish primary teachers are interested in improving their provision of science.

In total about 4% of NNA respondents professed satisfaction with their knowledge and ability to teach science but acknowledged that, for most of their colleagues, science is very challenging. While these teachers feel more confident regarding their subject mastery, this has been seen to be no guarantee of adequate pedagogical content knowledge (Waldron 2007).

From the empirical evidence, which is supported by the qualitative data generated from the questionnaires, interviews and the literature, it seems that significant work remains to be done to raise the levels of confidence teaching science among Irish primary teachers. In an effort to give teachers a voice in how their science needs could be met, I attempted to determine what they perceive as effective professional development.

12.4 Empirical Evidence Regarding CPD Priorities

The empirical evidence indicates that Irish teachers hold conflicting values about professional development. Table 12.1 summarises the conflicting values evident in the data.

Factors	Principles of CPD Deduced From Data and Aligned with International Best Practice Principles (See Theoretical Framework, Table 3.3)	Principles of CPD Deduced From Data Which are Non-Supportive of Best Practice Principles (See Theoretical Framework, Table 3.3)
Teacher	1.Need for Science CPD acknowledged, Chapter 5, section 5.4.5. 2. Desire for CPD to be immediately relevant to practice, Chapter 6, section 6.2.1; section 6.3.1. 3. Desire to avail of opportunity to trial new methods and materials between sessions and avail of feedback on the experience, Chapter 6, sections 6.4.1 and 6.4.2; 6.4.3. 4.Identification of individual needs valued by majority, Chapter 6, sections 6.3.1 and 6.3.2. 5. Benefit of Discussion and Reflection valued by majority, Chapter 6, section 6.3.3; Chapter 3, Table 3.2; 6. Attitudes to CPD age and gender-related Chapter 6, section 6.6.1 and section 6.6.2	1.Perception of CPD as traditional in-service i.e. short, voluntary and individual, Chapter 6, section 6.4.1 and Table 6.8; 2. Negative attitudes towards the place of subject-matter knowledge and the relevance of research to practice, Chapter 6, section 6.2.2 and section 6.3.4; 3. Apathy in pursuing CPD (reflected in one third of respondents who indicated "Lack of Interest" as an impediment to participation) Chapter 6, Section 6.5.5; 4. Some evidence that identification of individual needs not a priority, Chapter 6, section 6.3.1; 5. Evidence of strong feelings about the financial cost of CPD, Chapter 6, section 6.6; 6. Individual professional identity does not include sense of responsibility for development of profession, as derived from lack of initiative shown by 51% in pursuing CPD, Chapter 5, section 5.4.5.

School	1. Importance attached to identification of school needs, Chapter 6, section 6.3.3. 2. Discussion and Reflection valued by majority, Chapter 6, sections 6.3.3 and 6.4.2 3. Observation as a means of support valued by majority of respondents, Chapter 6, section 6.3.3.	1. Lack of awareness of in-school, collaborative work as legitimate CPD constituent, Chapter 6, section 6.4.1; section 6.3.3; 2. Evidence that Observation not prioritised as a CPD process, Chapter 6, section 6.3.3; 3. Some hesitance about the merits of Discussion and Reflection Chapter 6, section 6.4.2.
External	Long term support from tutors with relevant classroom experience valued, Chapter 6, section 6.3.3 and Table 6.5; Chapter 3, Table 3.2.	1. Division between research community and practitioners evident, Chapter 6, section 6.3.4 and section 6.6; 2. Third level provision as currently provided presents greatest combination of identified constraints e.g. time, cost and workload, Chapter 6, section 6.6; 3. Apparent ambivalence regarding the relevance of research to improve practice, Chapter 6, Section 6.3.4, Table 6.7.

Table 12.1 Conflicting Evidence Regarding Teachers' Perceptions and Beliefs Around CPD

In order to make sense of what appears to be conflicting evidence, it is necessary to understand the historical context of CPD in Ireland as discussed in Chapter 6, Section 6.5.3. Section 12.4.1 and 12.4.2 outline my conclusions regarding the individual factors which determine teachers' beliefs, attitudes and dispositions regarding CPD.

12.4.1 Teacher factor: Beliefs and attitudes regarding CPD

Irish primary teachers have come to equate CPD with short provision, which is generally voluntary and, rather arbitrary, in that the topics are not necessarily chosen with reference to needs (as in summer courses) or mandated day courses provided by the DES. The short timeframe of this provision, coupled with teachers' clear desire that CPD be directly relevant to their practice, may explain teachers' reluctance to engage in any time-consuming process which may detract from time available for what they perceive as essential - the provision of 'teaching ideas' (See Chapter 6, Table 6.2).

The processes around which some ambiguity was evident included observation, discussion, reflection and reading research. While teachers accepted the need to base professional development provision on school needs, they were less enthusiastic about having any focus on their individual needs.

In relation to teachers' preferred type of CPD, there is evidence of a clear desire for two-part courses which are in-term and in-school. However, teachers are slow to relinquish the more familiar "one shot, sit and get" (Hunzicker 2011, p.177) formats perhaps because of:

(a) EPV days associated with this type of provision;

(b) The need to reconcile conflicting demands of professional and personal lives, or;

(c) Simply because they are not aware that it is possible to access professional development in any other manner than that to which they have grown accustomed.

It would seem that teachers have been enculturated into a model of professional development which removes them from their places of practice.

There was evidence in the qualitative data of an isolationist culture around CPD with many respondents displaying an ‘investment’ perspective of CPD. This perspective of CPD suggests that the primary motive for participation is for individual gain e.g. increases in salary, promotion, or EPV days. A similarly isolationist viewpoint evident in the qualitative data was that of the “deficit” (Kshir, 1999, p.300-301) perspective where teachers viewed CPD as a means to up skill those perceived to be in need of remediation. From these perspectives, professional development is considered to be a “way to correct a defect” or a means to an end “rather than as a normal growth process of CPD” (Kshir 1999, p.300).

There was very little evidence from either the NNA or the Trial Sites of teachers demonstrating a problem-solving attitude when faced with difficulties regarding their implementation of the science curriculum. This lack of agency is now discussed.

12.4.2 Teacher factor: Teacher Agency

Teachers have become accustomed to either having CPD mandated by the DES or choosing from a pre-determined range of courses offered by various providers. Traditionally there has not been a culture of individual teachers or schools demonstrating agency regarding identifying and addressing their own needs. The programme of School Self-Evaluation (SSE) introduced by the DES in 2012 (Circular 0040/12) could be perceived as an effort to address this culture of awaiting external assessment of need. However, the manner of introduction of School Self-Evaluation and the language contained within the introductory documents do not support teacher agency but rather indicate that self-evaluation is mandatory.

> ***From 2012/13, schools are required to engage in school self-evaluation.*** A whole-school approach to the self-evaluation and improvement of teaching and learning, including literacy and numeracy, should be adopted (emphases in original).
> DES (2012)

Rather than encouraging teachers to autonomously develop more systematically the informal means by which they garner support for their efforts to identify solutions to practice problems (OECD 2009) the DES is seeking to impose collegiality and collaboration into a system rife with individualism. This could well cause alienation and resentment among teachers leading to superficial compliance without any real commitment to a genuine engagement with the process.

The DES has itself neglected to take cognisance of the research findings that collaboration cannot be introduced to a school by "requiring" it to happen (Frankham and Howes, 2006). Such a "requirement" neglects to accord ownership of the change effort to teachers. As the WSIS trials have shown, the development of collegiality is a slow process requiring the development of respectful relationships among all parties with power being distributed equally among all stakeholders. Section 12.5 summarises how the alternative approach of the WSIS model of science CPD sought to cultivate increased agency among the teachers in the two trial schools.

12.5 The Whole-School, In-School (WSIS) CPD Model

The WSIS model of CPD used in the two trial schools is not a prescriptive model. The same principles were used and the same methodologies were offered to both school communities. The resultant programmes, however, reflected the unique features of each site. This responsiveness to the context of individual schools is considered to be a ‘success factor’ of the model. The principles governing the CPD programmes in both schools included the following:

1. The programme in each school was based on a Needs Analysis conducted prior to beginning the programme. The Needs Analysis took the form of anonymous questionnaires and individual, informal interviews;
2. The programmes were Whole School in nature, i.e.
   - The entire school community received the same education and the same level of support;
   - The same target concept was pursued throughout the school at the same time;
   - Teachers were encouraged and supported to teach science at all levels of the school;
   - Members of an enlarged school community were encouraged to work together to improve provision for everyone, i.e. emphasis was on the collective rather than on individual teachers or classes.
3. The data from the National Needs Analysis (NNA), together with data from the literature and the schools involved in the trials, informed the selection of methodologies offered. This data also supported the selection of the target concept. In both cases, the schools initially chose the topic of Forces. The methodologies used included the following:
   - Subject mastery in the target concept using target methodology i.e. teachers and parents were taught using a constructivist approach;
   - Modelling of lessons - participants observed me teaching science;
   - Paired teaching-teachers supported me teaching science;
   - Group teaching - pairs or small groups of teachers prepared, taught and reviewed lessons together;
   - Individual teaching supported by mentoring or coaching - this involved self-observation using video recording;
   - Group mentoring - this also involved reviewing of recorded lessons where the focus was on the learning of the students rather than on the teachers;
   - Formal and informal discussion of the target concept;

- Enlarging the learning community to include parents and local businesses;
- Team-Teaching: Five teachers (parents, SNAs or teachers) co-taught science lessons. These lessons were taught to all class-levels of the school
- A Home-School technology project based on the target concept.

4. The programmes in both schools placed particular emphasis on developing the following relationships through increased opportunities for communication:

- The teachers' professional and personal self-esteem;
- The teachers' relationships with one another;
- The teachers' relationships with the principal;
- The teachers' relationship with the leader of the programme;
- The teachers' relationships with the children and their guardians;
- The teachers' relationship with the subject of science.

The criterion for success was an improved experience of science for both teachers and students. The data from teachers, parents and children in both sites indicated a heightened awareness and enjoyment of science among children, and increased levels of confidence teaching the target concept among teachers. While this data is subjective and affective in nature, the fact that responses at both sites were positive, confirms that this approach is likely to support confidence building around the teaching of science and improve the quality of children's experiences of science. It was felt that any effort to empirically determine outcomes by testing student outcomes would have inhibited teachers from engaging with the programme.

12.5.1 Success factor: Building individual capacity

It was argued in Chapter 9 that the reason why the implementation of the 1999 science curriculum has not met all expectations may be because its introduction relied too heavily on individual responses. The approach I took was to empower individuals to engage with their colleagues in the task of implementing the science curriculum. In order to participate in productive relationships with other members of the learning community, teachers needed to have a strong sense of self-efficacy. The first contributor to confidence was, I believe, the large number of "mastery experiences" (Haigh and Anthony 2012, p. 652) which participants in the WSIS programme enjoyed. My approach was to build individual capacity by initially assuaging any sense of guilt for individual difficulties with implementation. Individuals were then supported to develop their self-confidence by providing them with a differentiated programme. This included an in-depth science education on the target concept; modelled science lessons; co-teaching lessons with me; joint planning; support accessing necessary resources/equipment; review of lessons with peers and leaders of the programme and opportunities to re-teach reviewed lessons.

Teachers' developing identities as competent teachers of science were contingent on experiencing the esteem of others in the educational community. Thus the organisational culture of TS2 was adjusted gradually so that teachers had increasing opportunities to work together to improve their practice. The improved confidence thus generated, enabled teachers to better engage with their colleagues and contribute to the development of the collective capacity of their schools. The subsequent changes in identity observed, were outlined in Chapter 9, and included increased agency; improved attitudes towards science; improved individual capacity; increased value in colleagues' contributions; improved principal's perception of staff capacity and increased ability to participate in the conversation about science in the school. My interventions, therefore, set up a symbiotic relationship between individuals and other school personnel, which boosted the capacity of each.

12.5.2 Another success factor: Building collective capacity

Chapter 10 discussed how I sought to develop a culture of collaboration by enabling the adoption of a common vision of improved science for the school. This was achieved through creating opportunities for dialogue among the various players. The dialogue took different forms for different groups: coaching; mentoring; reflection with emphasis on successes; small group and large group reflection and informal discussion. The school community was enlarged by involving local businesses, parents and Special Needs Assistants in an active way delivering the science curriculum. This was found to be an effective driver of the reform effort in the school. The adoption of a common vision was reliant on an atmosphere of trust and this was achieved by allowing autonomy regarding participation; differentiated provision of support; equality of access; and respectful listening to individual needs.

Once a common vision was embraced by all stakeholders, commitment to mutual professional development was pursued by encouraging interdependence among all members of the school community. This was achieved through the use of 'Team-Teaching', which involved science lessons being taught jointly by five adults (teachers, parents or SNAs). Each of the five facilitators had sole responsibility for one sub-section of the entire lesson. All five, however, were responsible for the lesson as a whole. It was essential to the group effort that each teacher clearly understood his/her target concept or sub-concept and how it contributed to the target concept. These lessons culminated in a plenary session conducted by one teacher (a role which was rotated). Each teacher had to actively assess the learning of the students and share this knowledge with their team in order to decide on the next steps for intervention. This process led to group commitment to supporting each other's learning. All stakeholders moved from clearly defined roles which had no overlap, to a situation where all stakeholders became co-workers striving equally to achieve a mutual goal. This represents a major shift in CPD, which has traditionally been concerned only with one's own individual practice, to actually having a stake in one's colleagues' professional development. The interconnectedness of individual development with the development of one's colleagues set up a symbiotic relationship which inspired collaborative ways of working. This mirrors the Japanese programme of *Jugyou Kenkyuu* discussed in Chapter 3. Section 12.6 now discusses how the findings of this research support the claim that Irish schools could successfully accommodate an adaptation of *Jugyou Kenkyuu*.

12.6 What Hope for an Irish Version of *Jugyou Kenkyuu*?

I proposed in Chapter 3 that a programme of professional development based on the principles of the Japanese system of *Jugyou Kenkyuu* would fulfil the criteria for internationally endorsed effective science CPD for Ireland. In Section 3.5 I considered some features of *Jugyou Kenkyuu* which might prove challenging for the Irish system. I suggested that "Evidence-based practice", "Reflection" and "Leadership" would need to be further developed in Irish schools. This hypothesis was borne out in the research. There is accumulated evidence from the empirical data that Irish teachers are alienated from the contribution of the research community with nearly one in two teachers unsure of its relevance to their practice (Chapter 6, Table 6.2). Observation is a core element of *Jugyou Kenkyuu* and, while respondents to the NNA and the participants at the two trial sites expressed some misgivings about its merits, I found that theses misgivings could be successfully addressed through the WSIS model. Reflection on practice throughout the two trials of the WSIS model was determined by the amount of time that teachers had at their disposal and this in turn depended on the nature of leadership at each site.

12.6.1 Leadership

There is evidence from the different experiences at TS1 and TS2 that the principals' beliefs and attitudes impacted on how teachers experienced the WSIS CPD. This indicates the importance of principals having an opportunity to reflect on any pre-conceptions they may have regarding valid use of school time and what constitutes worthwhile CPD. In TS2, where the principal demonstrated trust in the staff to exploit the CPD experience, she experienced a return on that investment of trust as the teachers responded by assuming added responsibility and showing leadership towards the development of their colleagues. P2's relinquishing of control allowed a distributed form of leadership to emerge from within the ranks of the staff which drove a new culture within the school. This was a culture of collaboration and sense of responsibility towards individual and collective development which had not been in evidence prior to the WSIS programme. This was quite different from TS1 where the principal was reluctant to relinquish control over how the teachers experienced the professional development activities. Teachers in TS1 remained very dependent on the leader of the programme, focussed on their own individual development without any sense of responsibility for the development of their colleagues.

12.6.2 Observation

The second issue which caused some defensiveness among participants at the Trial Sites and among respondents to the NNA was the use of observation. Teachers had negative pre-conceptions of observation based on pre-service experiences. I sought to introduce more positive experiences of observation into the WSIS model. The following uses of observation became acceptable in both sites:

(a) Self-observation using technology - this became a source of affirmation for teachers who lacked confidence teaching science.

(b) Modelling - teachers observed me modelling lessons for them. This was a very positive experience of observation as it gave teachers an overall view of what a constructivist science lesson would look like. I used modelling to achieve the following:

- To motivate teachers - I taught lessons which allowed teachers witness the kind of excitement that could be generated amongst children by science;
- An introduction to a pedagogy of science which uses formative assessment to take into account children's ideas and current theories of learning in science;
- Some classroom management skills appropriate to science;
- An introduction to the target scientific concept;
- An introduction to the scientific process and an awareness of the need for evidence to support ideas and theories;

- To introduce a technology project, related to the target concept, to the children as a means of engaging them and their parents in the CPD programme;
- To initiate an awareness of and enthusiasm for science in the school;
- To allow teachers to see that teaching science is possible for all teachers.

(c) Observation of children - This was an on-going process used in all lessons to assess what the children were thinking and the kinds of learning experiences which were most productive in facilitating their understanding;

(d) Being the observed - This was the most difficult of all uses of observation for teachers but became more normalised as teachers increasingly co-taught lessons. The use of Team-Teaching, whereby one teacher conducted a plenary at the end of the lesson while his/her colleagues observed, facilitated greater acceptance of the role of observation where the emphasis was on assessing the children's learning as opposed to the teacher's teaching. This leading of the plenary provided opportunities for teachers to demonstrate their skills and was a source of affirmation from their colleagues.

It became clear from the interviews that it is more the fear of negative comment which inhibits greater use of observation than the actual observation itself.

12.6.3 Time

The most difficult issue to resolve at both sites was that of time and particularly the issue of trying to balance personal and professional time. The need for dedicated child-free time to facilitate planning and group reflection was raised by the participants. It was suggested by them that this could be achieved during term time if EPV days were granted to teachers in lieu of time spent outside of school hours but within the school year on CPD activities.

Anxious to exploit my expertise, teachers tended to dismiss the need to reflect on lessons taught and wanted to rush on to 'get ideas' for the next lesson. It was not that they did not sufficiently value reflecting on their work, it was just that their experience of short in-service had conditioned them to want to short-circuit the process of development to 'getting teaching ideas'. This suggests that it would greatly benefit teachers being required to teach the same lesson a number of times.

12.6.4 Conclusions regarding Irish *Jugyou Kenkyuu*

Concerns expressed in Chapter 3 Section 3.5, regarding the potential pitfalls for *Jugyou Kenkyuu* in Ireland, were seen to be justified in the two Trial Sites. However, in spite of difficulties with some elements, being able to use their own school/classrooms as sites for CPD work facilitated a much longer engagement with CPD than any of the teachers had ever experienced before. This extended opportunity to observe, reflect and amend science lessons with the support of one's colleagues gave teachers the experience of trialling the use of some processes which have not traditionally been part of Irish teaching practice. In spite of initial difficulties, the positive outcomes and improved attitudes of participants to the use of observation, reflection and re-teaching of amended lessons justifies the conclusion that Irish teachers could adapt a form of *Jugyou Kenkyuu* for use in Irish schools.

12.7 Limitations of This Research

While some conclusions have been drawn from this research project, it is acknowledged that these are limited by nature of the case-study methodology used. While I do not claim that the WSIS CPD model can be successfully applied in its entirety in every school, this model has demonstrated its potential to be responsive to the unique contexts of individual schools.

Because this research was conducted by one researcher, there was ample room for bias in both the collection and analysis of data. While every effort was made to eliminate bias by providing data from a variety of sources and by referring the findings back to the participants for their approval, I cannot claim to have totally eliminated it.

Because I undertook this work as an individual, I was responsible for the personal handling of large amounts of data. While every effort was made to enlist objective, experienced researchers to review allocations of codes prior to analysis and findings as they emerged, final interpretation of the data was mine. Because I was a practitioner-researcher, it is possible that participants may have aligned their responses according to the nature of my relationship with them. Being aware of my agenda, they may have sought to give me the responses they thought I wanted! Secondly, my background as a teacher educator gave me a unique advantage in understanding the needs and learning styles of Irish primary teachers. This may impact on efforts to emulate the approach, as such expertise would take time to develop in teachers wishing to apply the model in their own schools.

While the NNA purports to be fairly representative of the population of Irish primary teachers as it was based on a random selection of 1,000 schools, it must be recalled that there was an over-representation of principals, the majority of whom were male. This may have skewed the responses. At times, some of the questions asked for an opinion on general perceptions as opposed to personal perceptions. This is a flaw of the study.

There is also some evidence that those who had a particular interest in the subject of primary science were more likely to respond to the NNA. However, this is a factor that cannot be controlled and was counter-balanced by the fact that TS2 was a completely random choice.

Evaluation of the WSIS CPD model was based on teachers' perceptions of their own improved confidence and improved experience of science for the children, based on teachers', parents' and their own evaluations. While I acknowledge that conclusions based on such subjective data are limited, I felt that any form of 'before and after' testing would have had the potential to intimidate participants and affect their willingness to engage with the programme.

The recommendations arising out of this research are presented under the categories of the theoretical framework: Teacher factors, School factors and External factors.

12.8 Conclusions and Recommendations Regarding Teacher Factors

Irish primary teachers are less confident teaching the 1999 science curriculum than they are teaching any other subject on the curriculum. They have particular difficulty with the Energy and Forces strand and the Materials strand. Empirical evidence from this study shows that there is a direct correlation between related subject mastery and confidence teaching these strands (Chapter 5, Section 5.6.2, and Table 5.29). 70% (N=467) of respondents to the NNA feel in need of extra science professional development (Chapter 5, Section 5.6). In order to address teachers' concerns about what they perceive as constraints on participation in CPD, as well as to apply the principles of CPD endorsed both internationally and by teachers themselves, a Whole-School, In-School model of Science CPD was developed. This model was premised on socio-constructive principles and was responsive to the various contexts in which it was used. The teachers' needs, beliefs and attitudes were at the core of the model. The process to improve teachers' provision of science began by improving individual capacity by providing many mastery experiences in a differentiated way for each individual. This process increased self-confidence which in turn facilitated increased dialogue among stakeholders. This dialogue led to the adoption of a common vision of improved implementation of the 1999 science curriculum among colleagues. Interdependence among stakeholders was engineered by changing organisational structures so that teachers worked together to provide science lessons across all classes of the school. This interdependence meant that teachers had a vested interest in the professional development of their colleagues. The feedback about what was a new way to experience CPD for teachers was very positive, in that teachers felt they had access to appropriate support for far longer than they were accustomed to. It would appear that an adaptation of the Japanese model of professional development known as *Jugyou Kenkyuu* could be implemented successfully in Ireland. The resultant investigative-type science lessons, which the children experienced, were positively received by both children and parents. Teachers expressed a new-found sense of confidence in their ability to teach science. I do not believe, however, that this new practice has become embedded in either of the two trial schools predominantly, because the teachers had not been trained to adopt the role of coach for each other. Work therefore remains to be done to see what is required to embed this new approach to CPD into practice. The Teacher Factors isolated in the Theoretical Framework (Table 3.3) were teachers' sense of agency, their needs and their beliefs. Section 12.9.1 outlines my recommendations about how best to support the development of teachers' agency in identifying and addressing their needs.

12.8.1 Agency

Teachers need to be the drivers of reform efforts. In order to achieve this they need to be encouraged to identify their needs. They need support to develop the necessary skills to research their practice and devise appropriate interventions where necessary. In order to be able to contribute to the capacity of their schools teachers need to experience success as individuals. The development of a confident professional identity can be supported by creating opportunities for teachers to experience the esteem of the children, parents, colleagues and other stake-holders.

12.8.2 Beliefs and attitudes

Teachers' association of CPD with short in-service needs to be explored with teachers. The investment attitude towards CPD evident in many responses needs to be re-directed towards a new form of 'return'. Instead of teachers pursuing CPD for the financial rewards or Extra Personal Vacation days, teachers need to make the link between CPD participation and improved student outcomes which might provide the impetus for participation. If EPV days remain the only attraction in pursuing summer courses, found by many to be ineffective in terms of impact on practice, many participants suggested that these days could be awarded for time spent outside of school hours but during term-time on CPD activities. The clear message from teachers is that CPD must be immediately relevant to practice and they want long-term support for their efforts to change. This signifies the desirability of basing CPD on-site and making it site-specific. The WSIS trials suggest that this is feasible.

Teachers' attitudes regarding the relevance of subject mastery also need to be addressed if Irish primary teachers are to come to grips with the challenges of the demanding 1999 science curriculum. This needs to be addressed by the Colleges of Education, who ideally should carry out an inventory of concepts understood by under-graduates, with a view to increasing their personal understanding before attempting any science pedagogy. It is also my belief that science courses in Colleges of Education should be standardised and mandatory for all colleges. Programmes of science CPD must commit to the development of secure subject mastery if teachers' confidence teaching science is to improve.

Teachers' apparent disregard for the contribution of research to their practice needs to be explored with teachers with a view to enabling them to become "capable of applying research to their work in a constructive and reflective way" (Sahlberg et al., 2012, p.13).

12.9 Conclusions and Recommendations Regarding School Factors

In this section I make recommendations in the light of the findings regarding the leadership and support culture necessary to facilitate a Whole-School, In-School model of science CPD.

12.9.1 Leadership

Principals who distance themselves from the change effort reinforce a 'deficit' view of CPD. Principals also need access to support themselves, possibly in the form of coaching, in order to explore their attitudes to CPD; valid use of school time; opportunities for staff collaboration; opportunities for leadership from within the staff; opportunities for dialogue, reflection and observation. Without reflecting on and justifying the values which determine their decisions, principals could potentially unwittingly undermine change efforts (Borman et al. 2005, p.29).

Training of CPD leaders from within staffs would be beneficial if this method of CPD were to be extended to other schools. As well as ensuring adequate subject mastery among leaders, this training should also include some preparation to coach/mentor.

12.9.2 Support culture

Extending the school community to include parents and local businesses proved a valuable source of support for teachers' efforts to change during the WSIS programme. Parents are keen to have more involvement in the educational aspect of school life (NPC, May 2012). My work with the Home Education Network of Ireland has served to increase my awareness of the potential of parents to be a driving force for change on behalf of their children. Schools would do well to harness this source of support for their efforts.

CPD programmes should be based on a rigorous needs analysis of both whole school and individual needs and ideally should have a whole school community approach where the community consists of all teaching and non-teaching stakeholders in the children's education. To be 'whole school', one language and one focus across the community was found to be effective, with the emphasis on improving collective capacity.

There ought to be a collective approach to organising and sharing resources and materials for science lessons to reduce the burden on individuals. A successful method used as part of the WSIS model was to pursue the same topic at the same time within a school, so that the same materials and equipment might be shared.

The processes of dialogue, observation, reflection and repeated teaching of the same lesson are considered to be worthwhile means of increasing confidence among teachers. Time for these CPD activities needs to be negotiated with teachers and acknowledged by principals as legitimate use of school time.

It is clear that Irish teachers, because of the culture of isolationism in Irish primary schools, do not have sufficient opportunity to experience the affirmation of their colleagues. Because of the lack of mobility within the profession and in the absence of affirmation, teachers may find it difficult to sustain the moral purpose of teaching. It is imperative that teachers enjoy extended support from the whole school community and external providers of expertise if their change efforts are to succeed.

12.10 Conclusions and Recommendations Regarding External Factors

The data generated by the NNA survey revealed that Irish primary teachers hold negative views about the relevance of the work of the third level community to their practice. This research provides evidence that the traditional model of teachers individually pursuing post-graduate qualifications in third-level institutions is not only too expensive, but this method of upskilling teachers is too remote from practice. This traditional format of professional development reinforces a view of CPD as extraneous to practice and 'extraordinary'. It is also unlikely to be effectual in terms of systemic reform (as evidenced from TS1 where three members of staff who had completed the post-graduate diploma in science were unable to effect change among their colleagues prior to the WSIS programme).

The NNA data were very clear that Irish primary teachers are not convinced of the relevance of research to their practice (Chapter 6, Section 6.2.2). This perception of third level research was echoed in the work of Fisher and Rogan (2012, p.130, p.132). While Irish teachers seem to reject the relevance of educational journals and the research reported therein (Chapter 6, Section 6.3) this does not mean that third level institutions do not have a vital role to play in developing the professionalism of primary teachers. Chapter 8 concluded that socio-constructive theories underpin effective professional development. Warford (2011) in Postholm (2012, p. 406) claims that teachers "may be assisted in their zones of proximal development by more competent others". My role as the "more competent other" was essential to the entire programme. The expertise to teach the subject matter, to model the required methodology and to mentor/coach participants did not exist within the school community prior to the project. Developing leadership skills, providing subject-matter expertise and pedagogical expertise are all the remit of external agencies such as third level institutions. These can also provide the training in research skills necessary to enable teachers to incorporate research into their practice (Sahlberg Munn and Furlong, 2012, p.14-15).

I now make some proposals regarding the utilisation of inter-school networking, higher education expertise and community-based stakeholders to support teachers' efforts to improve practice.

12.10.1 Inter-school networking

Time constraints, restrictions imposed by P1 and teachers' impatience to rush onto the next topic limited the amount of re-teaching of revised lessons experienced in the two Trial Sites. Both Halai (2006) and Dillon et al. (2002) acknowledge the value of presenting work for one's peers, as is integral to the practice of *Jugyou Kenkyuu*.
In an effort to support teachers to avail of this aspect of the model more effectively, I propose that a network of cooperating schools might re-teach amended lessons to

each other. This would broaden the level of support for the change effort and would also increase the motivation to improve lessons so that they are capable of being showcased. This exchange of growing expertise would also increase teachers' autonomy and authority as well as providing a source of affirmation for teachers.

12.10.2 Higher education expertise

Third level institutions need to rethink how they interact with teachers. They should recognise teachers as equal partners/co-researchers in the CPD process and allow teachers negotiate the nature and amount of support which they need. Working more in tandem with schools to provide on-site and site-specific research and development as in the case of the WSIS programme would be more supportive of a culture of teaching where "ongoing and lifelong professional learning embedded in schools" is "a natural and expected component of teachers' professional activities"(OECD 2010, p.32).

> In addition to the lecture itself, in order for the learning process to be optimal, the dialogue must continue – which, for teachers, means continuing the dialogue in school.
> (Postholm 2012, p.407)

This centrality of teachers was the essential difference noted between Western and Eastern programmes of CPD in Chapter 3, Fig. 3. 2. External expertise is particularly necessary for developing subject-matter mastery and research skills among teachers. The pre-service education of teachers in Ireland needs to be brought into line with international best practice (Sahlberg et al. 2012, p.14-15). This means increased attention to developing among teachers a facility with research methods and familiarity with using research evidence to support professional decisions. Empirical evidence from this research indicates that it behoves providers of initial teacher education in Ireland to address deficiencies in science subject matter knowledge among under-graduates in order to increase confidence teaching the science curriculum.

12.10.3 Community-based stakeholders

Involving the local community in the schools' efforts to improve the provision of science was a source of motivation and support for teachers attempting to change their practice during the WSIS CPD trials. Connecting the efforts of schools to learn science with local businesses or individuals as exemplified by the new Junior Entrepreneur Programme (www.juniorentrepreneur.ie) could potentially be a source of support for teachers trying to improve their practice in the area of science.

12.11 Further Work to be Done

This study raises some questions. How long would the WSIS programme need to run before teachers could successfully assume responsibility for coaching each other? What is needed to embed this method of professional development in teachers' practice? Should principals receive specific preparation to empower them to facilitate a model of CPD based on the WSIS principles? If so, what form should this preparation take? What kind of preparation would CPD leaders need to empower them to improve the subject mastery of participants and to introduce coaching as a means of long-term support? Who should these CPD leaders be? Is there sufficient scientific expertise available among the current cohort of primary teachers?

A burning issue in both trial schools was the issue of time for CPD activities. The experience at both Trial Sites was that it was possible to learn while teaching. However, in order to build collaborative relationships, child-free time is needed. Is it possible to negotiate time for professional development activities outside of school hours? If so, what incentives are needed to persuade teachers to invest personal time in CPD activities? Teachers were very enthusiastic about preparing for new lessons but how do we motivate them so that they take adequate time to reflect and revise lessons? Is there a possibility that teachers might re-teach a revised lesson to classes in a partner school?

I believe that the absence of a strong culture of science teaching in Irish primary schools heretofore means that it will take time to develop a culture of collaborative CPD systemically. The two trials of the WSIS model of science CPD has illustrated that all Irish primary teachers are capable of understanding and teaching science concepts well, because they have a strong tradition of excellent pedagogy premised on a child-centred education. If Irish primary teachers receive an adequate scientific education in Colleges of Education and embrace collaborative CPD as part of their professional identity, there is no reason why every primary teacher in Ireland, when motivated to do so, should not become an excellent teacher of science.

APPENDICES

APPENDIX I: Summary of all Data Collected for This Research Project

Item	Data Collected	Research Tool	Details
1.	National needs analysis	Questionnaire	467 of 1000 primary teachers surveyed
2.	Pre-Intervention individual teacher needs analysis	Questionnaire and Semi-structured interview	Trial Site 1: 13 teachers
3.	Pre-Intervention school needs analysis	Semi-structured interview/ conversations with principal	Trial Site 1: Principal
4.	Account of Action Research	Observation Individual teacher journals Researcher journal Video and written recordings of planning meetings and lessons	Trial Site 1: Principal 13 Teachers Children Parents
5.	Post Intervention evaluation	Questionnaire and semi-structured interview	Trial Site1: 13 Teachers
6.	Post Intervention evaluation	Semi-structured interview	Trial Site 1: Principal
7.	Post Intervention evaluation	Questionnaire	Trial Site 1: Parents
8.	Post Intervention evaluation	Questionnaire	Trial Site 1: Children
9.	Pre-Intervention individual teacher needs analysis	Questionnaire and Semi-structured interview	Trial Site 2: 11 Teachers
10.	Pre-Intervention school needs analysis	Semi-structured interview/ conversations with principal	Trial Site 2: Principal
11.	Account of Action Research	Observation Individual teacher journals Researcher journal Video and written recordings of planning meetings and lessons	Trial Site 2: 11 Teachers, Principal, Children, Parents.
12.	Post Intervention evaluation	Questionnaire and semi-structured interview	11 Teachers
	Post intervention evaluation	Semi-structured interview	Principal (TS2)
13.	Post Intervention evaluation	Questionnaire and Semi-structured interview	11 Teachers
14.	Post Intervention evaluation	Questionnaire and Semi-structured interview	Parents
15.	Post Intervention evaluation	Questionnaire	Children

APPENDIX II: Comparison Between the General Characteristics of Case Study Research and the Characteristics of this Study

General characteristics of case study research (Hitchcock and Hughes, 1995)	**Characteristics as applied to the study**
1. Concerned with a rich and vibrant description of events relevant to the case.	1. The large amount of data gathered gives a detailed picture of life in a typical Irish primary school during 2008-2009 and the factors which support/mitigate against teachers participating in whole-school, in-school CPD.
2. Provides a chronological narrative of events relevant to the case.	2. Chronological sequence of events is detailed in Appendix XV.
3. Blends a description with the analysis of the events.	3. Detailed descriptions of events and their analyses are given in Chapters 7, 8, 9, 10 and 11.
4. Focuses on individual actors or groups of actors and seeks to understand their perception of events.	4. The study attempts to understand teachers' perspective of the problems and possible solutions.
5. Highlights specific events that are relevant to the case.	5. The theoretical framework developed is used to analyse the data and isolate relevant aspects.
6. The researcher is integrally involved in the case.	6. I worked as a full time member of staff in TS2 and was intimately involved in the day to day life of TS1. By adopting a full time teaching role, I eliminated, or at least reduced, the 'researcher versus the researched' phenomenon.
7. An attempt is made to portray the richness of the case in writing up the report.	7. The variety of research tools and the perspectives of various stakeholders combine to give a multi-faceted view of the research project.

APPENDIX III: Comparison of Action Research Methodology with this Research Study

Characteristics of Action research as outlined by Argyris and Schon, 1991 p.86	**Characteristics of Action Research as applied to this study**
1. Action research takes its cues - its questions, puzzles and problems - from the perceptions of practitioners within particular, local practice contexts.	1. Teachers in the two trial schools were aware to varying degrees of their inability to provide a structured, cohesive science programme within the school and expressed difficulty accessing CPD which specifically addressed their personal needs and the particular needs of their schools.
2. It bounds episodes of research according to the boundaries of the local context.	2. The staff of each trial school differed in the degree to which they acknowledged problematic provision of science. In both cases they almost unanimously voted to pursue a Whole School, In School (WSIS) programme of CPD. In Trial Site 1(TS1) a period of one term was initially agreed upon. At the end of the first term participants sought to re-negotiate the boundaries. In Trial Site 2 (TS2) it was agreed to trial the model over one school year.
3. It builds descriptions and theories within the practice context itself…..	3. Teachers constantly revised the manner in which they received support for their change efforts. This was done in response to reflection on their own practice ‘
4. ……and tests them there through intervention experiments	4. The intervention model was implemented over one school term in TS1 and over one school year in TS2. At the end of each month the model was reviewed and modified accordingly.
5……which bear the double burden of testing hypotheses and effecting some putatively desired change in the situation.	5. The model was evaluated continuously both by the researcher and the participants in terms of how the teachers and their practice were changing as a result of the intervention. “Change was a process not an event.” (Fullan, 1993, p.3)
6. Conclusions about the efficacy of the intervention.	6. Conclusions based on the findings of data collection tools were discussed and agreed with participants - teachers, children and parents.

APPENDIX IV: Overview of Research Strategies and Timeframe

Overview of Research Methodology	**Timeframe**
Survey Postal questionnaire administered to a random sample of 1000 teachers - The National Needs Analysis (NNA)	December 2007
Case-Study 1: Needs Analysis Questionnaire; Individual and Group Mentoring and Coaching; School Observation; Lesson Observation; Staff and Individual Teacher Education; Trials of Constructivist Teaching Methodologies; Home/School technology project; Participant Journals; Researcher Journal; Interviews; Evaluation Questionnaires to multiple stakeholders i.e. teachers, principal, parents and children.	Spring-Summer term, February-June. 2008
Case-Study 2: Needs Analysis Questionnaire; School and Lesson Observation; Experimental Teacher Education (Whole staff and individual); Experimental Parent Education; Individual and Group mentoring and coaching; Trials of Constructivist Teaching Methodology; Trials of Team Teaching Methodology; Participant Journals; Researcher Journal; Interviews; Evaluation Questionnaires to multiple stakeholders, i.e. teachers, principal, parents and children.	School year, September 2008-July 2009

APPENDIX V: National Needs Analysis

Science In-service Needs of Primary Teachers

Part 1: General Information

(a) School Information

1. Situation of your school: ☐ Urban ☐ Rural
Please tick.

2. Number of Teachers: Males ______ Female______
Please tick.

3. Is your school: **Please tick.**

☐ All-boys ☐ All-girls ☐ Co-educational ☐ Single sex with co-educational Infant department

(b) Personal Background

4. Gender: **Please tick.** ☐ Male ☐ Female

5. Age range: **Please tick.**
☐ 20-30 years ☐ 31-40 years ☐ 41-50 years ☐ 51+ years

6. How long have you been teaching at primary level? **Please tick.**
☐ 0-5 years ☐ 6-10 years ☐ 11-20 years ☐ 21-30 years ☐ 30+ years

7. Are you: **Please tick.**
☐ Administrative principal ☐ Teaching principal ☐ Class teacher ☐ Resource teacher

8. Which class/classes are you presently teaching? **Please tick.**

☐ Infants ☐ 1^{st} ☐ 2^{nd} ☐ 3^{rd} ☐ 4^{th} ☐ 5^{th} ☐ 6^{th}
Other (Please specify)
____

9. Number of pupils in your class? Girls_____ Boys ______

Part 2: Primary Science In-service received

(a) Mandatory Department of Education and Science Courses

10. Did you attend **primary science** in-service courses in preparation for the 1999 primary curriculum, provided by the Department of Education and Science? **Please tick.**
If **No**, please proceed to **Section (b)** ☐ ☐

Yes No

11. Location of in-service: ________________

12. Duration of in-service: ________________

13. How would you rate the science in-service you received? **Please tick.**

☐	☐	☐	☐	☐
Extremely helpful	Very helpful	Helpful	Unhelpful	Very unhelpful

Please explain: ____

____

(b) Voluntary Courses

14. Apart from the DES courses prior to the introduction of the 1999 curriculum, did you attend any other science in-service courses in the last **5 years**? **Please tick:**
☐ ☐
YES NO

If **NO**, why not?

____

____

If you answered NO to Q.14, please proceed to **PART 3.**

15. If you answered **YES** to Q.14, in which years: **Please tick.**

☐	☐	☐	☐	☐
2003	2004	2005	2006	2007

16. **Please tick** the appropriate boxes to describe the **Most Recent Science In-service** received.

Title and approx. date	**Duration**	**Location**	**Tutors**	**Qualification**
	1 day ☐ 1-3 days ☐ Week ☐ Month ☐ Year ☐ Other ☐ Please specify ______________	In school ☐ Ed. centre ☐ 3rd level ☐ Other ☐ Please specify __________________	Colleagues ☐ 3rd level ☐ Cuiditheoirí ☐ Other ☐ Please specify ___________________	None ☐ Cert ☐ Diploma ☐ Degree ☐

17. How would you rate the In-service received**. Please tick.**

☐ Very good ☐ Good ☐ Average ☐ Poor ☐ Very Poor

Why?

____

____

18. **Please complete the following sentence:**
This course **would/would not** inspire me to do similar courses because:
(Mention duration, location, tutors, course content, materials, relevance to class work)

____

____

____

19. In your opinion, how easy is it to access **primary science in-service courses** relative to other subject areas? **Please tick**.

☐ Much easier ☐ Easier ☐ Unsure ☐ More difficult ☐ Much more difficult

Part 3: Education and Training

20. Teaching Qualifications**. Please tick highest qualification.**

☐ National Teacher ☐ B.Ed ☐ Primary degree + Post grad dip. ☐ Postgraduate degree ☐ Other (please specify) ___________________

21. Science subjects studied. **Please tick highest level studied.**

Junior Cert.	**Leaving Cert.**	**Science Degree**
	Biology ☐	Biology ☐
Science ☐	Chemistry ☐	Chemistry ☐
	Physics ☐	Physics ☐

22. Approximate number of hours you currently teach science ***per week.***
Please tick.

☐	☐	☐	☐
Less than 1 hour	1 hour	1-2 hours	2 hours or more

23. How would you rate your level of confidence teaching the following subjects?
Please tick.

Subject	Very confident	Confident	Some confidence	Poor confidence	No confidence
English					
Geography					
History					
Irish					
Maths					
Science					

24. How well **do you feel** you were prepared to teach these aspects of science **in training college**? **Please tick.**

Strand	Well prepared	Prepared	Some Preparation	Not well prepared	Not prepared at all
Working scientifically					
Designing and making					
Living things					
Energy and Forces					
Materials					
Environmental awareness					

25. Do you think science should be taught at primary level? **Please tick**.

☐	☐
YES	NO

26. In your opinion, how important is primary science, relative to most other subjects? **Please tick.**

☐ Not as important ☐ Less important ☐ About the same ☐ More important ☐ Much more important

Please explain:

___

___

27. Do you feel you need to undertake further training in primary science?

Please tick.

☐ YES ☐ NO

Please explain:

___

___

28**.** How would you rate your **confidence** teaching the following aspects of the science curriculum?

Topic	Very confident	Confident	Some Confidence	Poor confidence	No confidence
Human body					
Plant and animal life					
Environmental awareness					
Heat and temperature					
Sound					
Light					
Forces					
Electricity					
Magnetism					
Chemical and physical changes					
Properties of materials					
Solids, liquids and gases					

29. If you were doing a course on primary science, which of the following aspects would you like help with? **Please tick.**

Aspect	A lot	Considerable	Some	A little	None
Personal scientific knowledge					
Teaching ideas					
Investigations					
Concept development					
Other (please specify)					

30. How essential are the following aspects of an in-service course **to you**? **Please tick.**

Aspect of course	Very important	Im-portant	Slightly im-portant	Not nec-essary	Completely unnecessary
Opportunity to identify school needs.					
A focus on my individual needs.					
Recent relevant research					
Tutors with relevant classroom experience					
Opportunity to try out new methods and materials in own classrooms between sessions					
Realistic ideas about how to teach particular topics					
Materials to support teaching					
Opportunity to observe other teachers					
Time for discussion and reflection					
Long term support from knowledgeable others					
Other (please indicate how necessary you consider it to be)					

31. Which **time** structure would you prefer**? Please indicate your preference by ranking 1 to 5, where 1 indicates your first choice and 5 your least preferred option.**

1 day -3 days ☐
1 week in the summer ☐
Built into working day ☐
Afternoon / evening sessions during term ☐
Online course ☐

32. Which of the following options would you prefer? **Please tick.**

☐ A one-off continuous course ☐ A two-part course with time for trial of ideas in between

Explain your choice____

33. Which **location** would you prefer? **Please indicate your preference by ranking 1 to 4, where 1 indicates your first choice and 4 your least preferred option.**

School ☐

Education Centre ☐

3rd level ☐

Other (please specify) ☐

____

34. How significant are the following **constraints** on in-service participation?
Please tick.

Constraint	Very Sig-nificant	Sig-nificant	Slightly significant	Insignificant	Completely Insignificant
Teacher’s time					
Finance					
Lack of local providers					
Family responsibilities					
Lack of interest					
Additional work-load					
Poor quality/ unsuitable courses					
Other (explain)					

35. An additional qualification e.g. a certificate/diploma course at university level, tailored to your needs as a teacher of primary science, costs approx. €1200 per year. How willing are you to participate in such a course?

☐ Extremely willing ☐ Very willing ☐ Willing ☐ Unwilling ☐ Extremely unwilling

Please explain your answer:

____

____

36. **Any other general comments**:

____

____

____

____

Thank you for taking the time to complete this questionnaire. It is sincerely appreciated.

APPENDIX VI: Pre-Intervention Needs Analysis (TS1 and TS2)
Needs Analysis for Pilot Schools

1. Do you think Science should be taught at primary level? **Please tick**.

YES ☐ NO ☐

2. In your opinion, how important is Primary Science, relative to most other subjects? **Please tick.**

☐	☐	☐	☐	☐
Much more Import	More important	About the same	Less important	Not as important

Please explain your answer.

____

____

3. Do you feel you need to undertake further training in Primary Science?
Please tick.

YES ☐ NO ☐

4. How important **to you,** is the improvement of **Science** teaching **in your school**?

Very important	Important	Somewhat important	Not very important	Not important at all

5. Is there a fellow member of staff with whom you feel you could speak frankly in order to raise your confidence in the area of **Science**?
Please tick.
YES ☐ **NO** ☐

6. Do you believe working with the whole staff, in cooperation with a coach, for a number of weeks is a realistic way to raise the confidence of the staff in teaching Science?
YES ☐ **NO** ☐

7. Which strand of the Primary Science Curriculum would you choose as a topic for development in your school?

Strand	
Living Things	
Forces and Energy	
Materials	

8. How would you rate your confidence teaching these subjects?

Subject	Very confident	Fairly Confident	A Little confidence	Poor confidence	No confidence
English					
Geography					
History					
Irish					
Maths					
Science					

9. How well **do you feel** you were prepared to teach these aspects of science **in training college?**

Please tick.

Strand	Well prepared	Prepared	A little Preparation	Not well prepared	Not prepared at all
Working scientifically					
Designing and making					
Living things					
Energy and Forces					
Materials					
Environmental awareness					

10. How well **do you feel** you were prepared to teach these aspects of science **at in-service courses provided by the Department of Education and Science**?
Please tick.

Strand	Well prepared	Prepared	A little Preparation	Not well prepared	Not prepared at all
Working scientifically					
Designing and making					
Living things					
Energy and Forces					
Materials					
Environmental awareness					

11. How would you rate your **confidence** teaching the following aspects of the Science curriculum? **Please tick**

Topic	Very confident	Confident	Some confidence	Poor confidence	No confidence
Human body					
Plant and animal life					
Environmental awareness					
Heat and temperature					
Sound					
Light					
Forces					
Electricity					
Magnetism					
Chemical and physical changes					
Properties of materials					
Solids , liquids and gases					
Designing and making					

12. How would you rate your confidence teaching **Science** to the following class levels?
Please tick

Class	Very Confident	Confident	Some confidence	Poor confidence	No confidence
Special Needs					
Junior Infants					
Senior Infants					
1stclass					
2nd class					
3rd class					
4th class					
5th class					
6th class					

13. How would you rate the following contributors to your lack of confidence in **Science** with a particular class level? (Not necessarily your own class).
Please specify the class.

Reason	Major contributor	Contributor	Partial contributor	Minor contributor	Not a contributor
Lack of suitable teaching ideas.					
Lack of experience teaching at this level.					
Lack of sufficient Scientific knowledge.					
Classroom management.					
Uncertainty about concept development.					
Lack of coherent school plan.					
Fragmented implementation throughout the school.					

14. Which of the following aspects of Science teaching would you like to be addressed in an in-school programme of development?
Please tick.

Aspect	A lot	Considerable	Some	A little	None
Personal scientific knowledge					
Teaching ideas					
Investigations					
Concept development					
Classroom management					
Differentiation					
Assessment					
Other (please specify)					

15. How **desirable** are the following factors in a programme of in-school development? **Please tick.**

Support Factors	Very desirable	Desirable	Not sure	Undesirable	Completely undesirable
Opportunity to identify school needs.					
A focus on my individual needs.					
Recent relevant research on teaching skills.					
Opportunity to try out new methods and materials in own classrooms between sessions.					
Realistic ideas about how to teach particular topics.					
Materials to support teaching.					
Opportunity to observe other teachers.					
Time for discussion and reflection with colleagues.					
Long term support from knowledgeable others.					
Opportunity to cooperatively plan and review lessons with colleagues.					
Regular whole staff meetings.					
Regular meetings with other teachers at same class level.					
Other (please indicate how desirable you consider it to be).					

APPENDIX VII: Post-Intervention Evaluation for Pilot School TS1

<u>Reflection on the Science In School Project</u>

Part 1: General Information

Personal Background

1. Gender: **Please tick.**

☐ Male ☐ Female

2. Age range: **Please tick.**

☐ 20-30 years ☐ 31-40 years ☐ 41-50 years ☐ 51+ years

3. How long have you been teaching at primary level? **Please tick.**

☐ 0-5 years ☐ 6-10 years ☐ 11-20 years ☐ 21-30 years ☐ 30+ years

4. Are you: **Please tick.**

☐ Administrative principal ☐ Class teacher ☐ Resource teacher

5. Which class/classes are you presently teaching? **Please tick.**

☐ Infants ☐ 1st ☐ 2nd ☐ 3rd ☐ 4th ☐ 5th ☐ 6th

Other (Please specify)

____

6. Number of pupils in your class? _____________

Part 2: Reflection on the Science in School Project

7. Introduction to Constructivism at Staff Meeting:

How would you rate the introduction to this project? **Please tick.**

☐ Very helpful	☐ Helpful	☐ A little help	☐ Unhelpful	☐ Very unhelpful

Please explain:

____

____

8. Individual/Paired Instruction on Forces:

How would you rate the instruction given to you on Forces?

☐ Very helpful	☐ Helpful	☐ A little help	☐ Unhelpful	☐ Very unhelpful

Please explain:

____

____

9. Observing another teacher teaching science.

(a)Did you have an opportunity to observe another teacher teaching a science class?

☐ Yes	☐ No

(b) If you answered Yes, how helpful was it in increasing your own confidence levels?

☐ Very helpful	☐ Helpful	☐ Unsure	☐ Unhelpful	☐ Very unhelpful

Please explain:

____

____

10. **Materials provided.**

How useful were the materials provided?

☐ Very useful	☐ Useful	☐ Of little use	☐ Not very useful	☐ Useless

Please explain:

____

____

11. Joint Lesson Planning
How helpful were the lesson planning sessions?

☐ Very helpful ☐ Helpful ☐ A little help ☐ Unhelpful ☐ Very unhelpful

Please explain:

____

____

12. Post Lesson conversations
(a)Did you feel enough time was spent on analysing the lesson/s you taught?

☐ Yes ☐ No

(b) If you answered "Yes" how helpful was this in increasing your confidence teaching science?

☐ Very helpful ☐ Helpful ☐ A little help ☐ Unhelpful ☐ Very unhelpful

Please explain:

____

____

13. What was the impact of this project on the children's perception of science?

____

____

____

____

____

14. Sharing ideas with Colleagues
(a) Did you have sufficient opportunity to share ideas with colleagues?

☐ Yes ☐ No

(b) If you answered "Yes" how helpful was this in increasing your confidence teaching science?

Please explain:

____

____

15. How helpful was the provision of equipment for classes taught?

☐ Very helpful ☐ Helpful ☐ A little help ☐ Unhelpful ☐ Very unhelpful

Please explain:

---

16. How confident do you feel about teaching Forces after your participation in this project?

☐ Very confident ☐ Confident ☐ A little confident ☐ Lacking confidence ☐ No confidence

Please explain:

---

17. Did you use any different teaching techniques as a result of this project?

☐ Yes ☐ No

Please explain:

---

18. Would you consider this model of professional development suitable for other areas of the curriculum?

☐ Yes ☐ No

Please explain:

---

19. How did you develop your understanding of Forces during the project?

Source	Very Helpful	Helpful	Fairly helpful	Unhelpful	Very unhelpful
Conversations with Leader					
Conversations with colleagues					
Conversations with family and friends					
Listening to the children					
Listening to other teachers' classes					
Reading					
Internet					
Other(please specify)					

20. How well were the impediments to the teaching of primary science (identified by teachers at the start of the Project) and listed below addressed during the project:

Impediment	Very well	Well	Not well	Poorly	Very Poorly
Lack of teaching ideas					
Insecure knowledge of forces					
Lack of equipment					
Lack of space					
Classroom management issues					

21. Any other comments:

____

____

APPENDIX VIII: Post-Interventions Evaluation for Children (TS1)

Child's Name:

1. How did you find the science classes over the last few weeks?

2. What did you like about them?

3. What did you dislike about them?

4. How was it different to the way you did science before?

5. What did you like most about the project?

6. Would you like to study science when you are older?

APPENDIX IX: Post-Intervention Evaluation for Parents (TS1)

Parents' Questionnaire

Dear Parents,
Your comments on the Science in School project would be very welcome. Please answer the following questions and return the completed page to school on Wed. 4th June. Thank you for your support over the past number of weeks.
Nunci O' Mahony, UCC.

1. How did your child find the science project?

2. What was different about this experience of science compared to previous experiences?

3. Has it made a difference to how your child views science?
(Please explain)

4. Any other comments:

APPENDIX X: Post-Intervention Teacher Evaluation (TS2)

Reflection on the Science In-School Project **(TS2)**

Please tick the appropriate box in each case.

Personal Background

1. Gender

☐ Male ☐ Female

2. Age range

☐ 20-30 years ☐ 31-40 years ☐ 41-50 years ☐ 51+ years

3. How long have you been teaching at primary level?

☐ 0-5 years ☐ 6-10 years ☐ 11-20 years ☐ 21-30 years ☐ 30+ years

4. Please indicate your role in the school.

☐ Principal teacher ☐ Class teacher ☐ Learning support/Resource

5. Which class/classes are you teaching in the present school year?

☐ Infants ☐ 1st ☐ 2nd ☐ 3rd ☐ 4th ☐ 5th ☐ 6th

Other (Please specify)

____

6. Number of pupils in your class (if applicable)____________

Part 2: Reflection on the Science in School Project

7. Introduction to project at Staff Meeting:

How would you rate the introduction to this project?

☐ Very helpful ☐ Helpful ☐ A little help ☐ Unhelpful ☐ Very unhelpful

Please explain:

____

____

8. Individual/small group instruction on Forces?

How would you rate the instruction given to you on Forces?

☐ Very helpful ☐ Helpful ☐ A little help ☐ Unhelpful ☐ Very unhelpful

Please explain:

____

____

9. Individual/small group instruction on Materials?

How would you rate the instruction given to you on Materials?

☐ Very helpful ☐ Helpful ☐ A little help ☐ Unhelpful ☐ Very unhelpful

Please explain:

____

____

10. Observing another teacher teaching science.
(a)Did you have an opportunity to observe another teacher teaching some or all of a science class?

☐ Yes ☐ No

(b**) If you answered Yes, how helpful was it in increasing your own confidence?**

☐ Very helpful ☐ Helpful ☐ A little help ☐ Unhelpful ☐ Very unhelpful

Please explain:

____

____

11. Materials provided.
How useful were the materials (lesson plans; resources etc.) provided?

☐ Very useful ☐ Useful ☐ Of little use ☐ Not very useful ☐ Useless

Please explain:

____

____

12. Joint Lesson Planning
How helpful were the lesson planning sessions?

☐ Very helpful ☐ Helpful ☐ A little help ☐ Unhelpful ☐ Very unhelpful

Please explain:

____

____

13. Post Lesson conversations
(a)Did you feel enough time was spent on analysing the lesson/s you taught?

☐ Yes ☐ No

Please explain:

____

____

14. How would you describe the impact of this project on the children's perception of science?

____

____

____

15. What was the impact of this project on your perception of science?

____

____

____

16. Sharing ideas with Colleagues
(a) Do you feel you had sufficient opportunity to share ideas with colleagues?

☐ Yes ☐ No

Please explain

___
___
___

17. How helpful was the provision of equipment for the lessons you taught?

☐ Very helpful ☐ Helpful ☐ A little help ☐ Unhelpful ☐ Very unhelpful

Please explain:

___
___

18. How confident do you feel about teaching Forces after your participation in this project?

☐ Much more ☐ More ☐ About the same ☐ Less ☐ Much less

Please explain:

___
___

19. How confident do you feel about teaching Materials after your participation in this project?

☐ Much more ☐ More ☐ About the same ☐ Less ☐ Much less

Please explain:

___
___

20. Did you incorporate any different teaching strategies into your teaching as a result of this project?

☐ Yes ☐ No

Please explain:

___
___

21. Would you consider this model of professional development suitable for other areas of the curriculum?

☐ Yes ☐ No

Please explain:

___

___

22. How helpful were the following in developing your understanding of Forces and Materials during the project?

Source	**Very Helpful**	**Helpful**	**Fairly helpful**	**Unhelpful**	**Very unhelpful**
Workshops/lectures on staff development days					
Conversations with colleagues					
Conversations with leader					
Listening to the children					
Observing other teachers' classes					
Reading/Internet					
Teaching with colleagues					
Other(please specify)					

23. Which of the above would you recommend be include in future professional development projects?

___

___

Please explain:

___

___

24. Would you consider participating in this type of professional development again?

☐ Yes ☐ No

Please explain:

____

____

25. Do you feel this type of in-school professional development merits EPV days?

☐ Yes ☐ No

Please explain:

____

____

26. How does this type of professional development compare to other courses you have done in terms of the following elements?

Element	**Much better**	**Better**	**About the same**	**Worse**	**Much worse**
Impact on teaching					
Impact on confidence					
User friendly					
Meeting your professional needs					
Meeting your personal needs					
Impact on time teaching the focus topic					
Impact on children					
Whole staff development					

27. How well were the impediments to the teaching of primary science (identified by teachers at the start of the Project) and listed below addressed during the project?

Impediment	**Very well**	**Well**	**Not well**	**Poorly**	**Very Poorly**
Lack of teaching ideas					
Insecure knowledge of forces					
Lack of equipment					
Lack of space					
Classroom management issues					

28. Do you think this type of course should receive credit towards the award of a post- graduate qualification?

☐ Yes ☐ No

Please explain:

____

____

29. Would you recommend this type of a course to a colleague?

☐ Yes ☐ No

Please explain:

____

____

30. Any other comments?

____

____

____

____

APPENDIX XI: Post-Intervention Evaluation for Parents (TS2)

Dear Parents,
Your comments on the Science in School project would be very welcome. Please answer the following questions and return the completed page and return to school on Friday. 12th June. Thank you for your support over the past year. It is very much appreciated, Nunci O'Mahony.

1. Did your child enjoy the science lessons in school this year?
Yes No

Please explain:

2. Did you avail of the science classes for parents?
Yes No
↑ ↑
If yes, please indicate how helpful they were to your understanding of science.

Very helpful	Helpful	Not very helpful	unhelpful	Very unhelpful

Please explain:

3. Would you be willing to help teachers deliver science lessons in the future?
Yes No
↑ ↑
Please explain:

4. Has the science project made a difference to how your child views science?
Yes No
↑ ↑
Please explain:

5. Would you encourage your child to study science in the future?
Yes No
↑ ↑
Please explain:

6.Any other comments:

APPENDIX XII: Children's Evaluation of Intervention (TS2)

Science in School Project, (TS2) 2008/2009

Child's Name:

1. Did you like doing science this year?

Yes ☐ No ☐

Please explain:

____

____

2. Which did you prefer:

One teacher 5 teachers

Why?

____

____

3. Did you talk about the science classes at home?

Yes ☐ No ☐

Please explain:

____

____

4. Was it different to the way you did science before?

Yes ☐ No ☐

Please explain:

____

____

5. What did you like most about the project?

____

____

6. Would you like to study science when you are older?

Yes ☐ No ☐

Please explain:

____

____

APPENDIX XIII: Summary of the Process used to Develop the Questionnaires Used in this Research

Questionnaire	**Target Population**	**Efforts to ensure reliability and validity**	**Question types (based on advice of Pallant, J. 2007, p.10 and Cohen et al., 2000 p.247)**	**Data sought**
National Needs Analysis (NNA) (Administered by post November 21st 20070 Deadline for return; December 8th, 2007; Number administered: 1000; Number returned: 467.	National Population of Irish Primary Teachers	Piloted in my local school; Re-drafted several times in light of pilot run (Cohen et al., 2000; Munn and Drever, 1996; Wellington, 2000) and input from experienced researchers e.g. supervisors and colleagues from Statistics and Mathematics Departments.	Predominantly closed and numerical with opportunity for elaboration. Some personal data re age, gender, experience sought.	Needs, attitudes and beliefs of national population with regard to 1999 science curriculum; Perceptions of CPD types to best meet identified needs.
Pre-Intervention needs analysis	Staff of TS1	No pilot deemed necessary as this was based on the NNA	Predominantly closed and numerical with opportunity for elaboration. No personal data sought	Needs, attitudes and beliefs towards 1999 science curriculum; Focus topics for intervention; Perception of effective CPD processes.
Post- intervention questionnaire	Staff of TS1	Piloted in my local school; Re-drafted several times in light of pilot study and comments from supervisors and colleagues.	Predominantly closed and numerical with opportunity for elaboration.	Response to CPD model

Post-Intervention questionnaire	Parents of TS1 pupils	No pilot deemed necessary; Re-drafted a number of times in light of in-put from colleagues and supervisors	Open-ended	Response to CPD model
Post-Intervention questionnaire	Pupils of TS1	No pilot deemed necessary; Re-drafted a number of times in light of input from colleagues and supervisors	Open-ended	Response to CPD model
Pre-Intervention needs analysis	Staff of TS2	No pilot deemed necessary as this was adapted from the NNA and TS1 Pre-Intervention questionnaire.	Predominantly closed and numerical with opportunity for elaboration.	Needs, attitudes and beliefs towards 1999 science curriculum; Focus topics for intervention; Perception of effective CPD processes
Post-intervention questionnaire	Staff of TS2	No pilot deemed necessary as this was based on the TS1 Post-Intervention questionnaire	Predominantly closed and numerical with opportunity for elaboration.	Response to CPD model
Post-Intervention questionnaire	Parents of TS2 pupils	No pilot deemed necessary as this was based on the TS1 Parents' Post-Intervention questionnaire	Open-ended	Response to CPD model
Post-Intervention questionnaire	Pupils of TS2	No pilot deemed necessary as this was based on the Pupils' TS1 Post-Intervention questionnaire	Open-ended	Response to CPD model

APPENDIX XIV: Post Intervention Interview Schedule – Teachers, (TS1)

June, 5th, 2008

<table>
<tr><th>QUESTION</th><th>PROMPTS/PROBES</th></tr>
<tr><td>What is your background in teaching? Have you had any experience teaching science before now?</td><td rowspan="7">General prompts/probes:
Can you elaborate a little more?

Why do you say that?
Any other reason?
How did you feel about that?
Do you feel differently now about being observed by colleagues? Is this a problem?
Is there anything else you would like to say?
Why was this?
How could we overcome this?
Can you give me more detail?

Why do you say that?

What would be the benefits of that arrangement?

Neutral statements:
I see, I understand, OK.</td></tr>
<tr><td>In your opinion, are there any benefits in watching another teacher teaching?</td></tr>
<tr><td>Did any other teacher watch you teaching your science class?</td></tr>
<tr><td>Did you watch the DVD that I made of your science class?</td></tr>
<tr><td>What were your thoughts as you watched the DVD?</td></tr>
<tr><td>In your opinion, did you have enough time to discuss the project - classes; science concepts; teaching ideas etc.- with the rest of the staff?</td></tr>
<tr><td>Do you think we should meet as small groups of teachers or as a whole staff?</td></tr>
<tr><td>How would you describe the workload for teachers participating in this project?</td><td>What do you mean by intensive/ demanding/challenging etc?</td></tr>
<tr><td>What do you think were the benefits of keeping the journal?</td><td>Can you elaborate?</td></tr>
<tr><td>This project was run in the third term. Is there a time of year that would be more amenable?</td><td>Why would you choose that particular time of year?</td></tr>
<tr><td>In your opinion, was there enough time for post-lesson analysis?</td><td>Was this an issue for you?
How could more time be found for this?</td></tr>
<tr><td>What did you feel was the best way to assess the children’s progress?</td><td>What makes you say that?</td></tr>
<tr><td>Do you think this project will have any long term lasting effect on your teaching?</td><td>Why do you say that?</td></tr>
<tr><td>What kinds of support do you think you would need to maintain your current level of confidence?</td><td>Can you elaborate on that please?</td></tr>
</table>

What do you think would be the most appropriate amount of time to spend on a project of this nature?	Why would you choose that length of time?
The project sought to improve your confidence in two ways: (i)by supporting your scientific understanding; and (ii)by introducing some new teaching ideas. How well do you think it succeeded in achieving these two objectives?	Why do you say that? Were both objectives equally well met? Would you have liked more of either? Which aspects did you particularly like? Have you acquired any new techniques which you will foster in your teaching?
Do you feel that our emphasis on working from the children's ideas made the direction of the class less predictable?	How did that make you feel? Has your perception of teaching changed at all? Can you elaborate on that? Why do you say that?
Do you feel the project was too ambitious in attempting to get the whole staff involved?	Can you elaborate? What alternatives would you suggest?
How would you compare this type of in service with a summer course or the type of course you normally do? I'd be very interested in your personal views on the value or otherwise of this type of in-service. What made you decide to participate? What sort of things did you learn from it? What do you personally think are the benefits or drawbacks of this model of in-service?	Could you explain this in a little more detail?
Before we finish, is there anything else you would like to say about the project that has not come up in our conversation?	Thank you for so much for all your hard work and so much of your time.

APPENDIX XV: Post Intervention Principal Interview Schedule – (TS1)

Principal, P1
June, 5th, 2008

<table>
<tr><th>QUESTION</th><th>PROMPTS/PROBES</th></tr>
<tr><td>How long have you been principal here?</td><td rowspan="7">General prompts/probes:
Can you elaborate a little more?

Why do you say that?
Any other reason?
How did you feel about that?
Is this a problem?
Is there anything else you would like to say?
Why was this?
How could we overcome this?

Can you give me more detail?

Why do you say that?

What would be the benefits of that arrangement?

Neutral statements:
I see, I understand, OK.</td></tr>
<tr><td>Have you ever attempted whole school development in another subject area before?</td></tr>
<tr><td>As principal, what was your experience of this project?</td></tr>
<tr><td>What was your experience of the management of withdrawing teachers from class?</td></tr>
<tr><td>In your opinion, was the project worth the time invested in it by you and your staff?</td></tr>
<tr><td>Were there any negative impacts on the children as a result of this project?</td></tr>
<tr><td>How do you think, meetings of the teachers might be managed, in order to discuss their ideas and experiences?</td></tr>
<tr><td>How would you describe the workload for teachers participating in this project?</td><td>What do you mean by intensive/ demanding/challenging etc?</td></tr>
<tr><td>What do you think were the benefits of keeping the journal?</td><td>Can you elaborate?</td></tr>
<tr><td>This project was run in the third term. Is there a time of year that would be more amenable?</td><td>Why would you choose that particular time of year?</td></tr>
<tr><td>In your opinion, was there enough time for post-lesson analysis?</td><td>Was this an issue for you?
How could more time be found for this?</td></tr>
<tr><td>What did you feel was the best way to assess the children’s progress?</td><td>What makes you say that?</td></tr>
<tr><td>Do you think this project will have any long term lasting effect on the teaching in this school?</td><td>Why do you say that?</td></tr>
<tr><td>What kinds of support do you think would be need to maintain current levels of confidence?</td><td>Can you elaborate on that please?</td></tr>
</table>

What do you think would be the most appropriate amount of time to spend on a project of this nature?	Why would you choose that length of time?
The project sought to improve confidence in two ways: (i)by supporting scientific understanding; and (ii)by introducing some new teaching ideas. How well do you think it succeeded in achieving these two objectives?	Why do you say that? Were both objectives equally well met? Would you have liked more of either? Which aspects did you particularly like? Have you acquired any new techniques which you will foster in your teaching?
Do you feel that our emphasis on working from the children's ideas made the direction of the class less predictable?	How did that make you feel? Has your perception of teaching changed at all? Can you elaborate on that? Why do you say that?
Do you feel the project was too ambitious in attempting to get the whole staff involved?	Can you elaborate? What alternatives would you suggest?
How would you compare this type of in service with a summer course or the type of course you normally do? I'd be very interested in your personal views on the value or otherwise of this type of in-service. What made you decide to participate? What sort of things did you learn from it? What do you personally think are the benefits or drawbacks of this model of in-service?	Could you explain this in a little more detail?
Before we finish, is there anything else you would like to say about the project that has not come up in our conversation?	Thank you for so much for all your hard work and so much of your time.

APPENDIX XVI: Post-Intervention Teacher Interview Schedule (TS2)

JUNE 12TH, 2009

<table>
<tr><th>QUESTION</th><th>PROMPTS/PROBES</th></tr>
<tr><td>What is your background in teaching? Have you had any experience teaching science before now?</td><td rowspan="7">General prompts/probes:
Can you elaborate a little more?

Why do you say that?
Any other reason?
How did you feel about that?
Do you feel differently now about being observed by colleagues? Is this a problem?
Is there anything else you would like to say?
Why was this?
How could we overcome this?
Can you give me more detail?

Why do you say that?

What would be the benefits of that arrangement?

Neutral statements:
I see, I understand, OK.</td></tr>
<tr><td>In your opinion, are there any benefits in watching another teacher teaching?</td></tr>
<tr><td>Did any other teacher watch you teaching your science class?</td></tr>
<tr><td>What part of the project had the most impact on your confidence teaching science?</td></tr>
<tr><td>Which part of the project did you find least helpful?</td></tr>
<tr><td>In your opinion, did you have enough time to discuss the project - classes; science concepts; teaching ideas etc. with the rest of the staff?</td></tr>
<tr><td>Do you think we should meet as small groups of teachers or as a whole staff?</td></tr>
<tr><td>How would you describe the workload for teachers participating in this project?</td><td>What do you mean by intensive/ demanding/ challenging etc?</td></tr>
<tr><td>Did you keep a journal during the project?</td><td>Can you elaborate? If not, why not?</td></tr>
<tr><td>This project was run for an entire school year. How do you feel about the length of the project?</td><td>Why would you choose that particular time of year?</td></tr>
<tr><td>In your opinion, was there enough time for post-lesson analysis?</td><td>Was this an issue for you?
How could more time be found for this?</td></tr>
<tr><td>What did you feel was the best way to assess the children’s progress?</td><td>What makes you say that?</td></tr>
<tr><td>Do you think this project will have any long term lasting effect on your teaching?</td><td>Why do you say that?</td></tr>
<tr><td>What kinds of support do you think you would need to maintain your current level of confidence?</td><td>Can you elaborate on that please?</td></tr>
</table>

What do you think would be the most appropriate amount of time to spend on a project of this nature?	Why would you choose that length of time?
The project sought to improve your confidence in two ways: (i)by supporting your scientific understanding; and (ii)by introducing some new teaching ideas. How well do you think it succeeded in achieving these two objectives?	Why do you say that? Were both objectives equally well met? Would you have liked more of either? Which aspects did you particularly like? Have you acquired any new techniques which you will foster in your teaching?
Do you feel that our emphasis on working from the children's ideas made the direction of the class less predictable?	How did that make you feel? Has your perception of teaching changed at all? Can you elaborate on that? Why do you say that?
Do you feel the project was too ambitious in attempting to get the whole staff involved?	Can you elaborate? What alternatives would you suggest?
How would you compare this type of in service with a summer course or the type of course you normally do? I'd be very interested in your personal views on the value or otherwise of this type of in-service. What made you decide to participate? What sort of things did you learn from it? What do you personally think are the benefits or drawbacks of this model of in-service?	Could you explain this in a little more detail?
Before we finish, is there anything else you would like to say about the project that has not come up in our conversation?	Thank you for so much for all your hard work and so much of your time.

APPENDIX XVII: Post-Intervention Evaluation Principal's Interview Schedule (TS2)

Principal: P2
June, 5th, 2009

<table>
<tr><td>QUESTION</td><td>PROMPTS/PROBES</td></tr>
<tr><td>How long have you been principal here?</td><td rowspan="7">General prompts/probes:
Can you elaborate a little more?

Why do you say that?
Any other reason?
How did you feel about that?
Is this a problem?
Is there anything else you would like to say?
Why was this?
How could we overcome this?

Can you give me more detail?

Why do you say that?

What would be the benefits of that arrangement?
Was this an issue for you?
How could more time be found for this

Neutral statements:
I see, I understand, OK.</td></tr>
<tr><td>Have you ever attempted whole school development in another subject area before?</td></tr>
<tr><td>As principal, what was your experience of this project?</td></tr>
<tr><td>What was your experience of the management of withdrawing teachers from class?</td></tr>
<tr><td>In your opinion, was the project worth the time invested in it by you and your staff?</td></tr>
<tr><td>Were there any negative impacts on the children as a result of this project?</td></tr>
<tr><td>Time for post lesson analysis was found to be insufficient. How do you think, meetings of the teachers might be managed, in order to discuss their ideas and experiences?</td></tr>
<tr><td>How would you describe the workload for teachers participating in this project?</td><td>What do you mean by intensive/ demanding/challenging etc.?</td></tr>
<tr><td>This project was run over the whole school year. How did you find the amount of time spent on science? Is there a time of year that would be more amenable for a project like this?</td><td>Why would you choose that particular time of year?</td></tr>
<tr><td>We introduced Team-Teaching of science as part of this project in which you participated. What was your experience of this? Do you think it was worth doing for the teachers/children?</td><td>What makes you say that?</td></tr>
</table>

Do you think this project will have any long term lasting effect on the teaching in this school?	Why do you say that?
What kinds of support do you think would be need to maintain current levels of confidence?	Can you elaborate on that please?
What do you think would be the most appropriate amount of time to spend on a project of this nature?	Why would you choose that length of time?
The project sought to improve confidence in two ways: (i)by supporting scientific understanding; and (ii)by introducing some new teaching ideas. How well do you think it succeeded in achieving these two objectives?	Why do you say that? Were both objectives equally well met? Would you have liked more of either? Which aspects did you particularly like? Have you acquired any new techniques which you will foster in your teaching?
What was your experience of the science for parents' classes? Did it make a difference to the children's experience of science? Would you repeat this idea in other subject areas?	Was it at an appropriate level? Was it enjoyable? Did it benefit the home school relationship? How do you think parents felt about being invited to participate?
Do you feel the project was too ambitious in attempting to get the whole staff involved?	Can you elaborate? What alternatives would you suggest?
How would you compare this type of in service with a summer course or the type of course you normally do? Would you recommend this type of course to another principal? Why/Why not? Do you think the work on this course would merit EPV days/accreditation for teachers as opposed to summer courses? I'd be very interested in your personal views on the value or otherwise of this type of in-service. What made you decide to participate? What sort of things did you learn from it? What do you personally think are the benefits or drawbacks of this model of in-service?	Could you explain this in a little more detail?

Before we finish, is there anything else you would like to say about the project that has not come up in our conversation?	Thank you for so much for all your hard work and so much of your time.

APPENDIX XVIII: Matrix for Cross-tabulation of Data Sources with Themes to Report Post-Intervention Data

Summary of how the four data sources informed the framework used in the data analysis in Chapters 8, 9, 10 and 11

Themes from Theoretical Framework	**Post-Intervention data reported in Chapters 8, 9, 10 and 11**	**Interview data**	**Journals**	**Questionnaire data**	**Observation data**
Teacher, School and External Factors	How each of the Factors in the Theoretical Framework interact with one another	√	√	√	√
Teacher Factors	**Identity, Relationships and Change**: The impact of an individual teachers' identity on the development of the whole profession	√	√	√	√
CPD Processes through which relationships are developed	Essential elements of a collaborative culture: Which CPD processes support a vibrant, professional, collaborative culture.	√	√	√	√

APPENDIX XIX: Sequence of Events and the Methodology used in Data Collection and Analysis

Sequence of events for data collection and analysis	**Time Frame**
• Formulate Research Question. and Carry out Literature Review	January 2007 - September 2007
• Design and pilot questionnaire for National Needs Analysis	October - November 2007
• Collect data from the National Needs Analysis in the area of Science for Primary Teachers (“Baseline Data”)	December 2007
• Preliminary analysis of data from National Needs Analysis in the area of Science for Primary Teachers	December 2007 - February 2008
• Develop CPD model and implement it with Pilot School: Trial Site 1 (TS1); Collect data from TS1 via interviews, journals, observation and questionnaires during course of implementation.	February 2008 - June 2008
• Collect data from Trial Site 1 via interviews, journals, observation and questionnaires. (“Post-intervention data”)	June 2008
• Develop Theoretical Framework for Data Analysis	July 2008
• Carry out preliminary analysis of Post – Intervention data from TS1 using Theoretical Framework.	July 2008 - August 2008
• Carry out detailed analysis of Baseline Data using Theoretical Framework.	August 2008 - October 2008
• Modify CPD model and implement in School 2: Trial Site 2(TS2). Collect data during course of implementation.	September 2008 - June 2009
• Collect data from TS2 via interviews, journals, observations and questionnaires. (“Post- intervention data”)	June 2009
• Carry out analysis of all post- intervention data using Theoretical Framework.	July 2009 - July 2010
• Apply strategy developed and Theoretical Framework to assessment of effectiveness of Intervention package.	September 2010
• Results and Conclusions	October 2010 - October 2011
• Recommendations for a National CPD Strategy for Irish Primary Teachers of Science.	December 2011

APPENDIX XX: Summary of How Theoretical Framework Informed the Selection of Themes from Baseline Data

Category from Theoretical Framework (Appendix XIV)	**Themes identified in the baseline data**	National Needs Analysis (December 2007)	Pre-Intervention Needs Analysis Trial Site 1 (February 2008)	Pre-Intervention Needs Analysis Trial Site 2 (September 2008)
Teacher factors	**Science:** Teacher confidence, preparation, beliefs, attitudes	√	√	√
	Profession: attitudes, beliefs, perceptions of professional learning activities	√	√	√
School Factors	School capacity Leadership Professional Culture	√	√	√
External Factors	High Quality external support Award bearing courses Stakeholders	√	√	√
Processes	Mastery Location Duration Collaboration Research Reflection	√	√	√

APPENDIX XXI: Matrix for Cross-tabulation of Data Sources with Themes to Report Post-Intervention Data

Summary of how the four data sources informed the framework used in the data analysis in Chapters 8, 9, 10 and 11

Themes from Theoretical Framework	**Post-Intervention data reported in Chapters 8, 9, 10 and 11**	**Interview data**	**Journals**	**Questionnaire data**	**Observation data**
Teacher, School and External Factors	How each of the Factors in the Theoretical Framework interact with one another	√	√	√	√
Teacher Factors	**Identity, Relationships and Change**: The impact of an individual teachers' identity on the development of the whole profession	√	√	√	√
CPD Processes through which relationships are developed	Essential elements of a collaborative culture: Which CPD processes support a vibrant, professional, collaborative culture.	√	√	√	√

APPENDIX XXII: Summary of NNA Data from Which a Science Profile of Irish Primary Teachers will be Deduced

Factor	As exemplified by…	Location
1. Profile of respondents and profile of national population from which sample was drawn	Gender	5.2.1
	Age	5.2.2
	Experience	5.2.3
	Role in School	5.2.4
	Class size (where applicable)	5.2.5
2. Profile of respondents' schools; Profile of population of schools from which sample was drawn	Size	5.3.1
	Location	5.3.2
	Gender	5.3.3
3. Science profile of Respondents	Post Primary Science education	5.4.1
	Experience of Science at College of Education	5.4.2
	Attendance at Science CPD	5.4.3
	Perception of need for further CPD	5.4.4
4. Attitudes of respondents to Science	Exercise of choice at Post primary Level	5.5.1
	Voluntary attendance at Science CPD	5.5.2
	Time spent teaching Science	5.5.3
	Perception of place of Science on primary Curriculum	5.5.4
	Willingness to pay for post graduate qualification in Science	5.5.5
5. Respondents' confidence teaching Science	Expression of confidence teaching Science relative to English, Irish, Maths, History and Geography	5.6.1
	Expression of confidence teaching topics selected from each of three strands of the Primary Science Curriculum	5.6.2

APPENDIX XXIII: Matrix Linking Analysis Framework with Data from NNA: CPD Factors Pertinent to Irish Primary Teachers

Factors	Principles of CPD deduced from data and aligned with international best practice principles (See Theoretical Framework, Chapter 3, Table 3.2)	Principles of CPD deduced from data which are non-supportive of best practice principles (See Theoretical Framework, Chapter 3, Table 3.2)
Teacher	1.Need for Science CPD acknowledged, Chapter 6, section 6.2.1; Chapter 3, Table 3.2; 2. Desire for CPD to be immediately relevant to practice, Chapter 6, section 6.2.2; Chapter 3, Table 3.2. 3. Desire to avail of opportunity to trial new methods and materials between sessions and avail of feedback on the experience, Chapter 6, sections 6.4.3 and 6.4.4; Chapter 3, Table 3.2; 4.Identification of individual needs valued by majority, Chapter 6, sections 6.3.1 and 6.3.2, Chapter 3, Table 3.2 5. Benefit of Discussion and Reflection valued by majority, Chapter 6, section 6.3.2; Chapter 3, Table 3.2 6. Attitudes to CPD age and gender-related Chapter 6, section 6.6.2, p.63.	1.Perception of CPD as traditional in-service i.e. short, voluntary and individual, Chapter 6, section 6.4.1 and Table 6.12; 2. Negative attitudes towards the place of subject-matter knowledge and the relevance of research to practice, Chapter 6, section 6.2.3 and section 6.3.4; 3. Apathy in pursuing CPD (reflected in third of respondents who indicated "Lack of Interest" as impediment to participation) Chapter 6, Section 6.5.5; 4. Reluctance to engage with identification of individual needs Chapter 6, section 6.3.1; 5. Evidence of strong feelings about the financial cost of CPD, Chapter 6, section 6.6; 6. Individual professional identity does not include sense of responsibility for development of profession, as derived from lack of initiative shown by C.50% in pursuing CPD, Chapter 5, section 5.6.2.
School	1. Importance attached to identification of school needs, Chapter 6, section 6.3.2; Chapter 3, Table 3.2 2. Discussion and Reflection valued by majority, Chapter 6, section 6.3.3 and 6.4.4; Chapter 3, Table 3.2 3. Observation as a means of support valued by majority of respondents, Chapter 6, section 6.3.3; Chapter 3, Table 3.2.	1. Lack of awareness of in-school, collaborative work as legitimate CPD constituent, Chapter 6, section 6.4.1; section 6.3.2. 2. Reluctance to use Observation as a CPD process, Chapter 6, section 6.3.2; 3. Some hesitance about the merits of Discussion and Reflection Chapter 6, section 6.4.2.

External	Long term support from tutors with relevant classroom experience valued, Chapter 6, section 6.3.3 and Table 6.5; Chapter 3, Table 3.2	1. Division between research community and practitioners evident, Chapter 6, section 6.3.4 and section 5.6; 2. Third level provision as currently provided presents greatest combination of identified constraints e.g. time, cost and workload, Chapter 6, section 6.6; 3. Apparent ambivalence regarding the relevance of research to improve practice, Chapter 6, Section 6.3.4, Table 6.9.

APPENDIX XXIV: Bridging the Gap Between Internationally Endorsed CPD Principles and Those Endorsed by NNA Respondents

Internationally endorsed CPD Processes: General Teaching Council for England (GTCE), (2006) www.gtce.org.uk/documents/pubicationspdfs/research_survey07rpt1.pdf	Irish endorsed CPD Processes (NNA, 2007)	The Case Study: Bridging the gap
1. Reflecting on and enhancing practice	This was the clearest message from the data - Irish teachers wish their CPD provision to enhance practice. (Chapter 6, sections 6.2.2 and 6.3.1; Tables 6.3 and 6.4). Evidence of reticence to engage in Reflection on practice.(Chapter 6, Section 6.3.3; Tables 6.4 and 6.8)	Some hesitance about the value of reflection was evident in the data. This may have related to the difficulty of finding time for such reflection. Attitudes of those in positions of authority e.g. principals; CPD leaders etc. to determine the amount of time allocated to CPD processes can negatively impact on time allocation. (See Chapter 6, Section 6.3.4; Borman et al. 2005, p.28). **Possible solution: Address attitudes of decision makers to CPD processes.**
2. Identifying and addressing areas of pupil under-achievement	There was no evidence of awareness of pupil under-achievement in the area of science in the data.	Teachers who lack confidence in their own understanding of some of the major scientific concepts are unlikely to be overly aware of under-achievement among their pupils. **Possible solution: Address deficits in scientific knowledge among teachers**.
3. Developing behaviour management strategies	Behaviour management strategies are most needed where children are actively engaged in hands-on science. This process was not suggested by any respondent.	Many teachers (38%) indicated that they do not avail of the full time allocation for science. This suggests that among this cohort practical hands-on science classes are not the norm. **Possible solution: Immerse teachers in CPD where practical science classes are the norm and modelled.**

4.Career Development	There was evidence of a small percentage of teachers indicating a link between CPD and career development. This was evident among those who were willing to pay for an accredited course and was linked to age and gender of respondents. (See Chapter 6, Section 6.6).	For the majority, CPD was about improving their practice. Opportunities for upward mobility within teaching are limited in the Irish context in the current recession where middle management has been dismantled (See Chapter 2, Section 2.5.6) **Possible Solution: Opportunity to explore and address consciously or unconsciously-held attitudes towards CPD;** **The restoration of middle management in Irish primary schools.**
5. Recognising improvements in their own practice	The data revealed some ambiguity about focussing on individual needs (See Chapter 6, Section 6.3; Table 6.8). Without identifying needs, it would be difficult to be aware of improvement in practice.	The use of formative assessment for children is still uncommon in Irish schools. The process for teacher education is rarely if ever used. **Possible solution: The use of coaching to identify needs and means to address same; Incorporation of Formative Assessment into CPD.**
6. Working with evidence to exercise their creativity and judgement; **Producing, interpreting and managing classroom and pupil data.**	The idea of collecting evidence does not appear to form part of Irish teachers' repertoire of CPD activities. This is reflected in their ambiguous response to the usefulness of research. (Chapter 6, Section 6.2; Tables 6.5 and 6.6) The respondents' desire to trial materials however, reflects a value in using and adapting materials and ideas in their own classrooms. Their desire for feedback indicates that evidence re. the appropriateness of the innovation would be collected for the purposes of review.	Irish teachers seem to equate research with irrelevant theorising. Lack of research experience at either under or post-graduate levels may account for this perception. They do not display a research orientation and do not seem to view their practice as a source of problems to be solved through research. This is reflected in their apathy about creating professional development opportunities for themselves. They seem to await centrally mandated CPD indicating a lack of teacher agency. (See Chapter 6, Section 6.3.3). **Possible solution: Addressing beliefs and attitudes towards notion of "professionalism".** **Introducing research element into pre-service education and CPD.**

7. Discovering, evaluating and embedding effective new approaches to teaching and learning, planning and assessment and the curriculum.	The strongest finding from the NNA data was that Irish teachers want to access "effective new approaches." (See Chapter 6, Sections 6.2.2; 6.3.1; Tables 6.4 and 6.5).	Teachers traditionally have not been sufficiently involved in 'discovering' effective new practices and have been at a remove from curriculum development. **Possible solutions: Classroom research by practising teachers should inform curriculum development;** **Provide long-term in-school support from suitably qualified personnel whose expertise is respected by teachers;** **Explore teachers' values and beliefs about how children learn best.**
8. Exploiting all the opportunities to learn from other teachers. **Developing team working.** **Promoting inclusion.**	Indicators from the NNA quantitative data suggest that there is some ambiguity about such opportunities. **Observation, Discussion and Reflection** as a team are not valued unanimously. The reasons for this ambiguity will be further explored in the qualitative data discussed in Chapters 8, 9 and 10. It is possible that uncertainty about the availability of **time** for such activities may have impacted on responses. Insecure **professional identity** may have been responsible for negative responses to proposals re individual needs-identification and observation.	*While teacher development is the primary vehicle used for improving classroom instruction, our research indicates that individual schools create a context within which professional development facilitated teacher and student learning and that this makes or breaks professional development's ultimate impacts on both instruction and student advancement outcomes.* (Borman et al. 2005, p.202) *Schools have long been considered 'the key agent in mediating relationships across classrooms and teachers and between the school and other influences outside the school' (Cohen and Ball 1999). Their lack of success in effectively playing this role is well documented* (Opfer and Pedder 2011, p.5) *The development of all schools as learning organisations requires a deliberate process of building systems and supports (Collinson and Cook 2007; Earley and Bubb 2004; Loxley et al. 2007). Schools require help and guidance to develop these necessary capacities to support teaching and learning: they cannot do it on their own.* (Opfer and Pedder, 2011, p.22).

	It is evident that **team work** is not well established in all Irish primary schools. (Chapter 6, Section 6.3.3; Table 6.9)	**Possible Solution: Deliberate efforts to build capacity of schools must precede efforts to provide professional development to individual teachers.** **Professional development should primarily take place in school and involve the whole school with the emphasis on team work.**

APPENDIX XXV: Evaluation Checklist for Forces

Name	Push= Change in speed/ shape/ direction	Push= Away	Pull = Towards	Push= Contact only	Push= Non-contact	Push= Human only	Push= Non-human

APPENDIX XXVI: Validation Process

These are some of my initial conclusions from the experience of the WSIS CPD model in this school. Please indicate whether you agree or disagree with the following statements with an A (agree) or D (disagree). Feel free to comment.

Factors		Conclusions	Agree (A)	Disagree (D)
Teacher Factors	Beliefs	I have changed how I think about science. I have changed how I think about in-service/CPD.		
	Needs	I appreciated having my individual needs addressed.		
	Agency	I was able to initiate a cycle of mentoring when I needed it.		
	Awareness of my own capacity	I believe I can teach science better now or know how to access support when I need it.		
	Autonomy	Having a choice about when, where and how I could access support increased my ability to benefit from the CPD provided.		
	Authority	My input was respected and acted on.		
	Self-observation	I benefitted from watching recordings of my own teaching.		
	Increased scientific understanding	The science education and the ongoing conversations with various people in the school has improved my scientific understanding.		
	Increased ability to use constructivist style of teaching	I use some constructivist-type teaching in my class more often now.		
	Opportunity to observe others	Watching more experienced people teaching science helped me to develop my teaching skills.		

	Support from colleagues	Planning, teaching and reviewing lessons with my colleagues improved my confidence teaching science.		
	Support from parents	Having parents to help with various aspects of science teaching helped provide more varied experiences of science in the school.		
School Factors	Leadership	The principal's encouragement for the project helped me to avail of the support available.		
	Discussion	Having time to talk about the science concepts, the science lessons and the way we were learning in school was beneficial.		
	Common focus	Studying the same topic at the same time in the whole school was a good way to learn.		
	School-based	Learning to teach while teaching had more impact on my teaching than summer courses I have done.		
	Team teaching	Working as a group of five to teach one lesson was a good way to increase confidence, enthusiasm and willingness to teach science.		
	Observation	Seeing how other teachers approach topics and manage a class was a good learning experience.		
	Awareness of staff capacity	I have a better appreciation of my colleagues' unique contribution to the school.		

	Affirmation of colleagues	Colleagues' positive comments increased my motivation to learn and teach science.		
	Affirmation of parents	Parents' positive comments increased my motivation to learn and teach science.		
	Affirmation of principal	The principal's positive comments increased my motivation to learn and teach science.		
	Affirmation of children	The children's enjoyment of science increased my motivation to learn and teach science.		
External Factors	Experience of leader	I felt the leader knew what she was talking about and appreciated the complexity of teaching science in primary schools.		
	Relationship with leader	I felt the leader tailored her support to my needs and that she was easy to talk to. I was able to ask questions without being embarrassed.		
	Communication skills of leader	The leader was easy to understand. She was respectful of everybody's contribution.		
	Science education provided	I enjoyed the science education provided and learned from it.		
	Modelling of science lessons	It was a good learning experience to be able to watch the leader teaching my class.		
	Methodology of science teaching	I learned how to teach science constructively by watching the leader teach the staff and teach the children.		
	Resources provided	Having a large range of materials available when designing lessons was very useful.		

	Equipment provided	Having the necessary equipment ready to use in a manner that was easy to distribute to the children was instrumental in increasing my enthusiasm for science.		
	Research evidence	Understanding why I should use constructivist methodologies increased my willingness to try to use these methods.		

Comments:

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