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Examining Special Education Teacher Learning in Mathematics

A thesis written in fulfilment of the requirements for the degree of Doctor in Philosophy (Ph.D.)

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Declaration

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Summary

The purpose of this research study was to understand the factors, individual and contextual, influencing special education teachers acquisition of knowledge and skills for teaching mathematics to pupils with Special Educational Needs (SEN). The study also sought to understand the perceptions and experiences of the participants, of the influence of the mathematics input on a Post Graduate Diploma in Special Educational Needs (PGDSEN) programme on their acquisition of new knowledge and skills. Finally, the understandings of the participants of the transfer of their learning to classroom practice was examined. Barriers and facilitating factors influencing the implementation of their new practices were elicited.

Concerns have been expressed about attainment levels in mathematics (Department of Education and Skills, 2011f; National Mathematics Advisory Panel, 2008). Research has established that developing teacher mathematical knowledge increases the attainment levels of pupils (Hill, Rowan, & Lowenberg Ball, 2005). Some teachers acknowledge that they do not have the necessary skills and knowledge to teach pupils with SEN (Black-Hawkins, 2014). Continuing Professional Development (CPD) is vital to ensure that special education teachers are supported in meeting the specific challenge of teaching mathematics to pupils with SEN (Maccini & Gagcon, 2002). However, professional development for teachers in special education has received “little attention to date” (Florian, 2010a, p. xix).

The literature review for this study provides a contextual framework and justification for the research. **Inclusive education** has placed additional demands on teachers (Greer & Meyen, 2009). Practising teachers perceive that **CPD** is their route to the acquisition of the specialist knowledge required in inclusive education settings (Ware, Butler, Robertson, O'Donnell, & Gould, 2011). Some pupils find it **difficult to learn mathematics** and therefore require **skilled teaching** (Chinn & Ashcroft, 2007; National Council for Curriculum and Assessment, 2007). Although the knowledge base in mathematics difficulties is not as well developed as that of literacy, there is a base of evidence based practices to guide and support teachers to provide quality instruction to pupils with learning difficulties in mathematics (Gersten & Newman-Gonchar, 2011).

The research question and embedded questions which served to elicit the data for this study are as follows:

What factors influence special educators’ teaching of mathematics to pupils with SEN?

- What are the individual teacher factors influencing special educators’ acquisition of knowledge and skills in mathematics?

- What are the contextual factors influencing special educators' acquisition of knowledge and skills in mathematics?
- What are the special educators' perceptions and experiences of the influence of the mathematics input on the PGDSEN programme on their acquisition of knowledge and skills in mathematics?
- What are the special educators' understandings of the transfer of their learning to classroom practice?

Set within a constructivist paradigm, a case study design proved to be an appropriate means of gaining an in-depth insight into the phenomenon, special education teacher learning in mathematics. The study was conducted in four phases over a 30 month period. Primarily qualitative in nature, the data collection methods included questionnaires, measures, interviews, document analysis and reflective diaries. The data were analysed thematically. The themes which emerged from the data were; Inclusive and special education: Policy and provision; CPD and Translating the learning into practice: Teaching mathematics to pupils with SEN. Bronfenbrenner's (1979) ecological theory provided a framework to identify, organise and understand the complexity and interaction of factors influencing special education teacher learning and the subsequent transfer to practice of new knowledge and skills in the present research study.

Participants of this study held positive attitudes to inclusion. However, over half of the cohort expressed some concern about their personal skills and knowledge for teaching pupils with SEN. They believed that CPD would provide a medium for upskilling in SEN. There was considerable variation in the participants' mathematical knowledge for teaching. The participants agreed that the input on mathematics on the PGDSEN programme was relevant to their needs. Influences were seen at three levels – personal, class and whole-school. Participants agreed that they had implemented new practices in their teaching of mathematics to pupils with SEN. The transfer of new learning to classroom practice was more easily achieved when a whole school culture towards inclusion was in place. It was evident that class teachers held a pivotal position in many schools with regard to the implementation of new practices. Structural issues in schools such as access to resources, particularly assessments in mathematics and time to collaborate arose as a challenge to implementing new approaches.

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List of Acronyms

ADHD	Attention-Deficit Hyperactivity Disorder
ASD	Autism Spectrum Disorder
CPD	Continuing Professional Development
DEIS	Delivering Equality of Opportunity in Schools
DES	Department of Education and Skills
DD	Developmental Dyscalculia
DSM-IV	Diagnostic and Statistical Manual of Mental Disorders -IV
DTAMS	Diagnostic Teacher Assessment in Mathematics and Science
DS	Down syndrome
DPMT-R	Drumcondra Primary Mathematics Test-Revised
DTEN	Drumcondra Tests of Early Numeracy
EPSEN Act	Education for Persons with Special Educational Needs Act
EP	Educational Psychologist
EBD	Emotional and Behavioural Disorders
EAL	English as an Additional Language
EU	European Union
EPV	Extra Personal Vacation days
GAM	General Allocation Model
GAM/EAL	General Allocation Model/English as an Additional Language
HI	Hearing Impairment
HEI	Higher Education Institutes
ICDU	In-Career Development Unit
IEP	Individual Education Plan
IPLP	Individual Profile and Learning Programme
ICT	Information and Communications Technology
ITE	Initial Teacher Education
INTO	Irish National Teachers Organisation
LD	Learning Disabilities
LS	Learning Support teacher
LS/RT	Learning support/Resource teacher
LA	Low Achievers
MD	Mathematical Difficulties
MKT	Mathematical Knowledge of Teachers
MLD	Mathematical Learning Disability
MAS-UK	Mathematics Anxiety Scale-UK
MaLT	Mathematics Assessment for Learning and Teaching
MTEBI	Mathematics Teaching Efficacy Beliefs Instrument
MTOE	Mathematics Teaching Outcome Expectancy
MGLD	Mild General Learning Disability
ModGLD	Moderate General Learning Disability
NAMA	National assessments of mathematics achievement
NCCA	National Council for Curriculum and Assessment
NCSE	National Council for Special Education

List of Acronyms (contd.)

NEPS	National Educational Psychological Service
OECD	Organisation for Economic Co-operation and Development
PMTE	Personal Mathematics Teacher Efficacy
PGDSEN	Post Graduate Diploma in Special Educational Needs
PCSP	Primary Curriculum Support Programme
PLNs	Priority Learning Needs
PDST	Professional Development Service for Teachers
PISA	Programme for International Student Assessment
SERC	Report of the Special Education Review Committee
RD	Reflective Diary
RT	Resource Teacher
RtI	Response to Intervention
SDPS	School Development Planning Support
SSE	School Self Evaluation
STEBI	Science Teaching Efficacy Belief Instrument
SACIE-R	Sentiments, Attitudes, and Concerns about Inclusive Education Revised
SESS	Special Education Support Service
SEN	Special Educational Needs
SENO	Special Educational Needs Organisers
SNA	Special Needs Assistants
SpLD	Specific Learning Disability
SSLD	Specific Speech and Language Disorder
TES	Teacher Education Section
TALIS	Teaching and Learning International Survey
UK	United Kingdom
USA	United States of America
VI	Visual Impairment
KWL	What I know, What I want to know, What I have learned
WSE	Whole School Evaluation
WRAT	Wide Range Achievement Test

Chapter 1: Introduction

"I don't care what we do in this room as long as we don't do maths. Ok?"
Johnny, 5th class pupil in conversation with his Resource Teacher (RT) at the beginning of a new school year.

1.1 Introduction

*Johnny (aged 11 years) decided he no longer wanted to learn mathematics. He had a Mild General Learning Disability (MGLD), a negative attitude towards mathematics and he experienced mathematics anxiety. I was a newly appointed Resource Teacher (RT) in a mainstream primary school in a rural town and Johnny was one of my first pupils. As a recent graduate of a Post Graduate Diploma in Special Educational Needs (PGDSEN) programme, I was determined that Johnny was going to achieve in mathematics. And so, little by little, mathematics crept into our daily lessons together. Easy mathematics, fun mathematics, social mathematics, short, achievable lessons. The turning point occurred the day Johnny came to my class and said "Can we do maths first today, Miss?" He was finally achieving in mathematics, albeit at a level three years below his peers, and was clearly enjoying his success. His confidence levels increased. As he came to believe that he could learn mathematics, he asked to be challenged in mathematics. His mother told me of her pride in her son's achievements in mathematics. This story had a happy ending. My personal conviction that **all** children **can** learn mathematics has inspired my work as a special education teacher educator.*

Developing competency in literacy has traditionally taken precedence over mathematics (Berch & Mazzocco, 2007; Geary, 2011). However, society today demands higher standards in mathematics and the importance of mathematical competence for all pupils is now well established (Bryant & Bryant, 2008; Peterson Miller, 2009). In fact, the National Mathematics Advisory Panel (2008), an influential US report, argues that mathematical competency increases both career opportunities and higher income prospects. Yet, attainment levels in mathematics are of concern nationally and internationally (Department of Education and Skills, 2011f; Kilpatrick, Swafford, Findell, & Council, 2001; National Mathematics Advisory Panel, 2008). International measures of attainment levels in mathematics in the United States (US) indicate that performance there is behind that in other countries (Kilpatrick et al., 2001). Forbringer and Fuchs (2014) refer to the findings of the National Assessment of Education Progress (2011) in the US which found that 40% of fourth grade students achieved results which were “at or above the proficient level in mathematics” (p. xi). Similarly in Ireland, National Assessments of Mathematics Achievement (NAMA) carried out in 2004 found that there was no change in achievement in mathematics in the years following the introduction of the revised curriculum (Eivers & Clerkin, 2013). More recently, the performance of 15 year old pupils in the Republic of Ireland was described as “below average” in the Programme for International Student Assessment (PISA) 2009 tests (Department of Education and Skills, 2011f). Intensive efforts are underway here and elsewhere to increase the achievement levels of all pupils in mathematics including those with Special Educational Needs (SEN) (Department of Education and Skills, 2011e, 2011f).

Unfortunately, about 5% to 7% of children find learning mathematics difficult (Geary, 2011; Gersten, Chard, et al., 2009). Most researchers agree that the teacher is a critical influence on pupil achievement in mathematics (Hill et al., 2005; National Mathematics Advisory Panel, 2008). Research has established that developing a teacher mathematical knowledge base i.e. a knowledge of content and pedagogy, increases the attainment levels of her pupils (Hill et al., 2005). In addition to a knowledge of the subject content and its associated pedagogy, evidence based instructional approaches and assessment measures, special education mathematics teachers require a knowledge of the learning characteristics of their pupils and a knowledge of assistive technology to support their teaching (Brownell, Sindelar, Kiely, & Danielson, 2010; Chinn & Ashcroft, 2007; Mastropieri, Scruggs, & Mills, 2011; van Garderen, Thomas, Stormont, & Lembke, 2013).

In recent years, national and international policy directives have influenced the trend to inclusive educational provision in the Republic of Ireland (Government of Ireland, 2004; UNESCO, 1994). Teachers play a central role in creating inclusive practices in schools (Rouse, 2008; Shevlin, Winter, & Flynn, 2013) and generally express positive attitudes towards inclusion (Shevlin et al., 2009). However, the inclusion of pupils with SEN in mainstream schools has placed additional demands on teachers (Ainscow, 2014; Greer & Meyen, 2009). Teaching in inclusive settings not only demands positive teacher attitudes, values and beliefs to inclusion but also requires supports at systems level including time and resources (Forlin, 2010a). Researchers agree that some teachers feel they do not have the necessary skills and knowledge to teach pupils with SEN (Black-Hawkins, 2014; Jordan, Schwartz, & McGhie-Richmond, 2009; Ring & Travers, 2005) and that their Initial Teacher Education (ITE) has left them unprepared for this task (Ware et al., 2011). Practising teachers perceive Continuing Professional Development (CPD) as their route to the acquisition of the specialist knowledge required to fulfil their special education teaching duties (Ware et al., 2011). Maccini and Gagcon (2002) contend that CPD is vital for special education teachers to support them with the specific challenges of teaching mathematics to pupils with SEN. Recent studies indicate the positive influence of CPD on the teaching practices of special education teachers (Rose, Shevlin, Winter, & O'Raw, 2015).

The Combined Post-Graduate Diploma Programme of Continuing Professional Development for Teachers involved in Learning Support and Special Education (PGDSEN) is an accredited, funded CPD programme offered by the Department of Education and Skills (DES) to teachers working in special education in the Republic of Ireland (Department of Education and Skills, 2012a). This programme, offered by seven Higher Education Institutes (HEI) nationwide provides the focus for the current study. The researcher, a special education teacher educator in one of the seven HEI host institutions, had responsibility for the design and delivery of the mathematics input on the PGDSEN programme. This input provides the focus for the current study.

1.2 Rationale

The researcher's experiences as a Learning Support/Resource Teacher (LS/RT) provided the initial stimulus for this study. Overcoming negative pupil attitude, resulting from years of failure in mathematics class proved to be a formidable endeavour. Drawing on the skills and knowledge she acquired on a post graduate programme in SEN, she developed and taught successful mathematics intervention programmes to pupils with SEN. Positive outcomes were noted both in terms of pupil outcomes and pupil attitudes towards mathematics. In her subsequent role as special education teacher educator, the researcher developed and presented the input on mathematics for special education teachers engaging on a PGDSEN programme over a ten year time frame.

This research study therefore, occurred at an opportune time to consider the perceptions of special education teachers on the influence of the mathematics input on a PGDSEN programme on their learning and furthermore to consider their understandings of the ensuing changes in their practice. Given that Sindelar, Brownell, and Billingsley (2010) consider that school context has the capacity to influence the implementation of CPD, it was important also to consider the range of contextual factors influencing the transfer of special education teacher learning to practice.

Given the importance of special education teacher education in mathematics, in developing the mathematics competency of pupils with SEN and the relatively small literature base that exists in this aspect of special education (Feng & Sass, 2010), this research study will provide a valuable contribution to the literature base on CPD in mathematics for special education teachers and the transfer of their learning into classroom practice. The findings will be useful for policy makers, practitioners and researchers alike.

1.3 The Research Question

The purpose of the study was to better understand the factors, individual and contextual, which influenced special education teachers' acquisition of knowledge and skills for teaching mathematics to pupils with SEN. The study also sought to understand the perceptions and experiences of the participants, of the influence of the mathematics input on the PGDSEN programme on their acquisition of new knowledge and skills and their understandings of the subsequent transfer of this learning to their practice in classrooms. The findings will therefore add to the existing limited knowledge base on special education teacher learning in mathematics.

The research question and embedded questions which directed this study are as follows:

What factors influence special educators' teaching of mathematics to pupils with SEN?

1. What are the individual teacher factors influencing special educators' acquisition of knowledge and skills in mathematics?
2. What are the contextual factors influencing special educators' acquisition of knowledge and skills in mathematics?
3. What are the special educators' perceptions and experiences of the influence of the mathematics input on the PGDSEN programme on their acquisition of knowledge and skills in mathematics?
4. What are the special educators' understandings of the transfer of their learning to classroom practice?

The primary/special school teacher cohort of the PGDSEN programme (2012/13) were invited to participate in this four phase research study conducted over a period of two and a half years. Data collected at the baseline phase (n = 32) during the duration of the PGDSEN programme provided the contextual data for the study. Phase 1 (Cohort 1) of the study gathered data on individual teacher attitudes to inclusion, mathematics anxiety, mathematics teacher efficacy and content and pedagogical knowledge in mathematics. Qualitative research in the form of interviews undertaken in the participants' schools in Phases 2 and 3 yielded insights into the perceptions of the participants of their learning and of their understandings of the transfer of their new knowledge to their practice.

1.4 Thesis Outline

This thesis is presented in seven chapters. Chapter one presents the rationale and the research questions which guide the research. A thematic review of the literature is presented in chapter two. Four themes guide the analysis of the literature. The first theme, Inclusion, situates the research study within the context of inclusive educational provision for pupils with SEN. The second theme, Inclusive and special education: Policy and provision examines the influence of inclusive policy developments nationally and internationally on the development of inclusive educational provision in Ireland. Current provision for pupils with SEN in Ireland is outlined. The third theme, Continuing professional development (CPD) provides the context for the PGDSEN programme, the focus of this study. The final theme, Translating learning into practice: Teaching mathematics to pupils with SEN discusses and interprets the terminology associated with learning difficulties in mathematics. It subsequently explores issues relating to the teaching and learning of mathematics to pupils with SEN. The third chapter presents the theoretical framework for the study. Bronnfenbrenner's (1979) ecological theory permitted a broader analysis of the interconnecting factors which supported and negated the acquisition and dissemination of the expertise of the participants following their completion of the PGDSEN programme with a specific focus on mathematics. Chapter four outlines the study's methodological approaches. Set within a constructivist paradigm, a case study framework proved relevant to the collection of data in this study. Primarily qualitative nature, the data collection methods included questionnaires, measures, interviews, document analysis and reflective diaries. The findings of the study are presented thematically, phase by phase (Baseline, Phases 1, 2, 3) in chapter five. The discussion in chapter six, discusses and analyses the findings thematically. Finally, chapter seven, concludes the study. A summary of the findings are presented. The implications and conclusions of the study are discussed. The unique contribution of this study to the research and suggestions for further research conclude this study.

Chapter 2: Literature Review

2.1 Introduction

This literature review aims to establish the literature base relating to special education teacher learning in mathematics for pupils with SEN within an inclusive education system (Creswell, 2012; Robson, 2011). The thematic literature review will identify the existing knowledge base and areas within the literature requiring further development (Rose, Shevlin, Winter, & O'Raw, 2010). The literature relating to each of the four inter-dependent themes of *Inclusion, Inclusive and special education: Policy and provision, Continuing professional development* and *Translating the learning into practice - Teaching mathematics to pupils with SEN* will be presented, discussed and analysed, and will thereby provide a clear context and justification for the current study (Hart, 1998).

In tandem with the move towards inclusive education, education for pupils with SEN continues to change and evolve within a framework of international and national policy directives (Winter & O'Raw, 2010). The first theme, *Inclusion*, begins with a discussion of the concept of inclusion and presents current research on inclusive practices in Ireland. The second theme, *Inclusive and special education: Policy and provision* outlines the development of inclusive and special educational policy in international and national contexts. Education provision for pupils with SEN in Ireland today will be discussed and presented. The third theme, *Continuing professional development,* outlines policy developments in CPD. It focuses specifically on CPD for special educators, giving particular attention to the PGDSEN programme, within the context of the continuum of teacher education. The fourth and final theme, *Translating the learning to practice - Teaching mathematics to pupils with SEN*, clarifies the terminology associated with mathematical learning difficulties and examines the difficulties experienced by pupils with SEN when learning mathematics. The final section of this theme presents a framework for the teaching and learning of mathematics to pupils with SEN.

2.2 Inclusion

Changing trends and practices in special education in recent years have led to much debate on the topic of inclusion (Ainscow, 2014; Meegan & MacPhail, 2006; Winter & O'Raw, 2010). The move towards an inclusive education system, endorsed by the international community, has resulted in education systems in constant flux in their efforts to respond to the demands for an inclusive education system that caters for the diversity of its pupils (Ainscow, 2014; Ferguson, 2008). Led by inclusive whole school approaches in the United States of America (USA), following the passing of the Education for All Handicapped Children Act (1975), the globalisation of inclusion has resulted in the passing of legislation in all European Union (EU) countries to “promote or require inclusion” (Winter & O'Raw, 2010, p. 3). New practices involve changing cultures and structures for all pupils (Ferguson, 2008; Mittler, 2000). The process of inclusive education is a complex task and one which is dependent on factors both within and external to the school (Ainscow, 2014; Mittler, 2000; UNESCO, 2005). The adoption of inclusive practices also involves changes in pedagogical practice for teachers (Forlin, 2010b; Graham & Jahnukainen, 2011).

2.2.1 Understandings of inclusion

Definitions of inclusion abound and vary in their interpretations (Ainscow, 2007b; Armstrong, 2011; Brownell, Smith, Crockett, & Griffin, 2012; Farrell, 2012; Florian, 2008; Westwood, 2013) depending on the context in which they are used, the purpose of the term or who is using it (Armstrong, 2011; Peters, 2007). The absence of a universal definition bears testimony to the controversy the concept generates (Griffin & Shevlin, 2011; Rose et al., 2015) .

Definitions range from a narrow focus on special needs education (Ainscow & Sandill, 2010; Winter & O'Raw, 2010), to a broader focus on accommodating diversity within the school population. At the core of this broader concept is the belief that every child has the basic human right to be educated in a mainstream setting (Ainscow & Sandill, 2010; Florian, 2008). The broader concept of full inclusion, therefore, refers to the teaching of all pupils, irrespective of gender, ethnicity, language, ability or disability, in mainstream settings without the need for special classes/schools or units (Farrell, 2012; Thomas & Loxley, 2007; Winter & O'Raw, 2010). In this instance, additional support is provided in the classroom with the intention that the “child will benefit from being in the class rather than having to keep up with other students” (Meegan & MacPhail, 2006, p. 55). Critiques of this approach suggest that a broader view of inclusion may result in the specific needs of those with SEN not being met in the system (Winter & O'Raw, 2010) due to the focus on the placement of the child as opposed to the needs of the child (Meegan & MacPhail, 2006). For example, Winter & O’Raw (2010) refer to Kauffman (1989) who expressed concern about the efficacy of full inclusion. Hence, given the rights of all children to receive an appropriate education, full inclusion may not meet the needs of a small number of pupils with SEN (Winter & O'Raw, 2010), a point noted in the *Salamanca Statement and Framework for Action on Special Needs Education* (UNESCO, 1994).

Inclusive education in the United Kingdom (UK) and in Ireland has adopted a "flexible continuum of provision" (Westwood, 2013, p. 2), ranging from inclusion in mainstream schools, special classes in mainstream schools or special schools (Department of Education and Skills, 2007a). The continuum of provision promoted in Ireland is reflected in Winter and O'Raw's (2010) model which views inclusion "as a dynamic system that encompasses mainstream schools, special classes, special schools and the wider community" (p. 47). Winter and O'Raw (2010) further elaborate and define inclusive education in the Irish context as a process of

- addressing and responding to the diversity of needs of learners through enabling participation in learning, cultures, and communities; and
- removing barriers to education through the accommodation and provision of appropriate structures and arrangements, to enable each learner to achieve the maximum benefit from his/her attendance at school. (p. 39).

2.2.2 Inclusion in practice

Given the uncertainty and ambiguity which exists in the literature in its efforts to define inclusion (Ainscow, 2007a; Giangreco, Carter, Doyle, & Suter, 2010), inclusive practices in schools will vary from setting to setting informed by the conceptual understanding of inclusion in that context (Florian & Spratt, 2013; McLeskey & Waldron, 2002; Winter & O'Raw, 2010).

Inclusive practice, while generally based on the concept of accommodating all learners within the classroom (Ainscow, 2014; Winter & O'Raw, 2010) and "addressing differences where necessary" (Westwood, 2013, p. ix), also has a broad remit both within and outside of the classroom. Common features of inclusive practices in the literature include positive teacher attitudes, a whole-school culture or community of practice to inclusive education (Ainscow & Sandill, 2010), the provision of CPD for teachers in inclusive practices (Forlin, 2010a), effective leadership for inclusion and the development of Individual Education Plans (IEPs) for some pupils (Winter & O'Raw, 2010).

2.2.2.1 Inclusive pedagogy

The view expressed by Ainscow (2007a, 2014), that teachers form the nucleus of inclusive education practices is widely acknowledged in the literature. Shevlin et al. (2013) recognise that inclusive practice relies on "teacher knowledge, skills, understanding, capacity and attitudes" (p. 1119). Implementing inclusion is, however, a challenge for teachers who wish to embrace inclusive practices by adapting their teaching style to allow for learning by all pupils (Florian & Black-Hawkins, 2010). It is of interest that the teachers in Ring and Traver's (2005) study, were of the opinion that a "specialist pedagogy" was necessary to teach pupils with SEN (p. 48). In contrast, some researchers, such as Lewis and Norwich (2005, 2007), query the need for specific teaching strategies to teach pupils with SEN, given that all teachers endeavour to teach the same curriculum objectives to all learners in their classes. It is noteworthy that Lewis and Norwich (2005) admit that some teaching strategies relevant for low attaining pupils may not be suitable for high attaining pupils, suggesting that there is some flexibility in their views on inclusive pedagogy.

Lignugaris/Kraft and Harris (2014) argue that, just as the role of the general educator and the special educator is quite different, so too is the preparation required. Similar views are expressed by Leko and Brownell (2009). They suggest that "special educators need to know how to assist teachers in delivering content area instruction as well as in providing intensive instruction to students with disabilities on key strategies, concepts and skills" (Leko & Brownell, 2009, p. 65). In support of their views, they refer to the work of Vaughn, Moody & Schumm's (1998) view who emphasise that evidence based instructional approaches such as direct instruction "define what is 'special' about special education" (Leko & Brownell, 2009, p. 65).

2.2.2.2 Teacher preparation for inclusion

There is evidence to suggest that some teachers hold the view that they do not have the skills to teach pupils with SEN and, therefore, lack self confidence in their teaching abilities (Black-Hawkins, 2014; Florian & Black-Hawkins, 2010; Jordan et al., 2009; Rix, Sheehy, Fletcher-Campbell, Crisp, & Harper, 2013; Winter & O'Raw, 2010). For example, following their investigation into special educational provision in Ireland, Shevlin et al. (2008) reported that class teachers believed they had inadequate knowledge and skills to teach pupils with SEN, a finding which was also noted in another recent study on inclusive education conducted in Ireland by Rose et al. (2015) Similarly, in Banks et al.'s (2016) study of special class provision, teachers stated that they did not have the knowledge and skills necessary to work effectively with students who had SEN. These are important findings as perceived lack of knowledge and skills can impact negatively on the ability of schools to provide curricular inclusion for pupils with SEN (Rose et al., 2015; Shevlin et al., 2008). It is also of concern that the results of a study undertaken by Drudy and Kinsella (2009) indicated that CPD opportunities to gain expertise in special education may be inadequate, despite the considerable investment in CPD in recent years (Shevlin et al., 2008). It should be noted, however, that in a study conducted by Rose et al. (2015), teachers who had accessed CPD, were satisfied with the quality of the training they had received.

Several studies undertaken in Ireland highlight the critical need to offer teachers the opportunity to enhance their knowledge and skills in key areas of special education. For example, the special education teachers in a study by O'Gorman and Drudy (2010) requested upskilling in areas of learning difficulties, assessment techniques, teaching strategies and mathematics. Similarly, the findings of Shevlin et al. (2008) and Rose et al. (2015) underline the need for teachers to develop their skills in using assessment strategies. In another study conducted by Travers et al. (2010), teachers were found to require CPD to enable them to develop IEPs.

2.2.2.3 Whole-school approaches to inclusive practice

Inclusive education demands a whole-school response by all members of the school community (Shevlin et al., 2008). Given that "all schools are not equally inclusive" (National Council for Special Education, 2006b, p. 161), the creation of inclusive schools may require additional resources and training as well as changes to existing practices (National Council for Special Education, 2006b; Winter & O'Raw, 2010). The critical role of the principal in promoting inclusive school cultures and in leading whole school approaches to inclusive practices is highlighted in a study conducted by Banks et al. (2016). The results of this research suggest that, the principal plays a key role in the effective management by influencing the way "teacher expertise in special class settings is used" (Banks et al., 2016, p. 6).

The development of a whole school plan or policy on SEN is a legislative requirement of each school (Government of Ireland, 1998). School policies are required to outline, for example, procedures for assessment, differentiation and developing IEPs (Winter & O'Raw, 2010). Research undertaken by O'Gorman and Drudy (2011) and by Shevlin et al. (2009) that while most schools in Ireland had school policies for the inclusion of pupils with SEN, there were instances where the development of such policies was in progress and instances where existing policies were found to be outdated, did not reflect current policy or legislation or were exclusionary in nature (Rose et al., 2015). These practices are at variances with the views of Winter and O'Raw (2010) who emphasise that policies on SEN should "be kept under review and regularly evaluated" (p. 60).

2.2.3 Factors associated with effective inclusion

Positive teachers' attitudes to inclusion are an important factor in developing inclusive practices in schools (Ring & Travers, 2005; Westwood, 2013; Sharma, Forlin, Loreman, & Earle, 2006; Shevlin et al., 2013). A study by Travers et al. (2010) found that the majority of Irish teachers were positively disposed towards inclusion. Research undertaken by Shevlin et al. (2009) supports this finding. However, a certain scepticism about inclusion was observed in some teachers in the study of Travers et al. (2010). Teachers in their study indicated that the lack of time for planning and their lack of skills in SEN impacted on their abilities to include children with SEN (Travers et al., 2010). Teachers in a study undertaken by Shevlin et al., (2013) supported these findings and also indicated that the absence of adequate funding for resources and the lack of external supports for SEN posed difficulties in their efforts to promote inclusive practices. Furthermore, there is evidence to suggest that teachers who are not involved in inclusive practices have more negative attitudes to inclusion (Avramidis & Norwich, 2002). It is suggested that negative attitudes can be difficult to change (Shevlin et al., 2008), and can often be attributed to a lack of expertise in SEN (Westwood, 2013). Attitudes may, however, be changed by training in special education, which has been found to have a positive influence on teacher attitudes towards inclusion (Avramidis & Norwich, 2002).

The nature and extent of the collaboration between the class teacher and the special education teacher is a core factor in successful inclusive practice (Shevlin et al., 2008). However, Westwood (2013) points out that the lack of such collaboration presents an obstacle to inclusion. Shevlin et al., (2008) share Westwood's (2013) views as their research outlines the challenges that exist for collaboration. They point to the reduced opportunities for collaboration, given the preference of some class teachers for the withdrawal model of support. The facilitation of specific collaborative opportunities outside of the school day for class teachers and special education teachers to liaise and plan together, for the development of intervention programmes and IEPs, for liaising with parents and Special Needs Assistants (SNAs) is strongly recommended in the literature (O'Gorman & Drudy, 2011; Ring & Travers, 2005; Shevlin et al., 2009; Travers et al., 2010; Westwood, 2013).

Co-teaching, is an example of a service delivery approach that promotes collaboration between a mainstream class teacher and a LS/RT (Friend, 2014), It was first implemented in classrooms in the mid-1980s in the USA in response to the move towards inclusive practice (Friend, Embury, & Clarke, 2015). This model has also been used in Ireland since the 1990s (INTO, 1994). In its purest form, both the class teacher and a LS/RT "share instructional responsibility and accountability" in a mainstream classroom to deliver a curriculum meeting the needs of all pupils, including those with IEPs (Friend et al., 2015, p. 80). This approach is viewed as a means to "enhance instruction and facilitate learning" in an inclusive classroom (Zigmond, Magiera, Simmons, & Volonino, 2013, p. 116).

Six models of co-teaching, including team teaching and station teaching, have been clearly identified in the literature (Friend, 2014; Murphy & Scantlebury, 2010; Villa, Thousand, & Nevin, 2008). Although a popular inclusive instructional model (Cook, McDuffie, Oshita, & Cothren Cook, 2011), the limited research base on co-teaching to date is largely descriptive and discusses the logistics of co-teaching rather than being evaluative (Cook et al., 2011; Hanover Research, 2012). Following their review of the literature, Cook et al. (2011) cite Zigmond and Magiera's (2001) recommendation that "co-teaching be used with caution" (Cook et al., 2011, p. 148).

The provision of additional support for pupils with SEN in Ireland in the mainstream classroom was first advocated in the Report of the Special Education Review Committee (SERC) (1993) and later specifically outlined as a model for providing additional support to pupils with SEN by the Department of Education and Skills (2005c). Travers et al.'s (2010) study on inclusion in primary and post-primary schools in Ireland found evidence of team teaching in all schools. However, in another study examining the benefits of the withdrawal model in mathematics, Travers (2011) stated that 95% of the learning support teachers continued to support pupils in mathematics, using the withdrawal model. The approach was favoured because "it was easier to spend longer on a particular topic, there was less distraction and easier to keep the pupils on task" (Travers, 2011, p. 469). While team teaching was evident in a more recent study by Rose et al. (2015), the researchers found that Learning Support/Resource Teachers (LS/RTs) were predominantly using an individual or small group withdrawal model as a means of providing additional support to pupils with SEN. It can be concluded, therefore, that while co-teaching is in place in some classrooms, the withdrawal model remains a common approach to providing support for pupils with SEN (Kinsella, Murtagh, & Senior, 2014).

2.2.4 Summary

In common with educational systems internationally, the education system in Ireland has moved towards the provision of an inclusive education for all learners. This shift towards inclusion, directed by policy and legislation, has not been without its challenges. While increased resources to schools have enabled the inclusive movement, concerns remain regarding the capacity of teachers and school systems to provide a fully inclusive education. Key factors in this regard include the provision of CPD for teachers and SNAs, a restructuring of the school day to allow for time for collaboration and planning and the development of positive teacher attitudes to inclusion for all pupils.

2.3 Inclusive and Special Education: Policy And Provision

Educational provision for pupils with SEN has changed dramatically in recent years. While education for those with disabilities was first noted in Europe in the mid eighteenth century and in the USA in the following years, such provision was of a segregated, institutional nature provided by those with humanitarian philosophies and evangelical approaches (Winzer, 2007). The mid 1900s saw the publication of international policy statements asserting the rights of every citizen to education and thereby heralded the concept of inclusive education as we know it today. This section will trace the development of special education provision in both international and national contexts. The concept of inclusion in a special education context will be discussed and analyzed. The final section of this theme outlines the nature of special educational provision in Ireland.

2.3.1 Policy development - International contexts

The right to education for all children, including those with SEN was established and endorsed in international policy documents (UNESCO, 1990; United Nations, 1948). Compulsory elementary education requirements (United Nations, 1948) resulted in the development of educational structures to educate a diverse population (Florian, 2007) and were influenced by a number of international declarations (UNESCO, 1994; United Nations, 1975, 2006). The *World Declaration on Education for All* and its accompanying *Framework for Action* (UNESCO, 1990) stated in Article 3.5 that the "learning needs of the disabled demand special attention" and also stated that procedures be put in place to provide for such education as an "integral part of the education system". The education of children with SEN was subsequently identified and defined in the *Salamanca Statement and Framework for Action* (UNESCO, 1994), a widely acknowledged key document supporting inclusive education in the context of equal access to education for all. (Ainscow, 2007a; Vislie, 2003). It clearly stated "that those with special education needs must have access to regular schools which should accommodate them with a child-centered pedagogy capable of meeting those needs" (UNESCO, 1994, p. viii). Due to the commitment of the international community, including Ireland, the *Salamanca Statement's* definition of inclusive education has influenced policy and practice on a global level (Peters, 2007; Rose et al., 2015).

The publication of the *Dakar Framework for Action* in 2000 provided a continued impetus to the aims of the *Education for All* principles as outlined ten years previously (UNESCO, 2000). It re-assessed progress to date across a wide range of areas including that of inclusive education. A core challenge for Dakar was "to ensure that the broad vision of *Education for All* as an inclusive concept was reflected in national government and funding agency policies" (UNESCO, 2000, p. 14). While reaffirming that the "learning needs of all young people are met through equitable access to appropriate learning and life skills programmes" (UNESCO, 2000, p. 8), it noted the changes in inclusion from preparing children with special needs to "fit into existing schools" to "preparing schools so that they can deliberately reach out to all children" (UNESCO, 1990, p. 18).

In response to the international declarations in respect of the right to education for all (UNESCO, 1994; United Nations, 1948), individual countries developed policies and practices in education incorporating inclusive education (Griffin & Shevlin, 2011). For example, the passing of the *Education for All Handicapped Children Act* (1975) in the USA initiated such reform (Griffin & Shevlin, 2011). Subsequent legislation, including the *Individuals with Disabilities Education Improvement Act* (2004) and the *No Child Left Behind Act* (2001), continue to guide inclusive education (Meaney, Kiernan, & Monahan, 2005; Rouse & McLauglin, 2007) in the USA.

Influenced by the publication of the *Warnock Report* (Warnock, 1978), the passing of the *Education Act* (1981) in the United Kingdom (UK) (Evans, 2007) and the *Salamanca Statement* (UNESCO, 1994), education for pupils with SEN in the 1980s in the UK was grounded in the principles of equity and equal opportunities for all (Winzer, 2007). Special educational needs were defined according to a need for services (Peters, 2007) as opposed to the practice of placing children with disabilities in distinct medical categories (Evans, 2007). Policy and legislation in the UK such as the *Code of Practice on the Identification and Assessment of Special Educational Needs* (1994), the *Special Educational Needs and Disability Act* (SENDA) (2001), and the *Removing Barriers to Achievement* (2004) strategy (DfES, 2004) ensured the right for pupils with SEN to mainstream education (Rouse & McLauglin, 2007). The provision of CPD for teachers in SEN was a key action plan in the UK government's strategy for SEN, *Removing Barriers to Achievement* (DfES, 2004).

2.3.2 Policy development – Ireland

In line with international trends, education for children with SEN in Ireland, has evolved from a segregated provision in special schools and classes towards a more inclusive provision delivered principally in the setting of mainstream schools (Carey, 2005; Flood, 2010; Winter & O'Raw, 2010). This shift in special education provision in Ireland has been influenced by international agreements and national policies albeit at a later stage than the UK and the USA (UNESCO, 1994) (Government of Ireland, 1998, 2004)

2.3.2.1 Report of the Special Education Review Committee (SERC)

While the Irish government committed to the provision of an education for children with disabilities when it became a signatory of the *Convention on the Rights of the Child* (UNESCO, 1989) in 1992, it was the publication of the *Report of the Special Education Review Committee* (SERC) in 1993 which laid the cornerstone for the development of inclusive educational provision for children with SEN (Carey, 2005; Meegan & MacPhail, 2006; NCCA, 1999; Shevlin et al., 2008; Stevens & O'Moore, 2009; Swan, 1994). Its two fold remit included reporting on existing special educational provision and making recommendations for future provision (Department of Education and Skills, 1993). In so doing, the *SERC Report* presented a structured alternative to a special education system which had relied on charitable input to date (Griffin & Shevlin, 2011). The *Report* interpreted special education as “any educational provision which is designed to cater for pupils with SEN, and is additional to or different from the provision which is generally made in ordinary classes for pupils of the same age” (Department of Education and Skills, 1993, p. 18).

A number of principles were presented in the *SERC Report* with the aim of guiding the development of special education provision in Ireland (Department of Education and Skills, 1993). These included the right to education for all children, the provision of a continuum of educational provision, collaboration with parents in decision making and State resourcing for special educational provision (Department of Education and Skills, 1993). While the role of special schools in special educational provision was acknowledged, inclusion in mainstream schools was to occur where possible (Department of Education and Skills, 1993). Subsequent policy developments within the DES enabled the inclusion of children with SEN in mainstream educational settings (Shevlin, Kenny, & Loxley, 2008). Categories of disability were clearly defined in the report (Department of Education and Skills, 1993), despite trends in other jurisdictions to avoid such terminology (Warnock, 1978).

The findings and recommendations of the *SERC Report* (Department of Education and Skills, 1993) with regard to the training of teachers in special education are of particular relevance to the current research study. It noted that the “success of special educational provision for pupils with SEN is the quality of their teachers” (Department of Education and Skills, 1993, p. 70). It made a number of recommendations for developing and financing training courses for teachers in special education, including the provision of in-service and induction courses and courses at post-graduate level. It also suggested that a coordinated approach to the provision of such training was required (Department of Education and Skills, 1993). The myriad of special education CPD opportunities that exist today for teachers including the PGDSEN programme owe their origin to the recommendations of the *SERC Report* (Griffin & Shevlin, 2011).

Given the educational contexts of the time, the primary focus of the *SERC Repor*t on resourcing issues, while necessary, inevitably overlooked philosophical aspects such as exploring the rationale for the use of categories to identify disabilities (Griffin & Shevlin, 2011). Although there was some criticisms from parents of children with autism and from disability groups (Griffin & Shevlin, 2011; Stevens & O'Moore, 2009), the framework of provision and associated continuum of services suggested in the *SERC Report* provided the building blocks for the development of special educational provision as it is in Ireland today (Carey, 2005; Griffin & Shevlin, 2011; MacGiolla Phádraig, 2007; Meegan & MacPhail, 2006; NCCA, 1999).

2.3.2.2 Parental litigation

In reviewing the development of policy and practices in special education, the influence and impact of parental litigation (Shevlin et al., 2008; Swan, 1994) on the State to provide for education appropriate to the particular needs of their children with SEN is worthy of consideration (Carey, 2005). In the 1990s, a number of court cases were taken by parents against the state in their demands for an education (Carey, 2005; Stevens & O'Moore, 2009) that would meet the specific needs of their children. Two such cases illustrated this thrust by parents, namely the O’Donoghue case in 1993 (Stevens & O'Moore, 2009) and the Sinnott case later in 2000 (Carey, 2005; Griffin & Shevlin, 2011). Following the judgments, the State was required to provide education for children with SEN until they reached their 18th birthday based on their educational needs as opposed to their medical needs (Carey, 2005; Griffin & Shevlin, 2011; Meaney et al., 2005; Meegan & MacPhail, 2006; Whyte, 2002). The influence of the O’Donoughe case was evident in the subsequent publication of the *Education Act* (1998) which ensured provision for the education of all persons with SEN (Shevlin et al., 2008; Whyte, 2002).

2.3.2.3 The Education Act, (1998)

Influenced by the recommendations of the *SERC Report* (1993) (Kinsella & Senior, 2008), the *Education Act* of 1998 made provision for “the education of every person in the state, including any person with a disability or who has other SEN” (Government of Ireland, 1998, p. 5). Its enactment provided “a statutory basis for policy and practice in relation to all education provision” (Griffin & Shevlin, 2011, p. 57). The legal responsibilities of the Government in relation to education including special education were outlined for the first time (Flood, 2010; Meegan & MacPhail, 2006) and schools were required to "provide for the educational needs of all students" (Winter & O'Raw, 2010, p. 6). Special educational needs were defined in the *Act* in Section 2 (1) as "the educational needs of students who have a disability and the educational needs of exceptionally able students" (Government of Ireland, 1998, p. 8). However, criticism was levelled at the *Act* as it was perceived that its definition of SEN was not reflective of that proposed by the *SERC Report* (1993) (Banks & McCoy, 2011). The definition of a disability related to the medical model and ignored other "critical environmental and contextual issues" (Griffin & Shevlin, 2011, p. 58) such as "adverse social, emotional or material circumstances" that may additionally result in the presence of learning disabilities (MacGiolla Phádraig, 2007, p. 292). It therefore, excluded some children from receiving provision under the Act (MacGiolla Phádraig, 2007). While the *Education Act,* (1998) was significant in terms of its proposals for the provision of educational interventions for pupils with SEN, financial constraints with regard to the provision of resources were noted (Flood, 2010; Meaney et al., 2005). Critics of the *Act* argue that it therefore did not have a rights-based focus and that it did not provide for all the recommendations of the *SERC* Report (1993) (Kinsella & Senior, 2008: Drudy & Kinsella, 2009). The *Education Act*, (1998), did however, pave the way for subsequent legislation, including the *Education for Persons with Special Educational Needs Act* (EPSEN) (2004) which further developed the inclusion process.

2.3.2.4 The Education for Persons with Special Educational Needs Act (EPSEN), (2004)

The *Education for Persons with Special Educational Needs Act* (EPSEN) (2004) marked an important move forward by providing a legislative framework for inclusive education in Ireland (Flood, 2010; Meaney et al., 2005; National Council for Special Education, 2006b; Shevlin et al., 2008). Its central aim was to ensure that the education of people with SEN "shall, wherever possible, take place in an inclusive environment with those who do not have such needs" (Government of Ireland, 2004, p. 5). Despite its focus on inclusion, Rose et al., (2015) note a lacunae in the *Act* as it did not explicitly define 'inclusion'. The *EPSEN Act,* (2004) did however, define special educational needs and was notable by the fact that the definition adopted was not based exclusively on the previously stated medical model (Meaney et al., 2005). In recognizing the physical, sensory, mental health or learning disability factors impacting on ability to learn, the definition included "any other condition which results in a person learning differently from a person without that condition" (Government of Ireland, 2004, p. 6). The *Act* detailed a staged approach to assessment for special education and required that an education plan be prepared by a team for those accessing this provision (Meaney et al., 2005). The *EPSEN Act*, (2004) afforded a key role to the principal teacher in overseeing the implementation of inclusive education. It required that the whole school community be involved in inclusive educational provision (Government of Ireland, 2004). Although the *Act* did acknowledge the continued requirement for special schools for some children (Rose et al., 2015), it did not, however, provide any guidelines for special schools. This lack of guidance has made special schools "feel vulnerable with the drive towards inclusion" (Shevlin et al., 2008, p. 148).

Critiques of the enabling inclusive legislation outlined above note the entitlement to inclusive education is based on the availability of resources to fund such provision (Drudy & Kinsella, 2009; Shevlin & Rose, 2008). This therefore limits the "rights focus" of the legislation for such special educational provision to that of a "provider focus" (Drudy & Kinsella, 2009, p. 660). Access to additional special educational resources, including additional teaching hours provided for by Resource Teachers is determined by professional identification of special educational needs (Department of Education & Skills, 2005) by the National Educational Psychological Service (NEPS) or by the Scheme for Commissioning Psychological Assessments (SCPA) (Department of Education & Skills, 2016) provided for by the DES. However, these services have limited resources and consequently some parents seek professional identification of their children's special educational needs outside of these services in order to access additional support within the educational system. The obvious inequity in the system lends further support to the criticism of the "provider focus" nature of the EPSEN Act (Drudy & Kinsella, 2009).

The economic circumstances in the years following the publication of the *EPSEN Act* (2004) resulted in the failure by the than Government and indeed successive Governments to fully implement all elements of the *Act* (Rose et al., 2015). Although the *EPSEN Act* (2004) provided a detailed blueprint for the development and implementation of Individual Education Plans (IEPs) (National Council for Special Education, 2006a; 2006b), schools are not legislated to do so currently. Nonetheless, in line with established best practice in this area (Meijer, 2003), research indicates that IEPs have become an "established practice" in many schools in Ireland (Rose, Shevlin, Winter, O'Raw, & Zhao, 2012, p. 115; National Council for Special Education, 2006b). Failure to legislate the IEP process has resulted in schools adopting an individual approach to their development (Rose et al., 2012; Rose et al., 2015) despite the issuing of IEP guidelines by the National Council for Special Education (2006a). Rose and his colleagues argue that this practice suggests that schools are adopting a "reflective and experimental approach" to IEPs and that this "emergent approach" may in fact contribute to the future implementation of policy in this regard (Rose et al., 2012, p. 115).

The specific demands on schools, under the direction of school principals to implement inclusive approaches as outlined in the *EPSEN Act* is proving challenging for many schools (Griffin & Shevlin, 2011; Meaney, Kiernan & Monahan, 2005). Rose et al., (2015) noted in their longitudinal research on special educational needs in Irish schools, that policy development at school level did not mirror policy developments at national level. This resulted in the lack of substantial changes in inclusive school policies in schools (Rose et al., 2015).

Although sections of the *EPSEN Act* relating to assessment and education plans have been deferred due to financial restraints on budgets (Flood, 2010; Rose et al., 2015), the legislation has impacted positively on aspects of the development of inclusive approaches to education (Drudy & Kinsella, 2009), notably in respect of the provision of resources to support inclusive education (Meegan & MacPhail, 2006). However, it is acknowledged that "inclusion policy and practice have yet to become firmly embedded in Irish schools" (Shevlin et al., 2013, p. 1120). Evidence from their research prompt Rose et al., (2015) and Travers et al., (2010) to advocate for the immediate implementation of the *EPSEN Act* (2004) in order to marry the concepts of inclusive policy and inclusive practice in Irish schools.

2.3.2.5 The National Council for Special Education (NCSE)

The National Council for Special Education (NCSE) was established under the remit of the *EPSEN Act*, 2004 (Government of Ireland, 2004; Shevlin et al., 2013) to provide for the organisation and provision of resources and support the continuum of special education provision as outlined in the *Act* (Flood, 2010; Griffin & Shevlin, 2011). The appointment of *Special Education Needs Organisers (SENOs*) on a regional basis support the identification and assessment of special needs and the co-ordination of the necessary resources (Flood, 2010; Griffin & Shevlin, 2011). The NCSE has published a number of comprehensive research reports including for example an evaluation of education provision for students with Autism Spectrum Disorder (ASD) (Daly et al., 2016) and a longitudinal study examining experiences and outcomes for pupils with SEN in Irish schools (Rose et al., 2015). In its advisory role to the Minister for Education and Skills, the NCSE has published a number of policy documents. A recent document outlines the evolving provision for pupils with SEN in Irish schools (National Council for Special Education, 2013).

2.3.3 Summary

The principle of inclusion as outlined by the *Salamanca Statement* (UNESCO, 1994) has been supported by legislative and strategy documents (European Agency for Development in Special Needs Education, 2003) including the *Education Act* (1998) and the *EPSEN Act* (2004) to develop inclusive education systems. Variations in terms of its implementation exist as inclusion is dependent on the particular economic and political contexts of individual countries. The failure of successive Irish Governments to fully implement the *EPSEN* Act (2004) has been noted in the literature as a significant factor in inhibiting the principle of inclusion. Furthermore, the process of inclusion can be dependent on the type and degree of disability (Ferguson, 2008) and is influenced by cultural issues (Peters, 2007). While the research is optimistic about efforts to date to include pupils with SEN, the debate on a number of fronts including that of the effectiveness of the educational support systems, institutional frameworks and resources continues (Graham & Jahnukainen, 2011).

2.3.4 Provision for pupils with SEN in the Republic of Ireland

Special education provision in Ireland was provided initially by a number of religious communities on a voluntary basis (National Council for Special Education, 2006b; Stevens & O'Moore, 2009). The 1960s saw the establishment of special schools (Meaney et al., 2005). Special classes attached to mainstream schools were a concept of the 1970s (Stevens & O'Moore, 2009). International trends towards inclusion and the impact of Irish legislative demands have seen provision change radically in recent years (Government of Ireland, 2004; Irish National Teachers Organisation, 2003; Rose et al., 2010). This has resulted in an increase in the number of children with SEN attending mainstream schools with one in every four pupil in mainstream school having a special educational need (Banks & McCoy, 2011; McCoy et al., 2014). Provision for pupils with SEN in Ireland today is provided for along a continuum of support, a concept first introduced in the SERC report, ranging from full inclusion in special schools to a special class in a mainstream or special school or to enrolment in a mainstream school (Department of Education and Skills, 1993; National Council for Special Education, 2011).

2.3.4.1 Special schools

Special schools provide an education for pupils with “specific categories of need” (Ware et al., 2009, p. 22) and are acknowledged as an important element in the continuum of educational provision (Ware et al., 2009). It has been noted that special schools have moved towards a broader enrolment of pupils outside of their designated category (Kinsella et al., 2014), a move welcomed by the Department of Education and Skills (2011a). While the number of special schools increased during the period 1992 to 2002, Ware et al. (2009) cite the research of O'Keeffe (2004) which states that the special school pupil enrolment fell during this period. Changes in government policy, particularly the provision of resource teachers to assist with the education of pupils with identified disabilities, may help to explain this drop in enrolment (Department of Education and Skills, 1999a; Stevens & O'Moore, 2009). Notwithstanding the fall in enrolment, several researchers have highlighted the important role that special schools play in the continuum of special education provision in Ireland. For instance, following their study Day, Prunty, and Dupont (2012) advocated for the retention of special schooling. As it is likely that special schools will continue to provide for the needs of pupils with more complex disabilities, it is important that teachers are given opportunities to develop the necessary skills. The need for specialist training for teachers in special schools was highlighted in a study conducted by Ware et al. (2009).

2.3.4.2 Special classes

Special classes were established by the Department of Education and Skills (DES) in the 1970s to support the needs of pupils with MGLD (Irish National Teachers Organisation, 2003) and have been expanded to meet the needs of pupils with ASD, Specific Speech and Language Disorder (SSLD), Hearing Impairment (HI), Emotional and Behavioural Disorders (EBD) and Moderate & Severe/Profound General Learning Disabilities (Banks & McCoy, 2011; Department of Education and Skills, 1999b; Irish National Teachers Organisation, 2003). The number of special classes increased significantly in recent years and figures indicated that 0.5% of the pupil enrolment is in special classes in primary schools (Department of Education and Skills, 2013a; McCoy et al., 2014). Sixty percent of all special classes support pupils with ASD specifically (McCoy et al., 2014).

Special classes are generally taught by one teacher and supported by SNAs, the number of which is determined by the nature of the disabilities of the pupils (McCoy et al., 2014). Stevens and O'Moore (2009) report that the needs of pupils with MGLD in special classes is greater than those pupils with MGLD in a mainstream classroom (Stevens & O'Moore, 2009). Research indicates that there is a high level of satisfaction with the provision provided by special classes in Ireland (National Council for Special Education, 2011; Ware et al., 2009) but there were issues raised regarding the level of training provided to teachers in these contexts (National Council for Special Education, 2011). Banks et al. (2016) in their study on special classes in Irish schools, found that special class teachers felt that they did not have the skills and knowledge to teach in these contexts. They did however, feel more confident about their role following CPD from the Special Education Support Service (SESS) and other providers (Banks et al., 2016).

2.3.4.3 Mainstream schools

Resource teachers and learning support teachers provide supplementary teaching support to pupils with additional needs in mainstream schools (Department of Education and Skills, 2005c). The roles and responsibilities of each are outlined clearly by the DES (Department of Education and Skills, 2000, 2005c). However, in practice, Griffin and Shevlin (2011) note that the positions overlap. This view was supported by Kinsella et al. (2014) who found that the Learning Support (LS) and Resource Teacher (RT) posts were indistinguishable in most of the schools in their study.

2.3.4.3.1 Learning support teachers

Additional support in primary schools was initially provided by remedial teachers in Ireland in the 1960s (Irish National Teachers Organisation, 1994) who supported pupils functioning at levels below their peers (Irish National Teachers Organisation, 1994) with particular difficulties in literacy and/or numeracy (Griffin & Shevlin, 2011; Irish National Teachers Organisation, 1994). The service was gradually extended and by 1999 was available in all primary schools (Irish National Teachers Organisation, 2001). The primary focus of the earlier interventions was in the area of literacy with a lesser focus on mathematics (Department of Education and Skills, 1993; Irish National Teachers Organisation, 1994). The publication of the *Guidelines on Remedial Education* provided a framework for this support (Department of Education and Skills, 1988) outlining for example the importance of early screening and assessment measures and the duration of remedial support for pupils with learning difficulties (Department of Education and Skills, 1988). The SERC report suggested that remedial teachers work collaboratively with class teachers in a dual role of providing advisory and preventative support and in the provision of additional support (Department of Education and Skills, 1993). It recommended that all pupils scoring at or below the 10th percentile on standardized tests should receive support from a remedial teacher (Department of Education and Skills, 1993). However, despite the considerable increase in resources, the literature reports that standards in reading did not improve at this time (Department of Education and Skills, 2000; Irish National Teachers Organisation, 2001). A review of remedial education noted that over half of the schools provided additional support in mathematics (Irish National Teachers Organisation, 1994). Griffin and Shevlin (2011) point to a similar imbalance in favour of support in literacy. They refer to Shiel et al.'s (1998) report which found that while all schools with a remedial service provided additional support in literacy, just 41% of schools did so in mathematics (Griffin & Shevlin, 2011).

Findings from the research indicate a need for a revised structure for the provision of learning support and resulted in the publication of the *Learning Support Guidelines* (Department of Education and Skills, 2000; Griffin & Shevlin, 2011; Irish National Teachers Organisation, 2001). The guidelines provide a clear outline of the role of the remedial teacher, now referred to as the learning support teacher, in the context of a whole-school approach to the provision of learning support (Department of Education and Skills, 2000). They specified that the learning support teacher will provide “supplementary teaching to pupils who experience low achievement and/or learning difficulties” (Department of Education and Skills, 2000, p. 24). The learning support teacher works in collaboration with the principal teacher, the class teacher and parents providing support either in the learning support room or in the mainstream classroom (Department of Education and Skills, 2000).

2.3.4.3.2 Resource teachers

The shift towards inclusive education resulted in an increased number of children with SEN attending mainstream schools (Irish National Teachers Organisation, 2003). The DES responded by appointing resource teachers (RT) to mainstream schools from 1999 onwards in the form of additional posts to provide support for pupils with assessed disabilities (Department of Education and Skills, 1999a). From the start a whole school approach towards meeting individual needs was advocated, with the resource teacher liaising and advising teachers on the adaption of curriculum content, and liaising with parents and other relevant professionals (Department of Education and Skills, 1999a). The role of the resource teacher also included the assessment and recording of the child’s needs and progress, developing IEPs as well as direct teaching and/or team teaching, either in the mainstream classroom or on a withdrawal basis (Department of Education and Skills, 1999a). Given that the pupils taught by a resource teacher have significant learning difficulties, the instructional approaches adopted by their teachers have been described as being at “a qualitatively different level of provision than that offered by the learning support model” (Griffin & Shevlin, 2011, p. 263).

Resource teachers were allocated to schools based on the number of pupils meeting the criteria for additional support (Department of Education and Skills, 1999a). A weighting for support was assigned by the DES depending on the nature and degree of the disability. For the most part this was in line with the recommendations of the SERC Report (Department of Education and Skills, 1993, 1999a). This system of resource allocation involved significant investment by the DES. Subsequent reviews by the DES and by NEPS required revisions to be made to the process (Department of Education and Skills, 2003). Consequently, a weighted system of allocations for teaching resources for pupils with SEN was introduced from 2004 onwards. This was based on an allocation of resource teaching hours to schools based on a predicted incidence of SENs (Department of Education and Skills, 2003) and is referred to as the general allocation scheme or General Allocation Model (GAM) (Department of Education and Skills, 2005c).

While the appointment of resource teachers was valued and welcomed, the Irish National Teachers Organization (INTO) (2003) voiced their concern at the lack of support for the role, noting both the absence of induction for resource teachers and guidelines clarifying their roles and responsibilities. Their study found that many resource teachers did not have a qualification in special education (Irish National Teachers Organisation, 2003).

2.3.4.4 Special Needs Assistants (SNAs)

SNAs were initially appointed to support pupils with SEN in special schools (Stevens & O'Moore, 2009). The service rapidly expanded to provide support for the increasing numbers of pupils with SEN attending mainstream schools (Griffin & Shevlin, 2011; Rose & O'Neill, 2009; Stevens & O'Moore, 2009). Pupils who are described as having significant medical needs, or who have a significant impairment of physical or sensory function or where their behaviour is such that they are a danger to themselves or to other pupils are eligible to apply for support from an SNA (Department of Education and Skills, 2002). Duties of SNAs were outlined in Circular 07/02 as being of a non-teaching nature (Department of Education and Skills, 2002). Circular 30/14 provided further clarification of the care role of the SNA for pupils with disabilities in educational settings (Department of Education and Skills, 2014).

A recent research study found that the SNA scheme of provision is effective in its care remit of pupils with SEN in Irish schools (Department of Education and Skills, 2011g). The role of the SNA has been found, however, to deviate from that of the care role to supporting teaching and learning (Department of Education and Skills, 2011g; Lawlor & Cregan, 2003; O'Connor, Hansson, & Keating, 2012; Rose & O'Neill, 2009; Rose et al., 2015). This role is generally welcomed by teachers (Logan, 2006). Travers et al. (2010) recommended however, in their study that the SNA should not be given a role where they become a “substitute” for specialist teaching support (p. 288). Support provided by SNAs tended to be in the areas of literacy and numeracy and reinforced the work of the teacher (Rose & O'Neill, 2009). The findings of a recent review of the

SNA scheme prompted the DES to highlight to schools “that responsibility for the learning and teaching of students with SEN is the remit of the teacher” (Department of Education and Skills, 2011g, p. 13). Logan (2006), meanwhile, in her study found that CPD for teachers working with SNAs was not available, a factor which was considered important by the majority of teachers in a recent study (Keating & O’Connor, 2012). The lack of CPD for teachers working with SNAs was found to impact negatively on the working relationship between them (Rose & O'Neill, 2009). It is of interest that the development of management competencies of teachers working with SNAs was identified as a key finding in a review of the SNA scheme (Department of Education and Skills, 2011g). Funded CPD programmes in SEN for SNAs provided by the DES since 2005 at both an introductory level and at certificate level have been discontinued in recent years (Department of Education and Skills, 2011g). However, CPD continues to be provided by local Education Centres and by some HEIs. The importance of specific training for SNAs is noted in the literature (O'Connor et al., 2012).

2.3.4.5 The General Allocation Model (GAM)

The issue of Special Education Circular 02/05 (Sp. Ed. 02/05) (Department of Education and Skills, 2005c) by the DES provided guidance on the organization of teaching resources under the GAM model. The GAM was introduced in mainstream schools as a means of developing “truly inclusive schools” (Department of Education and Skills, 2005c, p. 4). This model takes into consideration that some schools experience greater need than others and is therefore, a means of ensuring equal access to additional teaching support for all pupils with SEN. The GAM ensures that schools have permanent teaching support for pupils with needs described as high-incidence disabilities such as Borderline MGLD, Moderate General Learning Difficulty (ModGLD) or Specific Learning Disabilities (SpLD) for example (Department of Education and Skills, 2005c). It also allows for additional support to be sought for pupils with needs arising from low-incidence disabilities such as physical disabilities, hearing impairment (HI), visual impairment (VI), specific speech and language disorder (SSLD) f(Department of Education and Skills, 2005c). The level of support allocated to each school is weighted on a number of factors including gender, school size and socio-economic status (Griffin & Shevlin, 2011). Schools are required to develop a system of screening, identification and assessment to assist in the selection of pupils requiring additional support known as the *Staged Approach to Assessment, Identification and Programme Planning.* (Department of Education and Skills, 2005c). A number of professional supports, NEPS, SESS and the Primary Curriculum Support

Programme (PCSP) provide professional support to schools in the implementation of additional teaching supports to pupils with SEN.

Economic influences had a negative impact on the allocation of resources required to implement the GAM in full in the 2011/12 academic year (Department of Education and Skills, 2011b). A 90% allocation of valid identified resource teaching allocation was made available to schools (Department of Education and Skills, 2011b) due to economic constraints at the time. General allocation posts and English as an additional language support (EAL) posts were combined into a single post in the school year 2012/13 (Department of Education and Skills, 2012c). These posts known as GAM/EAL posts were allocated to mainstream schools based on enrolment for 2011/12. 2,500 full-time resource posts were also in place in primary schools for the 2012/13 school year allowing teachers to undertake NCSE approved (low incidence) resource hours. A recent study noted that the GAM resulted in an increased number of schools providing support in the area of mathematics (Travers, 2010). Furthermore, Rose et al., (2015) noted that the GAM model had provided the framework for the creation of SEN teams in schools.Their research, however did note the concerns of schools regarding the equity of the allocated support to pupils with MGLD under the GAM model (Rose et al., 2015).

2.3.4.6 DES initiatives to develop teaching and learning in schools

There are a number of DES supported initiatives in place to support the development of teaching and learning in schools. While not all specifically directed to pupils with SEN, these whole school approaches were developed to enhance the educational outcomes for all pupils in the school.

A ten year national strategy to improve literacy and numeracy outcomes for children and young people was issued by the DES in 2011 (Department of Education and Skills, 2011f). Schools are required to develop plans to improve the literacy and numeracy skills of their pupils with a particular focus on increasing the number of pupils performing at higher levels and reducing the number of pupils performing at the lower levels. The empowering role of parents in the education of their children in mathematics and literacy is recognized and the strategy encourages the involvement of parents in supporting their children’s skills development in these areas (Department of Education and Skills, 2011f). It highlights that parents with literacy difficulties may require particular support to do so. Primary schools are required to provide an additional 70 minutes instruction in mathematics per week. As part of the implementation of the strategy, the DES outlined a three tier approach to assessment beginning with the assessment of individual pupils (Department of Education and Skills, 2011e). Schools are required to use assessment data to determine mathematical achievements at school level. They are also required to contribute to the national data base on numeracy by implementing standardized testing in mathematics to pupils in 2nd, 4th and 6th classes from the 2012 school year onwards. Pupils with a learning or physical disability or EAL pupils can be exempted if deemed necessary by the principal teacher (Department of Education and Skills, 2011e). Schools are supported through the medium of CPD to assist them with the implementation of the strategy. An interim review of the strategy is currently underway and its findings will provide an insight into the contribution of the strategy towards raising achievement levels in mathematics for all pupils (Department of Education and Skills, 2016b).

The School Self-Evaluation (SSE) process is another recent initiative of the DES. The SSE assists schools to identify areas of strength and need in teaching and learning and to develop action plans for improvement in the identified areas (Department of Education and Skills, 2012b, 2016a). Schools were mandated to engage with this process from the 2012 school year. This initiative was designed to support the National Literacy and Numeracy Strategy. Schools were required to focus on either literacy or numeracy during the first phase of the process (2012/13 school year).

The Delivering Equality of Opportunity in Schools (DEIS) Action Plan is an initiative which provides additional educational support to pupils living in disadvantaged areas attending designated schools (Department of Education and Skills, 2005a). DEIS schools are required to develop whole school action plans aimed at improving educational attainment in literacy and numeracy (Weir & Denner, 2013). Participating schools receive funding to implement a range of supports to support the teaching of literacy and numeracy (Weir & Denner, 2013). The *Maths Recovery* programme (Wright, Martland, & Stafford, 2006) provides individualized teaching by trained teachers to pupils experiencing difficulty learning mathematics in DEIS schools. *The Ready, Steady, Go Maths* programme provides resources to support the teaching of number and the *Maths for Fun* initiative is designed to include parents in supporting their children learn mathematics (Department of Education and Skills, 2005a). While evaluations of the DEIS initiatives noted the increased attainment levels in literacy and numeracy of pupils attending these schools, attainment levels in literacy were higher than those in numeracy (Smyth, McCoy, & Kingston, 2015). Evaluations also note the considerable variation in pupil attainment levels amongst DEIS schools (Smyth et al., 2015).

The *Guidelines for Teachers of Students with Learning Disabilities* (National Council for Curriculum and Assessment, 2007) detail a differentiated curriculum for pupils with additional needs and is relevant to all teachers of pupils with SEN. Although the requirement to develop IEPs as outlined in the *EPSEN* Act, 2004 has not been enacted to date, schools generally prepare Individual Profile and Learning Programmes (IPLSs) for pupils with learning difficulties and Individual Education Plans (IEPs) for pupils with SEN as outlined in the *Learning Support Guidelines* (Department of Education and Skills, 2000) the *Guidelines on the Individual Education Plan Process* (National Council for Special Education, 2006a). More recently, publications by NEPS such as *Behavioural, Emotional and Social Difficulties – a Continuum of Support-Guidelines for Teachers* (Department of Education and Skills, 2010) ensure that school communities have access to models of international best practice as they support pupils with SEN in inclusive settings.

2.3.5 Summary

Educational provision for pupils with SEN is provided for along a continuum of support. This system has evolved following the publication of the SERC Report (1993) and the subsequent legislative procedures to support its recommendations. While the education system has been heavily resourced through the appointment of additional teachers and through the development of initiatives to support teaching and learning for all pupils in schools, the ideal of full inclusion has yet to be reached (Griffin & Shevlin, 2011). The issue of CPD in SEN for all teachers has been advocated in the literature. While this is but one element of an inclusive education system, the expertise of teachers is central to the provision of a truly inclusive education for pupils with SEN.

2.4 Conclusion

The international shift towards inclusion has influenced the development of special educational provision in Ireland. The enactment of legislation has provided a framework for an inclusive education system. Numerous publications including the SERC Report, Circulars from the DES and advisory documents from NEPS and the NCSE have provided schools with a blueprint for inclusive practices.

While positive strides have been made, some challenges to full inclusion still remain. The provision of a rights-based education system has yet to materialize. The practice of developing school policies in SEN has become common place. However, the operational aspect of school plans is key to successful inclusive practices. School plans need to reflect the unique culture, ethos, strengths and needs of each school as they develop whole school approaches aimed at creating meaningful inclusive practices in education.

2.5 Continuing Professional Development (CPD)

There is international recognition that high-calibre teachers, who are afforded opportunities to develop professionally are at the epicentre of education systems (Chung Wei, Darling-Hammond, & Adamson, 2010; Conway, Murphy, Rath, & Hall, 2009; Government of Ireland, 1995; Ireland, 1992). Coolahan (2007) points to the suggestion made in the OECD (1991) review of Irish education that teacher education should be considered in terms of a teaching career spanning three stages – initial, induction and in-service teacher education (Coolahan, 2007). Referred to as the continuum of teacher education the current research study focuses on the third stage, in-service or in-career development or continuing professional development (CPD). (Kelleghan, 2009; The Teaching Council, 2011b). A review of policy and provision of CPD with a specific focus on special education in the broader education setting will provide the context for the present research study.

2.5.1 Continuing professional development – A definition

The Teaching Council refer to CPD as lifelong teacher learning which "comprises the full range of educational experiences designed to enrich teachers' professional knowledge, understanding and capabilities throughout their careers" (The Teaching Council, 2010, p. 21). The Organisation for Economic Co-operation and Development (OECD) (2005) states that these educational experiences are on-going throughout the career of the teacher. CPD provides opportunities for teachers to develop their existing "pedagogic and subject knowledge … professional judgement … expertise as a reflective learner, researcher and problem solver" (The Teaching Council, 2010, p. 21). The concept of lifelong teacher learning is a priority for teacher education both nationally and internationally and was intended to support teachers to adapt to the changing educational needs of the knowledge society over the duration of their teaching career (Conway et al., 2009; The Teaching Council, 2010, 2011b). According to Conway et al (2009), inclusion and attainment levels in mathematics represent two areas of challenge for education systems in the future, a challenge which the continuum of teacher education is required to respond to (Conway et al., 2009).

2.5.2 Policy

Socioeconomic demands internationally led to the adoption of the strategy of teacher lifelong learning at the turn of the 21st century (Coolahan, 2002, 2007). The publication of the OECD’s (1996) *Lifelong Learning for All* report was representative of the commitment of the then Ministers for Education to this strategy (Coolahan, 2002). This approach to lifelong learning was further supported by UNESCO in their 1996 publication on Education in the Twenty-First Century (Coolahan, 2002). The publication of a number of other policy advice papers in Europe at this time, including the 1991 OECD review on education in Ireland, led to the development of government policies on lifelong learning throughout Europe (Coolahan, 2002).

Echoing the recommendations of the seminal 1991 OECD review for the development of “a nationwide ... in-service system using the concept of the teaching career as the foundation” (Coolahan, 2007, p. 7), the Green Paper on Education (1992) adopted the concept of a continuum of education in Ireland (Coolahan, 2007). The OECD’s (1991) proposal to set up a council to oversee issues relating to teacher education, including in-service education, was incorporated into the Green Paper’s recommendation that the Teaching Council should be established (Coolahan, 2007). The publication in 1995 of the White Paper, a Government policy document, *Charting our education future*, brought clarification to the previous discussions on lifelong learning by formalising the concept as an element of the continuum of teacher education (Government of Ireland, 1995). It stated that the aims of in-career professional development programmes were to “equip teachers with the capacity to respond effectively to major changes in the education system, including changes in curriculum, teaching methodologies, assessment, school organisation and management, and to provide for teachers’ personal and professional development needs” (Government of Ireland, 1995, p. 135). In addition, it provided for financial support to implement this policy development. The White Paper specifically noted that the policy move towards inclusive education required the provision of CPD for teachers to enable them to teach all pupils in the education system (Government of Ireland, 1995).

Following the recommendations in the White Paper, the *In-Career Development Unit (ICDU)* was established in 1994 by the DES. Its function was to co-ordinate this development (Government of Ireland, 1995). Reformed as the *Teacher Education Section (TES)* ten years later, its remit includes CPD as part of the teacher education continuum. An investment from the EU in 1994 allowed for the construction of Education Centres, as suggested in the White Paper (Government of Ireland, 1995) and also for a programme of in-career development for teachers (Egan, 2004; PwC, 2012).

The Teaching Council Act, 2001 paved the way for the establishment of the *Teaching Council* in 2006, a statutory body for teaching in Ireland whose responsibilities included the “promotion of professional development of teachers” (Government of Ireland, 2001). Drudy (2006) welcomed this development as being a “very substantial educational reform” given the potential impact the Teaching Council had to “enhance the status and professionalism of teaching” (p. 2). European policy directives continue to support the concept of lifelong learning and also encourage teachers to participate in CPD exchange programmes such as Comenius as part of their personal development (Commission of the European Communities, 2007). The publication in 2011, of a *Policy on the Continuum of Teacher Education* (The Teaching Council, 2011b), was indicative of the Irish response to lifelong learning in education and provides the framework for the development of teacher education at each of the three levels of the continuum (Lawlor, 2009).

2.5.3 Provision

2.5.3.1 Developments in the 1990s

Prior to the 1990s, CPD was organised on an unstructured basis, without the support of a national plan (Loxley, Johnston, Murchan, Fitzgerald, & Quinn, 2007). CPD was a matter of personal choice for teachers (O'Sullivan, McConnell, & McMillan, 2012). Regional Education Centres and HEIs were the main providers of post graduate diplomas, higher degrees and short non-accredited courses (Killeavy, 2001; Loxley et al., 2007). Findings from international research paved the way for a major change in the provision of CPD along the continuum of teacher education in Ireland (Sugrue, 2011).

Policy developments in Ireland in the mid-1990s saw the formation of the In-Career Development Unit (ICDU) by the DES acting in a coordinating role for CPD (The Teaching Council, 2011b). The ICDU was reformed in 2004 (Department of Education and Skills, 2013c), and is now known as the Teacher Education Section (TES). It liaises with National Support Programmes such as the PDST and the SESS, Colleges of Education, Education Centres and other providers to support it in its remit (Department of Education and Skills, 2007b, 2013c). The TES supports CPD for school leaders and teachers across each level of the education system, in a broad number of areas, including school development planning, school development planning, school leadership and management, SEN, curriculum and pedagogy (Department of Education and Skills, 2007b, 2013c). A *Value for Money Assessment* of TES programmes in 2007 indicated that participants of the CPD programmes facilitated by the DES believed that the content was relevant to them and therefore the programmes were successfully meeting their targets (Department of Education and Skills, 2007b). Despite the attempt of the DES to coordinate CPD by the establishment of the TES, Conway et al.'s (2009) findings suggest that the provision of CPD continues to be "somewhat fragmented" (p. 180) due both to the range of providers and to the increased availability of CPD online.

2.5.3.2 National support programmes

The National Support programmes were established by the TES to provide CPD to teachers (Department of Education and Skills, 2007b). In 2007, there were twenty nine support services in operation by the TES (Department of Education and Skills, 2007b). Based in Education Centres, the programmes were staffed by teachers on secondment from their schools (Department of Education and Skills, 2007b; Murchan, Loxley, Johnston, Quinn, & Fitzgerald, 2005). It is interesting that the study of Sugrue (2011) queried the efficacy of this practice as it is an approach that "assumes that all of the necessary expertise to transform curricula, pedagogy and school leadership already resides within schools" (p. 797). In real terms, this practice prevented the development of a permanent team of personnel to deliver the CPD as seconded teachers were entitled to be recalled to their schools at the request of their Boards of Management (Sugrue, 2011). There has been a rationalisation of services in recent years and the PDST has now assumed a central role in the co-ordination and management of a number of support programmes.

2.5.3.2.1 Primary Curriculum Support Programme (PCSP).

The *Primary Curriculum Support Programme* (PCSP) was established in 1998 (Department of Education and Skills, 2007b) and became the first national initiative for CPD. The function of the PCSP was to support the introduction of the revised curriculum by mediating the content for 26,000 teachers (Department of Education and Skills, 2007b). Sugrue (2011) observed that the development of the PDSP was a positive move and was "indicative of a major commitment to supporting teachers professional learning" by the DES (p. 795). The seven year national programme of CPD, therefore, provided by the PCSP, represented a strategic, centralised, coherent approach to CPD for primary teachers through the provision of professional development on a whole-school basis through workshops, school based planning days and web-based support (Department of Education and Skills, 2005b). The PCSP had a challenging brief given the enormity and complexity of the implementation of the support programme (Murchan et al., 2005).

Evaluations of the PCSP suggest that it was largely successful and the majority of attendees indicated that they were satisfied with the quality of the seminars provided by the PCSP (Department of Education and Skills, 2007b; Murchan et al., 2005). However, it is significant that it was regarded by Murchan et al. (2005) as being successful as an information-giver as opposed to changing practice. Moreover, some respondents noted that the training focused largely on approaches to teaching in whole-class teaching contexts and indicated that the seminars also needed to respond to the specific needs of school and teacher contexts, for example, in multi-class contexts, large urban schools, small rural schools etc. (Department of Education and Skills, 2007b). Respondents also suggested that further training should incorporate a more “hands-on” approach, allowing opportunities for discussion and sharing of expertise between teachers (Department of Education and Skills, 2007b, p. 97). The programme was however, criticised for the perceived additional workload placed on teachers and principals due to the planning time required to implement the revised primary school curriculum. Murchan et al. (2005) agreed that the implementation of the curriculum should have received greater emphasis than the planning for implementation process.

2.5.3.2.2 Regional Curriculum Support Service.

The *Regional Curriculum Support Service* or *Cuiditheoiri Service*, was subsequently formed in 2001 to support and clarify the work of the PCSP (Department of Education and Skills, 2007b). The function of the *cuiditheoiri* was to provide on-site support in schools as a follow up to the initial CPD provided on a regional basis by the PCSP (Department of Education and Skills, 2007b). The *cuiditheoiri* visited schools advising teachers on aspects of curriculum implementation and providing clarification on issues relating to the revised curriculum (Department of Education and Skills, 2005b). An evaluation of the service found that participating teachers were very satisfied with the quality of the support they received from the cuiditheoiri (Department of Education and Skills, 2007b) and appreciated support given in relation to curriculum planning and teaching strategies (Murchan et al., 2005).

2.5.3.2.3 School Development Planning Support (SDPS).

The School Development Planning Support (SDPS) was also established at this time. It an initiative designed to support school development planning in schools (Department of Education and Skills, 2005b). The SDPS team worked initially with school representatives with a view to developing school plans which represented the particular educational philosophy of each school. The team subsequently worked with teachers through the medium of seminars in individual schools and with neighbouring schools (Department of Education and Skills, 2005b). This support programme was amalgamated with the PCSP in 2008 (Sugrue, 2011).

2.5.3.2.4 Professional Development Service for Teachers (PDST).

In order to overcome the somewhat fragmented nature of CPD that had resulted from the number of support groups which had been created by the DES/TES, the support services were consolidated and restructured in 2010 with the *Professional Development Service for Teachers* (PDST) becoming the umbrella organisation (Banks & Smyth, 2011). The PDST, funded by the TES, has continued to develop in its remit to provide professional development to teachers including the *Maths Recovery* programme, in supporting schools with the implementation of the Literacy and Numeracy Strategy and with the SSE process for example, (PDST, 2016).

2.5.3.3 CPD in inclusive settings

As the literature has indicated, an inclusive education system demands teachers skilled in the necessary practices (European Agency for Development in Special Needs Education, 2011; Smith & Tyler, 2011). The research base to support the development of such skills in inclusive practices is unfortunately sparse (Forlin, 2012; Mamlin, 2012; Sindelar et al., 2010). It is recognised however, that supporting teachers development of inclusive practices in a process of inclusion which is fluid and continually evolving requires ongoing professional learning and development (Forlin, 2010a; Mittler, 2000; Pugach & Blanton, 2014). An input on inclusion during initial teacher education provides the foundation for lifelong learning (Engelbrecht, 2013; European Agency for Development in Special Needs Education, 2010, 2012). Approaches to such professional development at this level have been documented (Chambers & Forlin, 2010; European Agency for Development in Special Needs Education, 2011; Florian & Linklater, 2010; Florian & Rouse, 2009; Florian & Spratt, 2013; Waitoller & Kozleski, 2010). Despite the inputs at this level, Forlin (2012) acknowledges that newly qualified teachers continue to express their lack of preparedness in special education.

In addition to providing support to teachers at undergraduate level, research conducted in Ireland and the UK discusses approaches to support practising teachers to develop their inclusive practices (Ainscow, 2014; Banks et al., 2016; Hart & Drummond, 2014; O'Gorman, 2010). Such approaches/programmes focus on adapting/changing practices and acquiring skills and knowledge to enable teachers become more inclusive in their teaching (Billingsley, 2011; Rose et al., 2015). Banks et al. (2016) suggest that the provision of CPD for teachers in special classes would "greatly enhance teacher confidence and ability to differentiate their teaching" (p. 6).

It is of interest that, research in the USA is examining the extent to which teachers sustain their newly acquired inclusive approaches over time (Billingsley, 2011). It is also investigating the conditions within schools that are necessary to support the implementation of new inclusive practices (Sindelar et al., 2010). In this regard, Ainscow (2014) underlines the benefits of viewing best practices in action as a means of developing inclusive practices and suggests an approach known as “lesson study” as an appropriate means of doing so (p. 175). He suggests that this approach has the potential to change individual levels of practice and will also have subsequent impact at school-wide level (Ainscow, 2014).

Although the research base in special education teacher education is in the early stages of its development (Sindelar et al., 2010), it is acknowledged that the provision of CPD to teachers in the field is essential for the future development of inclusive education (Bačáková & Closs, 2013; Florian, 2012; Forlin, 2012; Pugach & Blanton, 2014; Rose et al., 2015). The influence of professional development on teaching practices of special education teachers was found to be positive in the Project Iris research study (Rose et al., 2015). In contrast, the absence of CPD for teachers involved in SEN is viewed as a barrier to schools embarking towards inclusive practices (Rouse & Florian, 2009).

2.5.3.4 In-service provision.

CPD in inclusive and special education contexts has developed in tandem with national and international directives in general education settings. Prior to the publication of the SERC Report (1993), in-service in remedial education was provided primarily by the Colleges of Education. These part-time courses were held outside of school hours and were accredited by the Colleges. The first Diploma course in special education was offered by St. Patrick’s College in Drumcondra in the 1960s (PwC, 2012). The SERC Report found that there were insufficient courses available on a national level to meet with the demand by teachers for such training (Department of Education and Skills, 1993). Feedback from teachers suggested that, given whole-school approaches to special education, there was an urgent need to provide in-career support for all teachers in special education (Spelman & Griffin, 1994). Based on the premise that high quality teachers were necessary for successful special educational provision (Department of Education and Skills, 1993), recommendations were made by the SERC report for training to be provided at all levels of the teaching continuum.

Subsequently, diploma courses in learning support were offered at centres throughout Ireland, funded by the ICDU section of the DES. Teachers working with pupils with SEN in primary, post-primary, special schools and other educational institutions were, therefore, incentivised to attend. A Master of Education in learning support was also offered by the colleges/universities involved. Diploma courses designed specifically to meet the needs of resource teachers were offered at a later stage. The amalgamation of both the learning support and resource teachers' diplomas resulted in the *Combined post-graduate diploma programme of continuing professional development for teachers involved in learning support and special education (PGDSEN)* which is currently available to teachers providing learning support and resource teaching in primary, post-primary and other recognised educational services (Department of Education and Skills, 2013b). Offered by seven HEIs on a national basis, the aim of the programme is to "provide substantial theoretical and practical continuing professional development" for participating teachers (Department of Education and Skills, 2013b). The programme continues to be funded by the TES and until 2012 attracted an additional monetary allowance, payable to teachers on the successful completion of the programme. It involves eight weeks' release from school and its duration is that of one academic year. Each hosting HEI offers progression from the post-graduate diploma to Master of Education (M.Ed.).

In addition to the *PGDSEN* programme for teachers specifically involved in special education, colleges of education offer certificates and diplomas in other areas of special education for both class teachers and special education teachers. St. Patrick's College, Drumcondra for example, offer a Graduate Certificate in the Education of Pupils with ASD and a Certificate/Diploma in Education (Special/Inclusive Education) while St. Angela's College in Sligo offers a Post-graduate/Certificate in SpLD and in SEN (ASD). A five-day induction course for teachers of pupils with Severe and Profound General Learning Disabilities is also offered by St. Patrick's College. Online courses in special/inclusive education are provided on a fee-paying basis by Hibernia College, by the INTO and by the Institute of Child Education and Psychology Europe (ICEP). Recent research has indicated that there continues to be a high demand for CPD in special education (PwC, 2012).

2.5.3.4.1 Special Education Support Service (SESS).

The *Special Education Support Service* (SESS) was established in 2003 by the TES of the DES to consolidate and co-ordinate existing professional development in special education (PwC, 2012). This has resulted in a coordinated, strategic support to CPD in special education. The SESS has responded to teachers' professional needs through the medium of seminars, longer courses, online courses and onsite support for schools and works in partnership with other government agencies such as the NCSE, NEPS and the National Council for Curriculum and Assessment (NCCA) (Special

Education Support Service, 2013). Their aim is to provide CPD that is responsive to current needs and trends (Service, 2008) across all special educational settings (Griffin & Shevlin, 2011) at local, regional and national level (PwC, 2012). An evaluation of the work of the SESS indicates that it is meeting its aims and it is increasing teacher knowledge, skills and teaching practice in the area of special education (PwC, 2012). A study by Daly et al (2016) found that teachers of pupils with ASD valued the level of CPD afforded to them by the SESS (Daly et al., 2016).

2.5.3.5 Discussion of current issues

In line with international policy developments, the framework for CPD in Ireland has evolved from the fragmented approaches of the 1990s to that of a strategic approach of lifelong learning within the continuum of teacher education. Recent studies on CPD in the Irish context reveal interesting insights into the provision of CPD on the ground and establish a research basis for future developments relating to both policy and practice (Banks & Smyth, 2011; Glenn, McDonagh, Sullivan, Roche, & Morgan, 2012; PwC, 2012; Sugrue, 2011).

Banks and Smyth's (2011) study examining teacher participation in CPD is of particular interest in light of its recommendations for future policy developments. Their study examined factors at individual, school and class level impacting on teacher participation in CPD. Individual teacher characteristics, including qualifications, gender, age and number of years teaching, were analysed (Banks & Smyth, 2011). The impact of other school contexts, such as the size of the school and attitudes towards CPD were examined. Banks and Smyth (2011) found that more experienced teachers tended to have the highest level of participation in CPD. Policy implications in this regard include developing a means of encouraging participation at all stages of the teaching career. The researchers found that female teachers were more likely than male teachers to undertake CPD (Banks & Smyth, 2011). This is an issue that needs to be addressed by policy developers, particularly in the light of the declining numbers of male teachers currently in the education system (Banks & Smyth, 2011). Banks and Smith (2011) also found that teachers assisted by an SNA were more likely to take part in CPD when compared to those who do not. This may indicate that teachers of pupils with greater educational needs recognise the need to upskill in special education.

The professional development service provided by the SESS has been found to be successful in filling these lacunae in CPD with a high usage of the service by teachers working with pupils with SEN (PwC, 2012). An evaluation of the SESS indicated that the stakeholders were of the view that it had been successful in its attempts to co-ordinate and consolidate CPD in special education (PwC, 2012).

Both Egan (2004) and Killeavy (2001) found that many teachers were undertaking CPD at post-graduate level to enhance their teaching careers and to further their academic studies. These researchers found that in some instances, teachers were taking post-graduate courses in their own time and at a personal cost to themselves. This points to the demand that exists amongst the teaching profession for accredited CPD programmes.

The timing of CPD has been raised as a challenge in the literature (Egan, 2004; Murchan et al., 2005). To date, CPD funded by the TES, tends to take place within school hours and sometimes involves school closures (Egan, 2004). Attendance by teachers at the five-day traditional Summer Courses is incentivised by the receipt of three Extra Personal Vacation (EPV) days. Shorter courses hosted by Education Centres tend to be held outside of school hours. In the Teaching and Learning International Survey (TALIS), an OECD survey across 33 countries (OECD, 2014), Ireland had the highest percentage of teachers who had been allocated time to attend CPD (PwC, 2012). It was further noted that, block release to attend third-level based CPD programmes such as the PGDSEN programme is highly rated by teachers (PwC, 2012). While CPD within school hours is generally favoured by teachers, concerns have been raised about this practice occurring at the expense of children's learning , reducing as it does, the length of the school year (Egan, 2004; Murchan et al., 2005). Parents, likewise, can be inconvenienced by school closures due to CPD.

The issue of funding CPD has been raised by Kelleghan (2009). CPD is funded by the TES, by school boards of management, teachers unions and by teachers themselves. Given budget constraints in education and in society at large, this is likely to become an issue for discussion in years ahead. In line with other jurisdictions, questions have been raised regarding the impact of the considerable investments by the DES in recent years in CPD (Sugrue, 2011). Areas for future CPD need to be prioritised. For example, the publication of the PISA 2010 results, an international measure of 15 year old's attainment levels in reading, mathematics and science results in 2010, showed a decline in rankings in Ireland in reading from 5th place four years previously to 17th place in 2010 provide the initiative for the national plan to improve literacy and numeracy (Sugrue, 2011).

Given the demographic spread of the Irish population, multi-class settings are common in Ireland. The demand for training in this context needs to be addressed across the teaching continuum. It is significant that Banks and Smyth's (2011) research indicates that teachers in multi-class settings have a higher rate of participation in CPD than those teaching single classes. The findings of this study further suggest that CPD uptake is also higher when teachers work in schools with a positive atmosphere and where children are deemed to enjoy school (Banks & Smyth, 2011).

The predominant model of CPD in Ireland, has been that of the "one-shot workshop model" (Conway et al., 2009, p. xxviii), featuring a transfer of information mode which focuses on building teacher skills within the context of curriculum change (O'Sullivan et al., 2012). Conway et al. (2009) suggest that future CPD developments should include models which allow teachers to become interactive in the CPD process, thus enabling them to share new practices with their teaching colleagues within a community of learners.

2.6 Conclusion

Education reforms in the last two decades have resulted in an unprecedented growth in CPD. Informed by legislation, such as *The Education Act, 1998* and the *Teaching Council Act, 2001* (Government of Ireland, 1998, 2001), CPD provision has evolved from a fragmented approach (Conway et al., 2009) to one led primarily by the TES. Significant investments of resources by the DES have resulted in the formation of numerous professional bodies to support CPD in all areas of curricular reform, school management and leadership, special education and technology. The demand for CPD in special education, resulting from the trend towards inclusion, has been acknowledged by the TES in its funding of the PGDSEN programme and of short courses presented by the SESS.

Recent economic constraints with regard to funding have interrupted the pattern of current CPD provision (O'Sullivan et al., 2012) thus affording an opportunity to reflect and re-examine current practices (Sugrue, 2011). Both the availability of research on CPD (Conway et al., 2009; Glenn et al., 2012) and the pause in its current provision may provide a timely opportunity for policy revisions and changes in practice in the years ahead. The publication of Cosán, a framework for teacher's learning issued by the Teaching Council, will establish the next phase of development for teacher education along the continuum of teacher education in Ireland (The Teaching Council, 2016).

2.7 Translating Learning into Practice -Teaching Mathematics to Pupils with SEN

The importance of mathematics as an essential life skill for all pupils has been well documented both in the research literature and the public media in recent times

(Department of Education and Skills, 2011f; Engineers Ireland, 2010; Geary, Hoard, Nugent, & Bailey, 2012; Kilpatrick et al., 2001; Witzel & Little, 2016). Heretofore, the acquisition of literacy skills has been prioritised over mathematical skills (Bryant & Bryant, 2008; Geary, 2011). The demands of the 21st century require citizens to have higher standards in mathematics than was previously recognised (Geary, 2011; National Council of Teachers of Mathematics, 2000; Urquhart & Miller, 2010), and research has indicated that those with lower attainment levels in mathematics will be compromised in society (Geary, 2013; Gillum, 2014; Kaufmann & von Aster, 2012).

The publication of national and international assessments of mathematics indicate that the performance of pupils in Ireland in mathematics is below average, Ireland, for example, ranked 26th out of 34 OECD countries in the PISA 2009 tests for 15 year olds (Department of Education and Skills, 2011f; OECD, 2011). These results indicate that 20% of pupils leaving school in Ireland have not acquired basic levels of mathematics in order to function effectively in society today (Department of Education and Skills, 2011f, p. 13). Underachievement in mathematics for pupils with SEN has been highlighted in the professional literature (van Garderen, Thomas, et al., 2013; Witzel & Little, 2016). This has led to policy changes (Department of Education and Skills, 2011e, 2011f; Inspectorate, 2012), revised curricula in mathematics for both primary and post primary schools and initiatives such as *Maths Recovery* and *Mata sa Rang*, to remediate the issue (Jeffes et al., 2013; NCCA, 2012; O'Loughlin, 2012). The particular challenges for some pupils to acquire mathematical skills has been discussed extensively in the literature and their right to achieve support to increase their mathematical achievements is acknowledged (Department of Education and Skills, 2011f; National Council for Curriculum and Assessment, 2007; van Garderen, Scheuermann, & Jackson, 2013) .

Current definitions of mathematical difficulties/disabilities, challenges to learning mathematics, evidence-based interventions and approaches to assessment will be outlined and analysed next.

2.7.1 Terminology

Terms such as dyscalculia, mathematics learning difficulties, mathematics disabilities, learning disabilities related to mathematics, specific learning disabilities in mathematics and mathematics disorder are examples of terms used inconsistently in the literature to describe difficulties in mathematics (Landerl, Bevan, & Butterworth, 2004; Shalev, Auerbach, Manor, & Gross-Tsur, 2000). Researchers have been challenged in defining mathematics disabilities, given that low achievement in mathematics may arise for a number of reasons including for example, inferior quality teaching instruction (Dowker, 2005; Geary, 2004; Von Aster & Shalev, 2007) and/or an intellectual disability. Mathematics difficulties lie along a spectrum with some pupils having considerably greater difficulties in the subject than others (Chinn, 2012). Furthermore, Geary (2004) notes that achievement levels in mathematics may fluctuate from one school year to the next. In addition, pupils with maths difficulties may have varying profiles of strengths and learning needs and are said to be a heterogeneous group (Dowker, 2005, 2009). Geary suggests that about 7% of the population experience difficulties in mathematics (Geary, 2011; Geary et al., 2012) while Shalev et al. (2000) suggest that Dyscalculia occurs in between 3% and 6% of the population.

Given the dearth of literature on the topic of mathematics difficulties/disabilities (Berch & Mazzocco, 2007; Desoete, Roeyers, & De Clercq, 2004; Geary, 2010) and the complexity of the issues associated with a definition, it is likely that the discussions on terminology will continue (Geary, 2004; Geary, Hamson, & Hoard, 2000; Mazzocco, 2007). The importance of reaching a consensus is well recognised and documented in the literature (Chinn & Ashcroft, 2007). The use of differing terms causes confusion when used, for example, in prevalence ratings, or for criteria for participation for research studies or for eligibility for support services (Chinn, 2012; Geary et al., 2012; Gifford, 2006; Mazzocco, 2007). However, Kaufmann and von Aster (2012) argue, that the development of a pupil profile, to identify learning strengths and needs in order to devise an intervention programme is more important that the label used to identify the mathematical difficulty .

Table 2.1 Mathematics Difficulties – Terminology

Category of need	Identification	Source
Mathematical learning disability (MLD)	< 10^{th} percentile	(Geary et al., 2012)
Low achievers (LA)	11^{th} – 25^{th} percentile	(Geary et al., 2012)
Mathematics difficulties (MD)	< 35^{th} percentile	(Gersten, Jordan, & Flojo, 2005)
Dyscalculia (DC)	Umbrella term for difficulties in mathematics.	(Emerson & Babtie, 2013)
	Specific learning difficulty in mathematics	(Kaufmann & von Aster, 2012; Shalev, 2007)

Performance on achievement tests in mathematics which is “substantially below that expected for age, intelligence and education” is defined as a *mathematics disorder* in the *Diagnostic and Statistical Manual of Mental Disorders-IV* (DSM-IV) (as cited in Geary, 2011, p. 251). Shalev et al. (2000) argue that the inclusion of the term “substantially” gives this definition “vagueness” (p. 58) and therefore the identification of the disability rests with the clinician. Interestingly, Shalev (2000) and her colleagues adopted the term Developmental Dyscalculia (DD) while Geary (2011) used the term Mathematical Learning Disability (MLD) in their discussions on the DSM-IV definition of mathematics disorder. Such pupils, Geary et al. (2012) suggest score at or below the 10^{th} percentile on standardized mathematics achievement tests. The term *mathematical difficulties* (MD) was used by Gersten et al. (2005) to describe pupils scoring at or below the 35^{th} percentile (low average) in addition to those scoring well below average. While Chinn (2012) agrees with this term, he states that pupils with percentiles of < 25^{th} percentile fall into this category. Pupils identified with MD do not necessarily have a disability in mathematics but are low achievers (LA) (Mazzocco, 2007) and their ability levels lie between the 11^{th} and 25^{th} percentile (Geary et al., 2012).

The identification of dyscalculia is a complex issue and is the subject of much debate (Gifford & Rockliffe, 2008; Gillum, 2012). In their study Mazzocco, Feigenson, and Halberda (2011) refer to MLD and dyscalculia as synonymous. Farrell (2012) meanwhile states that “mathematics disorder is sometimes called dyscalculia” (p. 243). Emerson and Babtie (2013) refer to dyscalculia as an “umbrella term used to refer to various conditions that cause specific difficulties with maths, such as developmental dyscalculia, mathematical disability, numerical learning disability and number fact disorder among other terms” (p. 1). However, Chinn (2012) proposes that dyscalculia is “at the severe end of a spectrum of mathematical learning difficulties” (p. 5).

Generally, however, dyscalculia is a term used in the literature to describe pupils who have a specific difficulty in relation to the acquisition of arithmetic facts, calculating and solving problems (Landerl et al., 2004; Von Aster & Shalev, 2007). It was first defined by Kosc in 1974, as a specific learning disability in mathematics in a pupil with typical intelligence but with mathematical abilities falling considerably below expectations, given the pupil’s intellectual ability, age and level of educational opportunities (Farrell, 2012; Yeo, 2003). In the UK, Dyscalculia is recognised as a SpLD (DfES, 2001) as a neurological condition affecting the acquisition of arithmetical skills (Farrell, 2012; Gillum, 2012). The core challenges for pupils with dyscalculia are their difficulties with number sense and number concept (Sharma, 2015). Kaufmann and von Aster (2012) suggest that dyscalculia is “demonstrable by standardized psychometric testing that reveals poor calculating ability despite normal intelligence” (p. 769). The genetic origins of dyscalculia were noted in Kosc’s 1974 definition (Chinn &

Ashcroft, 2007; Hannell, 2013; Von Aster & Shalev, 2007). Pupils with dyscalculia "require special academic support" (Sharma, 2015, p. 278).

Given the challenges associated with defining difficulties experienced by pupils in mathematics, it seems plausible to adopt the term ***mathematics difficulties*** for the purposes of this research to incorporate the heterogeneity of such difficulties, albeit recognising the specific characteristics of mathematics disabilities and dyscalculia and acknowledging also the overlap therein.

2.7.2 Factors impacting the acquisition of mathematical skills

There is consensus amongst researchers that there is no single cause of mathematics difficulties and it is acknowledged that a variety of factors can impact the acquisition of mathematics skills (Chinn, 2012; Vaughn, Bos, & Schumm, 2011). Individual pupils have unique profiles of learning strengths and needs in relation to mathematics (Chinn & Ashcroft, 2007). Comorbidity significantly influences the development of mathematics skills (Chinn & Ashcroft, 2007). The interrelationships between the subject content in mathematics, the pupil and the learning opportunities afforded to them will determine the mathematical outcomes for each pupil (Chinn & Ashcroft, 2007). Each of these three factors will be presented and discussed.

2.7.2.1 Subject content

While the nature, structure and content of mathematics present as a challenge for many learners (Gillum, 2014; Riccomini & Smith, 2011; Westwood, 2011), pupils with learning difficulties in mathematics may find that the acquisition of mathematical skills is a daunting task (Patton & Cronin, 1997; Riccomini & Smith, 2011; Sherman, Richardson, & Yard, 2013). Definitions of mathematics are many and varied and can be viewed in different ways (Reys, Lindquist, Lambdin, & Smith, 2015). It has been described as a "universal, utilitarian subject" (Kilpatrick et al., 2001, p. 15), and as an "intellectual achievement of great sophistication and beauty that epitomizes the power of deductive reasoning" (Kilpatrick et al., 2001, p. 1). Mathematics uses a symbolic language which needs to be understood by the learner in the contexts in which it is used (Reys et al., 2015). The definition of mathematics proposed by Chinn and Ashcroft (2007) epitomises the demands of the subject for its learners. They say that "mathematics is a sequential subject, building on early skills and knowledge to take the student on to new skills and knowledge. It is a subject involving organisation and patterns and abstract ideas and concepts" (Chinn & Ashcroft, 2007, p. 14). Van de Walle, Karp, and Bay-Williams (2013) define mathematics as "the science of concepts and processes that have a pattern of regularity and logical order" (p. 13), a definition which supports the views of Chinn and Ashcroft (2007). Gillum (2014) also puts forward the hierarchical nature of mathematics and the sequential learning of basic skills in his discussion on mathematics. Given that core skills in mathematics are vital to ensure full participation in modern society (Kilpatrick et al., 2001; National Council for Curriculum and Assessment, 2007), it is the responsibility of educators to help their pupils to meet the demands of the subject and ensure that those pupils with learning difficulties in mathematics acquire basic skills (Sharma, 2015).

2.7.2.2 The pupil

Understanding the difficulties pupils experience when learning mathematics will enable teachers to adopt instructional approaches which are best suited to meet their needs (Bley & Thornton, 2001; National Council for Curriculum and Assessment, 2007; van Garderen, Thomas, et al., 2013; Vaughn et al., 2011). The difficulties range from those associated with cognitive development, memory difficulties or language and literacy difficulties, for example (Mancl, Miller, & Kennedy, 2012; Pedrotty Bryant, Kim, Hartman, & Bryant, 2006). The depth and range of learning characteristics unique to each pupil will impact on their ability to learn mathematics (Mercer, Mercer, & Pullen, 2011; National Council for Curriculum and Assessment, 2007; Peterson Miller, 2009). As acquisition of mathematics skill is sequential in nature, any early gaps in knowledge may impede future progress (Chinn & Ashcroft, 2007). Therefore, these pupils may require additional time to learn mathematics (Bley & Thornton, 2001).

Difficulties with cognitive development impact on mathematical development (Geary, 2013). These difficulties will affect the ability of pupils to calculate, to generalise strategies and to solve word problems (Geary, 2013; Pedrotty Bryant et al., 2006; Sliva, 2004). Pupils with memory difficulties will require additional support to recall basic facts, to process information, to recall and apply multiple-steps in problem solving (Mercer et al., 2011; Pedrotty Bryant et al., 2006; Sherman et al., 2013). Both receptive and expressive language difficulties contribute to difficulties in mathematics (Bley & Thornton, 2001; Pedrotty Bryant et al., 2006). As language is the primary means of communication in a mathematics class, pupils with language difficulties will require support to aid their comprehension of the mathematics language (Bley & Thornton, 2001). If the pupil has difficulty with reading and/or written language, alternative options need to be in place for both accessing content and for recording responses (Pedrotty Bryant et al., 2006). Pupils with mathematical difficulties may find problem-solving particularly challenging and generally do not have the strategies required for successful problem-solving (Jitendra & Montague, 2013; Jitendra & Star, 2011).

Many pupils with mathematical difficulties experience difficulties in acquiring skills in number sense and, therefore, lack an inherent sense of what a number means and experience difficulties with number operations (Gersten & Chard, 1999; Jordan, Glutting, Dyson, Hassinger-Das, & Irwin, 2012). Gersten and Chard (1999) discuss the analogies between the value of the acquisition of the concepts of phonological awareness in relation to reading disabilities and number sense in relation to mathematical difficulties in their earlier research on this area. Current research states that inadequate skills in number sense are an indicator of later mathematical difficulties and that number sense is a foundational mathematical skill (Geary, Bailey, & Hoard, 2009; Jordan et al., 2012). Thus, it will be necessary for special education teachers, to include interventions to teach number sense concepts to pupils with difficulties in mathematics (Pedrotty Bryant, Roberts, Bryant, & DiAndreth-Elkins, 2011).

Mathematics anxiety has been described as a feeling of tension and anxiety which impacts on the ability to solve mathematical problems (Richardson & Suinn, 1972). It impacts on attainment levels in mathematics (Akin, Kurbanoglu, & Takunyaci, 2011; Allsopp, Kyger, & Lovin, 2007; Emerson & Babtie, 2013) and influences attitudes towards learning mathematics and subsequent skill development (Kaufmann & von Aster, 2012; Sliva, 2004). As research indicates that mathematics anxiety is a “transitory-state construct” (Bagloglu & Zelhart, 2007, p. 608), Chinn (2012) proposes that mathematics anxiety be considered in diagnostic protocols in mathematics. Teachers need to be aware of the presence of mathematics anxiety when planning intervention programmes for pupils who experience difficulty learning mathematics and address deficits therein (Chinn, 2012; Witzel & Little, 2016).

Comorbid disabilities such as Attention-Deficit Hyperactivity Disorder (ADHD), Dyspraxia, Dyslexia and other disabilities may impact on attainment levels in mathematics (Vaughn et al., 2011; Zentall, 2007) and is an aspect of mathematics difficulties which has been identified as requiring further research (Geary, 2013). Von Aster and Shalev (2007) state that approximately 20 to 60% of pupils with dyscalculia will have comorbid difficulties including dyslexia or ADHD. In these instances, pupils may require support to stay on task, support with literacy or with the language demands of mathematics in order to achieve in mathematics (Kaufmann & von Aster, 2012; Sliva, 2004; van Garderen, Thomas, et al., 2013).

The challenges, as stated thus far, experienced by some pupils in learning mathematics clearly highlight the factors impacting on the acquisition of mathematical skills. It is essential that a skilled teacher of mathematics will have knowledge of these factors in order to plan and implement relevant interventions (van Garderen, Thomas, et al., 2013).

2.7.2.3 Opportunities for learning mathematics

The third and final factor to be considered in the discussion relating to the acquisition of mathematics skills relates to the learning situation and to the opportunities pupils receive to learn mathematics (Chinn & Ashcroft, 2007). The influence of the special educator on pupil attainment levels has been under consideration in the US recently and there has been a particular focus on the special education teacher's level of preparedness to teach mathematics (van Garderen, Thomas, et al., 2013). Teaching mathematics to pupils with mathematical difficulties requires a knowledge of the subject of mathematics itself (Chinn & Ashcroft, 2007; Mastropieri et al., 2011; National Mathematics Advisory Panel, 2008) and its associated pedagogy, coupled with an understanding of the learning strengths and needs of the learner (Mamlin, 2012; Mastropieri et al., 2011; van Garderen, Thomas, et al., 2013). Griffin, van Garderen, and Ulrich (2014) note that teachers who do not understand how a pupil learns mathematics or the difficulties they experience will not be effective teachers of mathematics for pupils with learning difficulties. Teachers require a knowledge of instructional approaches, also known as empirically validated practices or evidence-based practices and need to refer to these research-based approaches for teaching mathematics to pupils with mathematical difficulties (Maccini & Gagnon, 2006). In addition, knowledge of assessment procedures for pupils with SEN is considered essential (van Garderen, Thomas, et al., 2013; Zentall, 2007). It thus appears evident, that special education teachers require "a sophisticated knowledge base that extends beyond that of general education teachers" (Brownell et al., 2010, p. 371). This level of expertise will allow special educators to assess, plan and teach interventions which support the pupil with learning difficulties so that they can access the general curriculum (Brownell et al., 2010; Stough & Palmer, 2003) and ultimately increase their achievement levels.

Although the research on mathematical difficulties is not as well developed as that of literacy (Faragher & Clark, 2014; Gersten, Chard, et al., 2009; Gersten, Clarke, & Mazzocco, 2007; Gersten & Newman-Gonchar, 2011; Griffin & Shevlin, 2011; Norwich & Lewis, 2001), suffice it to say that there is a significant base of research based interventions available to guide and support teachers to provide quality instruction in mathematics to pupils with learning difficulties in mathematics (Clarke, Doabler, et al., 2011; Gersten, Chard, et al., 2009; Gersten et al., 2005; Gersten & Newman-Gonchar, 2011; Mercer et al., 2011).

2.7.3 Supporting pupils with mathematics difficulties

All students, regardless of their personal characteristics, backgrounds, or physical challenges, can learn mathematics when they have access to high-quality mathematics instruction. Equity does not mean that every student should receive identical instruction. Rather, it demands that reasonable and appropriate accommodations be made and appropriately challenging content be included to promote access and attainment for all students (National Council of Teachers of Mathematics, 2000, p. 2).

The *Principles and Standards for Mathematics Education* in the USA present six principles for the teaching of mathematics in an effort to raise the standards of mathematics for all pupils (National Council of Teachers of Mathematics, 2000; Pedrotty Bryant et al., 2006). The Equity Principle (quoted above) acknowledges that adaptions be made in order to ensure access and attainment for every learner (National Council of Teachers of Mathematics, 2000). Similarly in the Republic of Ireland, the *Mathematics Guidelines for Teachers of Pupils with Mild General Learning Disabilities* acknowledges both the challenges mathematics presents to pupils with learning difficulties (National Council for Curriculum and Assessment, 2007) and the role of the teacher in facilitating access to the mathematics curriculum (National Council for Curriculum and Assessment, 2007) for these pupils.

2.7.3.1 Providing additional support – A continuum of support

Additional support in mathematics (as in literacy) adopts a staged or tiered approach (Department of Education and Skills, 2005c, 2007a; Riccomini & Smith, 2011) of assessment and interventions. Referred to in the USA as *Response to Intervention (RtI),* the approach provides for the identification of specific difficulties experienced by pupils, research-based interventions at class level and subsequent focused, individual supports where necessary (Gersten & Newman-Gonchar, 2011; Riccomini & Witzel, 2010). Schools in Ireland are mandated to identify pupils with SEN within the education system and to ensure that these children receive an inclusive education relevant to their specific strengths and learning needs (Government of Ireland, 2004; Griffin & Shevlin, 2011). The *Staged Approach to assessment, identification and programme planning* as outlined by the DES (Department of Education and Skills, 2003, 2005c) and further developed by NEPS (Department of Education and Skills, 2007a) provides the framework for a similar multi-step approach to assessment and intervention (Figure 2.1: Continuum of Support).

The Continuum of Support framework provides a “graduated approach to identification and programme planning” (Department of Education and Skills, 2007a, p. 1) involving collaboration between the class teacher, learning support/resource teacher and external professionals. In line with best practice internationally, each step of the continuum involves assessment, planning and intervention and review of progress to date (Department of Education and Skills, 2007a; Riccomini & Witzel, 2010).

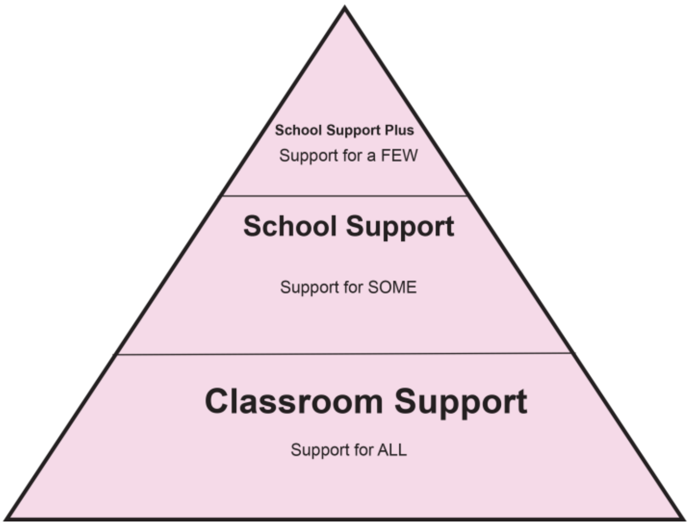

Figure 2.1 Continuum of support (Department of Education and Skills, 2007a)

Figure 2.2 presents the NEPS (2007) problem-solving process of assessment, intervention and review (Department of Education and Skills, 2007a).

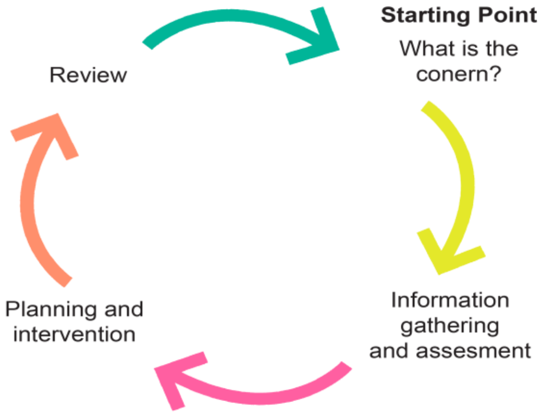

Figure 2.2 Assessment, intervention and review process (Department of Education and Skills, 2007a, p. 5).

The initial role of assessment in the context of supporting pupils with mathematics difficulties is that of screening or identification (Riccomini & Smith, 2011; Sherman et al., 2013). Class teachers gather information (formally and informally) (Lerner & Johns, 2012) through a number of assessment approaches (Department of Education and Skills, 2007a; Frederickson & Cline, 2009; National Council for Curriculum and Assessment, 2007; Peterson Miller, 2009) such as teacher observations (Griffin & Shevlin, 2011), performance on class-based activities, portfolios, criterion referenced tests and standardized screening measures (Gurganus, 2007; National Council for Curriculum and Assessment, 2007; Sherman et al., 2013). The *Drumcondra Tests of Early Numeracy* (DTEN) is particularly useful at this level given its early screening aspect (ERC, 2011). Following consultation with parents, interventions are planned and implemented at the classroom level (Department of Education and Skills, 2007a). Further assessments undertaken at the end of the intervention period will indicate the extent of the progress which has been achieved by the pupil (Griffin & Shevlin, 2011; Mercer et al., 2011; Westwood, 2013).

A smaller number of pupils require continued support (Gersten & Newman-Gonchar, 2011). The LS/RT plays a role in the identification of specific areas of mathematics to be targeted for intervention through the administration of diagnostic assessments at the second stage, School Support (Department of Education and Skills, 2007a). Information gleaned from assessments and that gathered through discussions with parents and teachers will lead to the development of a *School Support Plan* for each individual pupil (Department of Education and Skills, 2007a). This individualised planning document specifies the nature of the learning strengths and needs, the intervention programme, the monitoring arrangements and personnel involved (Department of Education and Skills, 2007a; Griffin & Shevlin, 2011).

The final stage of support is recommended for pupils for whom the interventions at the earlier stages have proved unsuccessful, and who require additional professional support to assess their progress and plan their intervention programmes (Department of Education and Skills, 2007a; Griffin & Shevlin, 2011; Riccomini & Smith, 2011). An *IEP* as stipulated in the *EPSEN* Act (2004) will be prepared and implemented at this stage (Department of Education and Skills, 2007a; Government of Ireland, 2004). In addition to the parents, a number of professionals such as the class teacher, the learning support/resource teacher, the educational psychologist (EP) will be involved in the implementation and monitoring of the intervention programme (Department of Education and Skills, 2007a).

2.7.3.2 Intervention programme

Following assessment of pupil needs, the next step of the continuum of support (at each level) involves the planning of an intervention programme (Department of Education and Skills, 2007a) to support the mathematical difficulties identified (Gersten, Beckmann, et al., 2009). While the mathematics curriculum identifies curriculum content or standards (Government of Ireland, 1999a; National Council of Teachers of Mathematics, 2000) for all pupils, the collaborative team involved in the programme planning, informed by the relevant assessments and discussions with parents and relevant professionals, will identify the elements of the curriculum and the instructional strategies to be included in the intervention programme (Cawley, Hayes, & Foley, 2008; Department of Education and Skills, 2007a; Gersten, Beckmann, et al., 2009; National Council for Curriculum and Assessment, 2007).

Traditionally, the focus of the curriculum for pupils with learning needs was based on the teaching of a set of functional skills (Browder, Spooner, Ahlgrim-Delzell, & Wakeman, 2008; Westwood, 2011), which subsequently resulted in the narrowing of the curriculum for these pupils (Rose, 2007). Current moves towards inclusion are reflected, for example, in the rationale for the *Guidelines for Teachers of Pupils with MGLD-Mathematics* where it states that the “aims and objectives of the Primary School Curriculum, Mathematics are valid for all students” (National Council for Curriculum and Assessment, 2007, p. 3). The *Principles and Standards for School Mathematics* in the USA as outlined by the National Council of Teachers of Mathematics (2000) support this view. Both policy documents, however, indicate that accommodations may be required for some pupils given the demands of the mathematics curriculum for pupils with learning needs (Kilpatrick et al., 2001; National Council for Curriculum and Assessment, 2007; National Council of Teachers of Mathematics, 2000).

In practice, teachers planning an intervention programme in mathematics for pupils with learning difficulties are likely to differentiate both the content and the teaching approaches (Hudson & Miller, 2006; Westwood, 2013). Generally, teachers maintain a focus on the core mathematics programme (Clarke, Doabler, et al., 2011; Patton & Cronin, 1997; Riccomini & Smith, 2011). A core curriculum consisting of the components necessary for mathematical proficiency (understanding key concepts, achieving computational fluency, the ability to solve standard algorithms and solve problems) will be most effective for pupils with learning difficulties in mathematics (Kilpatrick et al., 2001; National Mathematics Advisory Panel, 2008; Riccomini & Witzel, 2010; Woodward, 2006).

2.7.3.3 Evidence-based instructional approaches

Following the development of the intervention programme in mathematics for pupils requiring additional support, the next phase in the continuum of support is its implementation (Department of Education and Skills, 2007a; National Council for Curriculum and Assessment, 2007; Vaughn, Wanzek, & Denton, 2007). The nature of the interventions will range from those which will be implemented in the classroom at the first level of the continuum to those which are more specialised and focused for individual pupils at the School Support and School Support Plus levels (Department of Education and Skills, 2007a; Riccomini & Smith, 2011; Vaughn et al., 2007).

The definition of mathematical interventions proposed by Gersten, Chard, et al. (2009) provides a clear focus for the teaching of intervention programmes. They define mathematical interventions as "instructional practices and activities designed to enhance the mathematics achievement of students with Learning Disabilities (LD)" (p. 1205). Given that there is strong consensus in the literature, that pupils with additional learning needs are best supported by teaching interventions that are "quantitatively and qualitatively superior" (Gersten & Edwards Santoro, 2007, p. 191) to their peers, it is also recommended that teachers adopt mathematical interventions that are supported by *rigorous, scientific-based research* on best practice for pupils with LD (Doabler et al., 2012; Miller & Hudson, 2007; National Council of Teachers of Mathematics, 2007; Newman-Gonchar, Clarke, & Gersten, 2009; Riccomini & Smith, 2011; Riccomini & Witzel, 2010; Vaughn et al., 2007).

Findings from a number of meta-analyses studies (Gersten, Beckmann, et al., 2009; Gersten, Chard, et al., 2009; Kroesbergen & Van Luit, 2003; Newman-Gonchar et al., 2009) conducted on mathematics learning difficulties indicate the existence of a number of effective, research-based interventions in mathematics for this cohort of pupils (Jitendra, 2013; National Council of Teachers of Mathematics, 2007; Van de Walle et al., 2013). Many of these intervention practices will also be relevant for pupils with lower achievement levels in mathematics (Jayanthi & Gersten, 2011). Key instructional practices include for example; *the concrete to abstract (CRA) sequence, explicit systematic instruction, visual representations, think-alouds, peer-assisted learning and assessment* (Cole & Wasburn-Moses, 2010; Hudson & Miller, 2006; Van de Walle, Lovin, Karp, & Bay-Williams, 2014; Vaughn et al., 2011).

2.8 Conclusion

The difficulties experienced by some pupils when learning mathematics lie along a continuum with some pupils experiencing greater difficulties than others (Chinn, 2012). The terminology to describe these difficulties is not clearly defined in the literature (Landerl et al., 2004) and hence poses difficulties for both pupils and researchers alike (Geary et al., 2012; Gifford, 2006; Mazzocco, 2007). While the literature recognises the challenges of learning mathematics for many pupils, those with mathematics difficulties will be particularly challenged (Sherman et al., 2013; Westwood, 2011). Their ability to succeed depends upon the interrelationships between the subject content, the strengths and needs of the pupil and the opportunities they have to learn mathematics (Chinn & Ashcroft, 2007). The literature identifies the influence of the teacher on pupil attainment levels in mathematics (van Garderen, Thomas, et al., 2013). A knowledge of the content matter, the pedagogy and the particular learning strengths and needs of the pupil, is required to teach mathematics to pupils with learning difficulties (Mastropieri et al., 2011; van Garderen, Thomas, et al., 2013). Additional support is provided through a structured framework, the Continuum of support (Department of Education and Skills, 2007a), through an assessment, intervention and review process. Evidence-based instructional approaches are clearly outlined in the literature as effective means of delivering intervention programmes in mathematics (Kroesbergen & Van Luit, 2003; Newman-Gonchar et al., 2009).

2.9 Chapter Conclusion

The response to inclusive approaches to education has resulted in the enrolment of pupils with SEN in mainstream settings (Government of Ireland, 2004; Irish National Teachers Organisation, 2003; UNESCO, 1994). Inclusion has required schools to develop policies and practices to support the needs of a diverse pupil population (Ainscow, 2007a; Ainscow & Sandill, 2010). The beliefs, attitudes and actions of teachers play a key role in the creation of inclusive learning environments (Ainscow & Sandill, 2010; McLeskey & Waldron, 2002).

There is increased demand nationally and internationally for higher attainment levels in mathematics (Department of Education and Skills, 2011f; National Council of Teachers of Mathematics, 2000). Prevalence rates indicate that some pupils experience difficulties learning mathematics (Fuchs et al., 2011; Geary, 2013). Research in recent years has strengthened the research base with regard to the teaching of mathematics to pupils with SEN (Mastropieri et al., 2011; Vaughn et al., 2007). Teaching pupils with SEN requires a knowledge base incorporating content knowledge and its pedagogy, the particular challenges experienced by pupils with SEN in content areas such as mathematics and a knowledge of evidence-based intervention strategies (Brownell et al., 2010; Mastropieri et al., 2011; Vaughn, Wanzek, & Denton, 2014). Pupil outcomes are impacted by the quality of the instruction they receive (van Garderen, Thomas, et al., 2013). The provision of CPD for teachers is central to the success of inclusive education (Mastropieri et al., 2011; McLeskey & Waldron, 2002; Pugach & Blanton, 2014).

The purpose of this chapter was to provide the context for the current study within the relevant literature base. The specific focus of this study, teacher learning in the context of the mathematics lectures on the PGDSEN programme, encompasses the interdependent themes of Inclusion, Inclusive and Special Education: Policy and Provision, CPD and Translating learning into practice-Teaching mathematics to pupils with SEN. The next chapter will present an ecological perspective on special education teacher learning thereby enabling an in-depth understanding of the complexities of special education teacher learning and subsequent transfer of adapted practice in school settings.

Chapter 3: An Ecological Perspective on Special Education Teacher Learning in Mathematics

3.1 Introduction

This research study examined special education teacher learning in mathematics within the context of a PGDSEN programme recently completed by the participants, special education teachers, in primary and special schools. The purpose of the study was to understand the factors, individual and contextual, influencing special education teachers' acquisition of knowledge and skills for teaching mathematics to pupils with SEN. Contextual factors considered in this study included the support and attitudes of school leaders, national policies, inclusive school policies and practices, and collegial expectations. The study also sought to understand the perceptions and experiences of the participants, of the influence of the mathematics input on the PGDSEN programme, on their acquisition of new knowledge and skills. Finally, the understandings of the participants of the transfer of their learning to classroom practice was examined. The barriers and facilitating factors influencing the implementation of their adapted practices were elicited.

To design CPD in mathematics which is responsive to the needs of the special education teachers within the settings in which they teach, an in-depth knowledge of the variables influencing special education teacher learning in mathematics is essential for educationalists, researchers and policy makers. In order to achieve this, it was necessary to situate the development of the special education teacher within a theoretical framework in order to provide a "scientifically acceptable set of principles'' (Schunk, 2014, p. 10), which can be used to describe, analyse and interpret the findings of this research study.

3.2 Theoretical Framework – A Rationale

The study of human development captivated researchers historically and continues to be a subject of research to the present day. Theories, "organised sets of ideas" (Kail & Cavanaugh, 2010, p. 11), provide explanations of human development. Plato, an early theorist, hypothesised that knowledge was acquired from reason, while his student Aristotle viewed experience as the root of knowledge (Schunk, 2014). Other schools of thought have evolved. Psychodynamic theories link human development to the ability of the person to resolve conflicts they experience (Kail & Cavanaugh, 2010), while learning theories, including behaviourist approaches, view the formation of knowledge as a response to the "association of stimuli and responses'' (Schunk, 2014,

p. 21). Social learning theories, such as Bandura's social cognitive theory, hold the view that learning occurs through observation (Kail & Cavanaugh, 2010). Cognitive developmental theorists, including Piaget, focused on thought processes and how these developed and changed throughout the life span (Kail & Cavanaugh, 2010). Meanwhile, ecological approaches to child development are representative of changing trends in developmental psychology, which situate the development of the child within their socio-cultural context (Greene & Moane, 2000).

Bronfenbrenner's ecological approach (1979, 1989) and the Bildung-Psychology approach developed by Spiel and her colleagues (Spiel, Reimann, Wagner, & Schober, 2008), are examples of ecological theories. The literature acknowledges the usefulness of both models to educators as a means of aiding their understanding of specific issues relating to their students (Mc Guckin & Minton, 2014). The flexibility within the structures of both models allow for their application across a wide range of studies (Mc Guckin & Minton, 2014; Spiel et al., 2008). The Bildung-Psychology theory has been described as an "emerging discipline" (Spiel et al., 2008, p. 154), and has not been used in Irish research studies to date (Mc Guckin & Minton, 2014).

Given that theorists differ in their efforts to explain human development and that the nature of a particular type of learning determines the appropriateness of a theoretical perspective (Schunk, 2014), a theoretical framework with an ecological perspective was deemed best suited to the current research study. Bronfenbrenner's (1979) theoretical perspective on human development provides an internationally accepted framework for research in educational contexts examining the bi-directional nature of the interaction between the environment and the learner throughout his lifespan (Brownell & Smith, 1993; Greene & Moane, 2000; Mc Guckin & Minton, 2014; McTernan & Godfrey, 2006). Its remit extends from an understanding of the development of the child (Greene et al., 2010; Odom et al., 2004), to that of the development of adults, including teachers in educational settings (Brownell & Smith, 1993; Lewthwaite, 2011; Mc Guckin & Minton, 2014). In addition to its ecological perspective, the parsimonious nature of the Bronfenbrenner (1979) model to contextualise research findings suggested its suitability to the current study (Mc Guckin & Minton, 2014). A particular strength of the model in the context of the current research study lies in the flexibility of the framework to identify variables influencing special education teacher learning in mathematics, and in examining the relationships between the variables throughout the life span of the learner (Mc Guckin & Minton, 2014). The relevance of the Bronfenbrenner (1979) framework as a model for guiding research in Ireland is evident in its use in particular in the *Growing Up in Ireland* study (Greene et al., 2010). In that study, an analysis of the systems layers in Bronfenbrenner’s (1979) framework allowed for an understanding of how family conditions, the neighbourhood and the national economy impact on the health of children and, in turn, on the functioning of the family (Greene et al., 2010). Another example of the use of Bronfenbrenner’s (1979) theoretical model is in a study on inter-agency planning of services for children in Northern Ireland by McTernan and Godfrey (2006). Their study aimed to examine the relationship between the child and their environment and an adapted version of Bronfenbrenner’s (1979) theoretical model was used to frame their research (McTernan & Godfrey, 2006).

3.3 Bronfenbrenner’s (1979) Ecological Theory

Bronfenbrenner’s (1979) ecological theory is based upon the development of the learner within a series of nested and interconnected systems in an environment unique to the learner (Lewthwaite, 2011). Development is defined by Bronfenbrenner (1979) as “the person’s evolving conception of the ecological environment, and his relation to it, as well as the person’s growing capacity to discover, sustain, or alter its properties” and occurs within interrelated environmental systems, which he identified as the microsystem, mesosystem, exosystem and macrosystem (p. 9). The interactions between these nested systems, in addition to occurrences within them, in the context of the broader setting of the systems, influence the process of development of the learner to differing extents (Bronfenbrenner, 1979; Greene & Moane, 2000; Rosa & Tudge, 2013). This suggests, that the development of the learner, is strongly influenced by his immediate environment (microsystem), and by people and events and the interactions between them (mesosystem) in his wider environment (exosystem and macrosystem) (Odom et al., 2004). Bronfenbrenner (1979) views the interaction between the learner and his environment as two dimensional and states that the learner is “a growing dynamic entity that progressively moves into and restructures the milieu in which it resides” (p. 21).

This model is generally presented in graphic form as a series of concentric circles, with the child situated in the centre of the ecological system (Mc Guckin & Minton, 2014; Odom et al., 2004) (Figure 3.1). The surrounding circles are placed so that those which are proximal to the child impact more strongly on his development (Greene & Moane, 2000). The *microsystem*, the immediate surroundings of the child, was defined by Bronfenbrenner (1979) as a “pattern of activities, roles and interpersonal relations experienced by the developing person in a given setting with particular physical and material characteristics” (p. 22), and “containing other persons with distinctive characteristics of temperament, personality and systems of belief" (Bronfenbrenner, 1989, p. 227). He envisioned that the setting provided the context for face to face interactions with those who were particularly close to the developing child. The nature of the relationships the child had with others in her microsystem played a critical role in her development (McTernan & Godfrey, 2006). The microsystems in the case of Rachel, a nine year old girl, for example, would include her family (parents and siblings), her class (teacher and peers), after-school carers, football coach and fellow team members. A particular strength of this element of the ecological cycle is its facilitation of a description of each child's microsystem. This is recognised as being "particularly helpful in pointing to the ways in which one culture may differ from another, and how differences between sub-cultures within an over-arching culture lead to a very different set of experiences and developmental outcomes for children" (Greene & Moane, 2000, p. 124). The microsystem is not static, but evolves with the development of the learner, thereby advantaging the learning (Mc Guckin & Minton, 2014; McTernan & Godfrey, 2006).

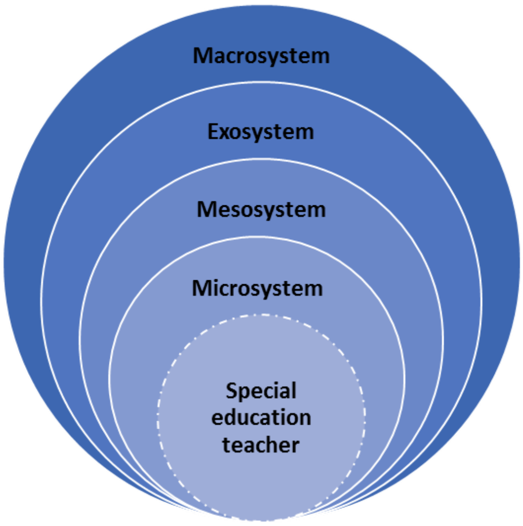

Figure 3.1   Ecological perspective on human development (Bronfenbrenner, 1979)

The *mesosystem* is described by Bronfenbrenner (1979) as "a system of microsystems" (p. 25), and is comprised of the relationships "amongst two or more settings in which the developing person actively participates" (p. 25). The extent and nature of these relationships both determine and influence the development of the child (Greene & Moane, 2000; McTernan & Godfrey, 2006). Strong connections between the micorosystems at the mesosystem level impact positively on the development of the child (Mc Guckin & Minton, 2014). The relationship between a child's parents and teachers can, for example, impact on the child's development (Odom et al., 2004). In the case of nine year old Rachel, the microsystems in her immediate environment, her family, school and peers interact with each other and impact on her development either positively or negatively. Positive influences are represented, for example, by the attendance of her parents at parent teacher meetings and parent workshops to support her acquisition of numeracy skills.

The mesosystem also incorporates linkages that exist between the microsystem and the next system, the exosystem (Greene, 1994). The *exosystem* refers to settings in which the child is not directly involved, but yet impact directly on the microsystem and hence, the development of the child (Bronfenbrenner, 1979; Hong & Garbarino, 2012). In the case of child development, elements of this system could include the health service, housing or social services policies etc. (McTernan & Godfrey, 2006). Rachel, the nine year old in the preceding examples, is aware that her parents view her education positively as they are active participants in her education. If, for example, her father lost his job due to the closure of his company and had to commute long distances to secure new employment to support his family, he would not be available to meet with her teacher or to support her with homework. In this instance, an event occurring in the exosystem can be seen to have a negative impact on Rachel's development even though she is not an active participant at this level.

The fourth system, the *macrosystem,* places the preceeding systems in the cultural ideologies, attitudes and beliefs of the setting (Greene, 1994). Bronfenbrenner (1989) suggested that "to the extent that is practically possible, every study of development in context should include a contrast between at least two macrosystems" (p. 231). Although removed somewhat from the immediate environment of the learner, the belief and cultural ideologies of the macrosystem may have a significant influence on his development (Mc Guckin & Minton, 2014; McTernan & Godfrey, 2006). Research undertaken by Odom et al. (2004) points to the influence of cultural and linguistic diversity on the inclusion of preschool children with disabilities. Findings from the study of Hanson and Gutierrez (1997) indicated the impact of language differences on home/school communications which, therefore, suggest the necessity of providing additional support in translation services. The responsive nature of the macrosystem to national and international changes, such as economic prosperity or recession, advances in technology or conflict, may result in the beliefs and cultural ideologies of the society changing or fluctuating thereby causing societal structural change over time (Mc Guckin & Minton, 2014). Recent economic trends in Ireland have resulted in an influx of immigrants arriving to take up employment and reside in the country. Children for whom English is an additional language are now in the microsystems of Irish school children and their teachers.

The fifth system, the *chronosystem,* present throughout each system, permits an examination of the changes or consistencies over time of both the learner and of his environment (Bronfenbrenner, 1994). Such changes may occur within the learner, i.e., ill health or may occur in the environment of the learner, e.g. life changes such as beginning school, getting married (Bronfenbrenner, 1989). The addition of this system serves to “make the framework more dynamic and complex” (Odom et al., 2004, p. 38). The passage of time results in changes at each level of the framework. The impact of influences and their interconnecting relationships change, for example as the learner gets older (Odom et al., 2004). Following their study, Lewis, Cruise, Fearn, and Mc Guckin (2009) suggest that there would be value in replicating the religious and life perspectives of young people in Ireland in order to identify changed perspectives over time. This is another example of change at the chronosystem level.

3.4 Application of Bronfenbrenner’s (1979) Theory to Current Research Study

Bronfenbrenner’s (1979) model provides the framework for the analysis of the individual and contextual factors influencing special education teacher learning in mathematics for the purposes of this research study. The ecological framework further permits an analysis of special education teacher perceptions, experiences and influences of the PGDSEN programme on the acquisition of new knowledge and skills, and on their understandings of the transfer of their learning to practice. It enables an examination of special education teacher learning and of their interactions with significant others to be undertaken in the context of the school setting and within the broader educational system.

The special education teacher lies at the centre of Bronfenbrenner’s (1979) ecological framework. An ecological perspective on special education teacher learning in mathematics is presented in Figure 3.2. The special education teacher participants in the current study were participants in a CPD programme, namely the PGDSEN programme. While they were experienced class teachers, the participants (microsystem) had less experience in special education. They were therefore motivated to participate in CPD to learn new skills and knowledge and for promotional purposes in their schools. They had positive attitudes to applying new skills and knowledge to their practice. Participant levels of content and pedagogical knowledge in mathematics was varied. All participants expressed positive attitudes towards inclusive education approaches. They believed that they could teach mathematics effectively to their pupils.

Microsystems	Special education teacher
	    Teaching experience (mainstream & SEN)
	    Case load
	    Mathematics teaching efficacy beliefs
	    Mathematics anxiety
	    Attitude to inclusion
	    Attitude to mathematics
	    Mathematical knowledge for teaching
	    Participation in CPD (including PGDSEN)
	Class teacher
	    Attitude to inclusion
	    Attitude to teaching mathematics to pupils with SEN
	    Teaching experience
	    SEN experience & expertise (CPD)
	    Expectations of the role of LS/RT
	Principal
	    Leadership style
	    SEN experience & expertise (CPD)
	    Attitudes to inclusion
	School
	    School climate (collaboration, attitudes to inclusion, mathematics standards, expectations in mathematics for pupils with SEN)
	    Policies (related to inclusion)
	Parents
	    Priority of mathematics for their children
	    Personal attitude to mathematics
	    Expertise in mathematics
	SNAs
	    CPD
	    Expertise
	    Role (teaching versus care)
	Pupil
	    Pupils' level of need
	PGDSEN
	    Skills (mathematics)
	    Knowledge (mathematics)
	    Experiential component (application)

Mesosystem	Principal
	    Attitude to inclusion
	    Attitude to mathematics
	    Attitude to CPD (including PGDSEN)
	    Attitude to co-teaching
	    Influencing school policy to allocate time for collaboration between class teacher and LS/RT
	    Influencing school policy to provide intervention programmes in mathematics
	    Class teacher
	    Attitude to support provided by the LS/RT

Exosystem	Socio-economic factors such as recession
	Multi-agency supports
	    NEPS - EPs
	    HSE – S&LTs, OTs
	    National policies and legislation
	        EPSEN Act (Government of Ireland, 2004)
	        School self-evaluation (Department of Education and Skills, 2012b)
	    The literacy and numeracy strategy 2011- 2020 (Department of Education and Skills, 2011f)
	    DEIS: An action plan for educational inclusion (Department of Education and Skills, 2005a)
	    PGDSEN programme of CPD-Circular 01/11 (Department of Education and Skills, 2011c)
	    Circular 02/05 (Department of Education and Skills, 2005c)
	    Certificate Course in SEN for SNAs (DES funded course)

Macrosystem	Societal attitudes to mathematics Societal demand for higher standards in mathematics Societal attitudes towards inclusion

Figure 3.2 An ecological perspective on special education teacher learning in mathematics - Adapted from (Greene et al., 2010)

As suggested by Bronfenbrenner (1979), the immediate setting of the special education teachers, their classroom, is positioned within their microsystem. Each participant in the current study (excepting the participants in the special school and special class) provided additional support to pupils with SEN. Such support was provided to pupils either in the special education teacher classroom or within the mainstream classroom by the participants. Other influences in their microsystem included contextual factors such as school policies, class teachers, SNAs, parents, and school leadership personnel.

The mesosystem consists of the relationships the participants have with the variables in the microsystem. Teaching pupils with SEN in the Irish education system is a collaborative process. It involves the professional and administrative support of colleagues within a whole school setting under the leadership of the principal teacher. Intervention programmes are directed by school policies both in special education and in mathematics. The relationship between positive parental attitude and parental support for mathematics may impact on pupil learning. On the other hand, the impact of negative parental attitude towards the ability of their children to learn mathematics or to the necessity for their acquisition of skills in mathematics will be examined. The current research study examines the nature and strength of the microsystem relationships and identifies their influence on the ability of the participants to apply the expertise gained through their participation on the PGDSEN programme to classroom practice.

The mesosystem is also influenced by elements of the exosystem. The socio economic nature of the school setting may advantage or disadvantage pupils with SEN in their effort to learn mathematics. The study identified the influence of legislation such as the *EPSEN* Act (2004), national policies including the SSE, the Literacy and Numeracy Strategy and DEIS numeracy plans on the teaching of mathematics in the schools.

The macrosystem comprises of the cultural beliefs of the society in which the learner and her school is situated. National systems such as the economic, education and political systems, for example, have the capacity to influence policy in education, including special education. The attitudes of society towards inclusion and towards mathematics can be said to broadly influence lower levels of the ecological system, ultimately resulting in either positive or negative influences on the outcomes of the mathematics programme taught by the special education teacher. An example of shifting economic demands in Ireland currently is evident in the response of the education system to the increased demands of society for the Science, Technology, and Engineering and Mathematics (STEM) subjects. The increased points allocation in the Leaving Certificate mathematics is indicative of one such response at the exosystem level. The initiatives of the Literacy and Numeracy Strategy (Department of Education and Skills, 2011f) (exosystem) is another national response impacting on the teaching of mathematics at microsystem level. Parents and pupils in both primary and post primary education have become more aware of the importance of achieving high grades in mathematics and the other STEM subjects. The *EPSEN* Act (Government of Ireland, 2004) (exosystem) has resulted in changes in the educational provision for pupils with SEN. Pupils with SEN are now afforded the opportunity of an inclusive education in mainstream schools and are provided with additional teaching and care support to meet their identified needs.

The chronosystem focuses on the passage of time throughout each system. The timing of events influencing the special education teacher's development throughout the school year and throughout her career needs to be considered. Does the timing of CPD throughout the school year make a difference for example? Is the length of teaching experience a factor in influencing the development of the teacher? The value of longitudinal research to document influences and changes over time is an element of the chronosystem. A follow up study of the PGDSEN participants within a five year period following their participation in this CPD would be an example of this.

3.5 Conclusion

Bronfenbrenner's (1979) ecological theory provided a framework to identify, organise and understand the complexity and interaction of factors influencing special education teacher learning in the present research study. The systems theory enabled an initial focus on the individual special education teacher by identifying personal characteristics and attributes influencing teacher development from the PGDSEN programme perspective within the unique contexts of their classroom/school settings. The participants of this research study, graduates of the PGDSEN programme, returned to their special education classrooms to implement their newly acquired skills and knowledge in mathematics. Bronfenbrenner's (1979) ecological perspective permitted a broader analysis of the interconnecting factors which supported and negated the acquisition and dissemination of their expertise in mathematics. The application of Bronfenbrenner's (1979) ecological framework to research on special education teacher learning will provide a blueprint for further research in this area. It is anticipated that the research findings from each systems level will enhance the future planning and implementation of CPD in mathematics for special education teachers. By so doing, the present study will make a unique contribution to the current limited research in Ireland in this field of study.

Chapter 4: Methodology

4.1 Introduction

The aim of this chapter is to provide an overview of the methodological approaches adopted for the purpose of the current study. In order to set the research in context, the chapter begins with an overview of the research topic.The purpose of the research and the research questions are outlined. The research design is presented and discussed in detail.

4.2 Research Topic

The *Salamanca Statement* (1994) is a universally acknowledged key document supporting inclusive education (Ainscow, 2007a; Vislie, 2003). It states “that those with SEN must have access to regular schools which should accommodate them with a child-centred pedagogy capable of meeting those needs” (UNESCO, 1994, p. viii). Ensuing legislation and policy documents in Ireland (Government of Ireland, 1998, 2004), in the UK (Department for Education, 2012; Evans, 2007; Warnock, 1978) and internationally defined the rights of pupils with SEN to be educated in mainstream schools.

The inclusion of pupils with SEN in mainstream schools has placed additional demands on teachers (Vaughn et al., 2007) and has implications for the preparation of special education teachers (Brownell et al., 2010). The importance of preparing teachers to teach in inclusive contexts is firmly noted (Greer & Meyen, 2009; Jordan et al., 2009), as it is recognised that teachers possessing the necessary knowledge and skills base are central to the successful inclusion of pupils with SEN (Brownell et al., 2010; Department of Education and Skills, 1993; Florian, 2010b; Jordan et al., 2009; O'Gorman & Drudy, 2011). The evolving role of the special education teacher and the developments in research on special education require special education teachers to partake in CPD to ensure that they acquire a knowledge and skills base in special education which remains responsive to the needs of their pupils(Swanson, Harris, & Graham, 2013; Vaughn et al., 2007). However, the literature notes that CPD for teachers in special education has received “little attention” to date (Brownell et al., 2010; Florian, 2010a, p. xix).

International test results (Department of Education and Skills, 2011f) indicate that attainment levels in mathematics are a cause for concern in Ireland. A national strategy to improve standards in literacy and numeracy was launched by the Department of Education and Skills (2011f) to increase attainment levels in these subject areas for every pupil, including those pupils with SEN. CPD for teachers is one of a number of strategies designed to achieve this aim (Department of Education and Skills, 2011f). The mathematical knowledge of teachers (MKT) has been associated with positive pupil attainment levels in mathematics (Faulkner & Cain, 2013; Hill et al., 2005). Studies indicate that the MKT of teachers can be improved through their participation in professional development (Faulkner & Cain, 2013). However, the MKT of teachers (general and special education) working with pupils with SEN is an area that has not been well developed in the literature (Faulkner & Cain, 2013). It is recognised that CPD is vital for special education teachers to support them with the specific challenges of teaching mathematics to pupils with SEN (Maccini & Gagcon, 2002).

Although traditionally, CPD has focused on developing the knowledge and skills of individual teachers (Chen & McCray, 2012; The Teaching Council, 2011b), current literature notes the broader role of CPD for teachers cognisant of their school settings and their professional role within a whole-school context (The Teaching Council, 2011b). While the literature is in agreement that improved learning outcomes for pupils can be achieved through effective CPD for teachers (Chen & McCray, 2012; Chung Wei et al., 2010; Desimone, 2009), it also clearly identifies factors, individual and contextual, impacting on the effective implementation of CPD (Brownell et al., 2013; Chen & McCray, 2012; Dingle, Brownell, Leko, Boardman, & Haager, 2011; Loxley et al., 2007). A recent study on the individual and contextual factors influencing special education teacher learning in a CPD programme in a literacy context, identified the need for further research to consider how such factors be reflected in the future design of CPD programmes (Brownell et al., 2013).

In Ireland, CPD for special education teachers is provided primarily by the DES, the SESS and through the local network of Education Centres. The primary school teacher participants of the 2012/13 *Post-Graduate Diploma Programme of Continuing Professional Development for Teachers involved in Learning Support and Special Education* (PGDSEN), a programme funded by the DES, are the focus of this research.

4.3 Research Purpose

The mathematics input on a PGDSEN programme (Department of Education and Skills, 2011c) for special education teachers provided the stimulus for this research study. The purpose of the study was to better understand the factors, individual and contextual, which influenced special education teachers' acquisition of knowledge and skills for teaching mathematics to pupils with SEN. Individual teacher factors such as teacher motivation, attitude and commitment to CPD were considered as were teacher sentiments, attitudes and concerns about inclusive education. In addition, mathematics teaching efficacy beliefs, personal mathematics anxiety levels and measures of teacher content and pedagogical knowledge in whole number/computation provided an insight into individual teacher factors influencing the acquisition of new knowledge and skills by the participants, LS/RTs, special class and special school teachers in Irish primary schools. Contextual factors considered in this study included school leadership, national policies, inclusive school policies and practices and collegial expectations. The study also sought to understand the perceptions and experiences of the participants, of the influence of the mathematics input on the PGDSEN programme on their acquisition of new knowledge and skills. Finally, the understandings of the participants of the transfer of their learning to classroom practice was examined. Barriers and facilitating factors towards the implementation of their adapted practices were elicited.

The findings presented an in-depth description and analysis of the facilitating factors, the barriers and the contexts experienced by this cohort of special education teachers when teaching mathematics to pupils with SEN. It is anticipated that the outcomes of the study, the understandings of the network of relationships influencing special education teachers teaching of mathematics, will inform the future design of CPD programmes in mathematics in special education. The resulting CPD would therefore be more closely aligned to meeting the specific needs of special education teachers in mathematics and it is possible that the resulting change in teacher practice would make a contribution towards improving attainment levels in mathematics for pupils with SEN.

4.4 Statement of Research Question

The purpose of this research study was to answer the question: *What factors influence special educators' teaching of mathematics to pupils with SEN?* Specifically, the research addressed the following research questions:

- What are the individual factors influencing special educators' acquisition of knowledge and skills in mathematics?
- What are the contextual factors influencing special educators' acquisition of knowledge and skills in mathematics?
- What are the special educators' perceptions and experiences of the influence of the mathematics input on the PGDSEN programme on their acquisition of knowledge and skills in mathematics?
- What are the special educators' understandings of the transfer of their learning to classroom practice?

4.5 Research Paradigm

It is necessary at the outset of any piece of research to outline the framework for the process of inquiry. The establishment of a foundation for the research will result in the natural evolution of the methods and methodologies. The researcher, albeit knowingly or unknowingly, brings his own worldview or paradigm, his way of looking at the world to the research (Creswell, 2013; Creswell & Plano Clark, 2007; Mertens, 2015). This set of philosophical assumptions will in turn guide and influence the design of the research project (Creswell, 2013; Grix, 2004; Mertens, 2015).

The research literature abounds with descriptions of the research process. However, differing perspectives, varied use of terminologies and styles of presentation often serve to confuse the emerging researcher. Denzin and Lincoln (2011)'s statement that "three interconnected, generic activities, known by a variety of different labels, define the qualitative research process" provides clarity to the understanding of the process (p. 11). *Ontology, epistemology* and *methodology* also referred to as *theory*, *method* and *analysis* provide the framework for the research process (Denzin & Lincoln, 2011; Grogan & Simmons, 2007) with each stage influencing the other (Crotty, 1998). The terms "*paradigm"* or "*interpretive framework"* are used to refer to the *ontological, epistemological* and *methodological* stance of the researcher (Denzin & Lincoln, 2011). The importance for the researcher of identifying his particular philosophical assumptions, beliefs and orientation in order to situate his research within one of the identified paradigms is noted in the literature (Mertens, 2015).

Several paradigms have been identified and can be broadly categorised as either post-positivist or constructivist and relate to the traditional quantitative and qualitative approaches in social research approaches (Creswell, 2009; Robson, 2002). Researchers differ in their categorisation of paradigms (Mertens, 2015). Grix (2004), in his discussion of paradigms adds positivism as a key category to post-positivism and constructivism. Denzin and Lincoln (2011) refer to the existence of four major paradigms structuring qualitative research namely: positivism and postpositivism, constructivism-interpretivism, criticalism and feminist-poststructuralism.

The constructivist (also known as interpretivism and social constructivism) paradigm provides the foundation for the current study. Commonly linked to qualitative approaches, the subjective views of the participants provide an understanding of the phenomena in question (Creswell, 2009; Creswell & Plano Clark, 2007). The participants of the current study, special education teachers, will provide personal insights into their perspectives of their learning and the transfer of this learning to practice. The views of the participants are developed in social contexts in places where they live and work (Creswell, 2009; Crotty, 1998). Given that the current study relates to the work of the participants, i.e. the work they do in classrooms, interviews will be undertaken in their place of work, their classrooms. It is this view that will create the "reality" for the researcher (Robson, 2002, p. 27) creating research that is formed or constructed from the viewpoints of individuals (Mertens, 2015). The resulting data will lead to the formation of broad patterns or themes which may be applied to a theory (Creswell & Plano Clark, 2007; Crotty, 1998). Three themes emerged from the data of the current study. The themes were applied to Bronfenbrenner's (1979) ecological theory. As the interpretations of the researcher are informed by his life experiences in social contexts, his view of his interpretations will be acknowledged in the research (Creswell, 2009; Mertens, 2015). The researcher's previous personal experience as a LS/RT and her present experience as a special education teacher educator warranted special consideration in the interpretation of the data. Having identified and discussed the paradigm for the current study, it is now necessary to outline definitively the ontological, epistemological and methodological stances associated with constructivism.

The study of *ontology* addresses the issue of the nature and structure of reality (Creswell & Plano Clark, 2007; Crotty, 1998; Grogan & Simmons, 2007; Morrison, 2007; Schraw, 2013) and is concerned with "the study of being" (Crotty, 1998, p. 10). Based on a relativist ontology (Denzin & Lincoln, 2011), the constructivist paradigm sees reality as being socially constructed (Mertens, 2015) and accepts that there may be multiple realities (Creswell, 2013) and perspectives which may change and evolve over time (Bryman, 2004). The researcher engages closely with the participants in the research process in order to construct knowledge set in the context of the social reality of the participants (Lincoln, Lynham, & Guba, 2011). In the current study, the researcher personally engaged with the study participants. Individual and contextual factors determined the perspectives of the participants. Their perspectives were obtained over a 30 month period.

Epistemology has as its focus the process of the gathering of knowledge (Grix, 2004) between the inquirer and the inquired-into and seeks to ascertain how reality is known (Creswell, 2013; Schraw, 2013). It is the theory of knowledge (Sikes, 2004). The aim for the researcher, in the context of the constructivist paradigm, is to adopt a personal approach to the data collection (Mertens, 2015), gathering data in the field (Creswell & Plano Clark, 2007) and thereby experiencing the social contexts of the participants (Creswell, 2013). Both the data generated and the outcomes of the research are linked to the social contexts of the participants (including that of the researcher) (Lincoln et al., 2011). The researcher of the current study personally engaged with the participants and gathered data in the field. Undertaking research in the participants' classrooms enabled the researcher to experience the social contexts of their work place, their classrooms.

Qualitative approaches to data collection such as interviews and text analysis (Creswell, 2013) are the features of the *methodological* style of the constructivist paradigm (Mertens, 2015). Each of these qualitative approaches were applied in the current study. The use of the term '*qualitative-researcher-as-bricoleur*' (p. 5) by Denzin and Lincoln (2011) implies however, that the researcher can choose and adapt quantitative methods should they be appropriate to the data being collected. The researcher of the current study chose to include a number of quantitative measures to the data collection process. Adopting an inductive approach, the researcher gathered and interpreted the data to create patterns, theories and generalisations (Creswell & Plano Clark, 2007). The process of data gathering and interpretation has been described as "hermeneutical and dialectical" due to its focus on obtaining multiple viewpoints of the participants and on the methods used to arrive at interpretations (Lincoln et al., 2011, p. 104). Interpretations are formed through a dialogue of contrast and comparison, where conflicting ideas are refined to ensure that the interpretations formed are representative of the initial discussions (Mertens, 2015). An overview of the paradigm for the current study is presented in Figure 4.1.

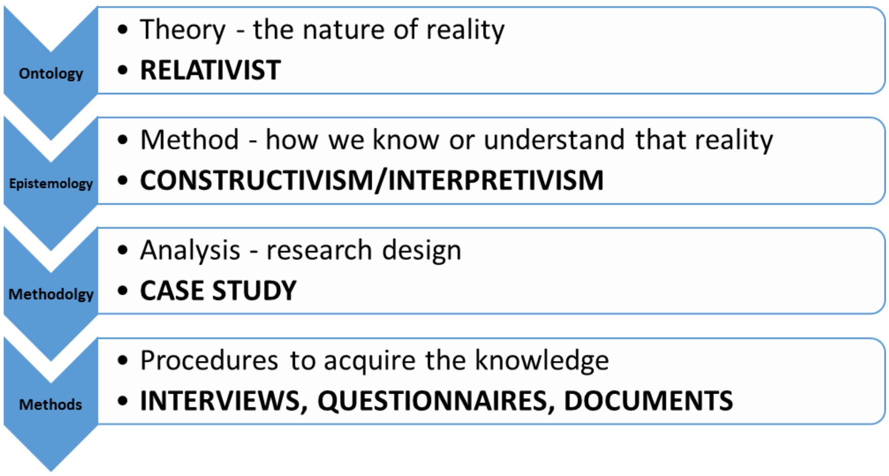

Figure 4.1 Theoretical perspective (Grix, 2004; Hamilton & Corbett-Whittier, 2013; Mertens, 2015).

4.6 Researcher Reflexivity

The current study was situated within the constructivist paradigm, a paradigm commonly linked to qualitative research. This paradigm views knowledge as being social construed by the active participants of the research study (Mertens, 2015). The function of the researcher in this instance, is to interpret the findings from the viewpoint of the participants (Robson, 2002). Researcher reflexivity is a medium which supports interpretation within this paradigm (Finlay, 2002).

Given the central role of the qualitative researcher in the research process, due consideration of the impact of her “values, assumptions, beliefs or biases” on the research process is required (Mertens, 2015, p. 261) in order to maintain an objective stance and to ensure the credibility of the research (Berger, 2015; Finlay, 2002). However, the literature suggests that (Ahern, 1999; Finlay, 2002) research is a “product of the values of researchers” and therefore “cannot be independent of them” (Mertens, 2015, p. 17). Nonetheless, qualitative researchers tend to engage in reflexive practices to ensure the reliability of their research studies (Ahern, 1999; Creswell, 2012; Roulston & Shelton, 2015). Reflexivity, a process whereby the researcher is engaged in a “process of a continual internal dialogue and critical self-evaluation” of her position in the research and a recognition that her role may influence the “research process and outcome” (Berger, 2015, p. 220) is recognised in the literature as a medium for transparency in such issues (Creswell, 2012; Finlay, 2002; Merriam, 1998; Stake, 1995). In addition, the reflective process enables the researcher to gain an understanding of the research question and the research process (Watt, 2007). It is suggested that reflexivity be undertaken from the beginning of the research process (Creswell & Miller, 2000). This process allows the researcher to document “the connections by which subject and object influence and constitute each other” throughout the research study (Finlay, 2002, p. 533).

Using a Reflective Diary is one strategy recommended in the literature as a means of enabling reflective practices (Ortlipp, 2008). The researcher of the current study maintained a Reflective Diary throughout the entire research process. She envisaged that this would be a means of maintaining objectivity and a means of acknowledging her personal values, beliefs and biases to herself and to her readers (Ortlipp, 2008). Reflections on the research question and research process were documented in hard copy format. The researcher used the Reflective Diary to document her thinking process and the changes therein in relation to finalising her research question. For example, an initial draft of the research question (RD, 09/05/2012) focused on an investigation of the impact of a CPD programme and other factors on the teaching of mathematics to pupils with SEN. The Reflective Diary tracked the numerous revisions in the research question and thereby provided visual evidence of the researcher's learning in her subsequent refinement of the research question.

The "personal, contextual and circumstantial aspects on the process and findings of the study" (Berger, 2015, p. 221) were also documented and therefore, permitted the researcher to debrief and to reflect and overcome potential biases including personal biases relating to her position as the "instrument" for data collection (Mertens, 2015, p. 261). The researcher encountered an unexpected event in the data collection process which resulted in a slight deviation from the original research design. The Reflective Diary was used to document the event itself, the reaction of the participants to the event and the emotional feelings of the researcher. The researcher also documented feedback from her supervisor in relation to the event. In this instance, the Reflective Diary was particularly useful to aid the researcher to debrief after the event and enabled her to maintain an objective stance as she successfully redrafted an element of the original research design.

Reflections during the analytical stages of the research study were recorded digitally using NVivo software. The Reflective Diaries (hard copy and digital format) supported the other data sources (interviews, measures and documentation) in assisting the researcher to interpret the findings of the research study. The Reflective Diary entries proved particularly useful to the researcher during the analytic stage of the research process as they permitted her to contextualise the responses of the participants and provided deeper insights than that provided solely by the transcripts (McNiff, Lomax, & Whitehead, 2009).

4.7 Research Design: Case Study

The identification of a methodological approach or research design which will provide a validated structure to the research process is the next step in the research process (Creswell, 2013). The research methodology for the current study will take the form of a case study. A rationale, definition and issues for consideration including data collection and data management of case studies will now be presented.

4.7.1 Rationale

Qualitative case studies are regular features in educational research (Gomm, Hammersley, & Foster, 2000; Hamilton & Corbett-Whittier, 2013; Merriam, 1998; Stake, 2000) and have a long and respected tradition in the field (Creswell, 2013; Flyvbjerg, 2011; Yin, 2012). Case study designs are a feature in some of the classic studies in the social sciences. Foote Whyte's 1940s study of an Italian American slum in Boston is a classic example of a case study (Whyte, 1993).

Key characteristics of case study design support a methodology that is predominantly qualitative in nature, features the researcher predominantly in the field gathering the emic or inside perspective producing descriptive data (Merriam, 1998). The case study approach is appropriate for researchers seeking to undertake an in-depth understanding of a specific social phenomenon in the context in which it occurs and by so doing, develop an understanding of the broader social context to which the case belongs (Richards & Morse, 2013; Yin, 2009, 2012). This approach is much used in the field of special education as it is an appropriate means of “providing an in-depth view of specific phenomena or contexts” (Rose & Shevlin, 2014, p. 2).

While some concerns have been expressed in the literature regarding the lack of rigor of case study research (Rose & Shevlin, 2014; Yin, 2009) and issues of generalisation and applicability (Yin, 2012), the value of the case study approach as a procedure for gaining rich, descriptive insights (Merriam, 1998; Richards & Morse, 2013) into the unique phenomenon in question serves the purposes of the current research study adequately. Bryman (2004) advocates the case study as a means of deriving analytical outcomes from the data which Rose and Shevlin (2014) suggest would be useful in influencing “policy and practice in special educational provision at school level” (p. 8). Their justification of this approach in special education as a useful medium for describing “educational interventions used in schools” provided a firm rationale for a case study approach to the present study (Rose & Shevlin, 2014, p. 3).

4.7.2 Definition

Case study approaches have an established history (Flyvbjerg, 2011; Robson, 2002), used by social science researchers (Creswell, 2013; Richards & Morse, 2013) and in broader contexts such as law, medicine, business and anthropology (Hammersley & Gomm, 2000; Stake, 1978). The varying contexts of its use have resulted in the term being used in an unclear sense (Hammersley & Gomm, 2000).

While numerous definitions of case study are to be found in the literature (Bassey, 1999; Flyvbjerg, 2011; Merriam, 1998), the definition proposed by Yin (2009), possibly best encapsulates the essence of the case study in educational research contexts. He describes case study as “an empirical inquiry, investigating a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between the phenomenon and context are not clearly evident” (p. 18) with its own particular methodology (Yin, 2012). Merriam’s (1998) definition emphasises the “process of conducting the inquiry” within a bounded unit (p. 43). Stake (1995) meanwhile notes the importance of the case as the object to be studied as opposed to it being a process and further states that it is the duty of the researcher to “understand this one case" (p. 4). Mindful of the views of Merriam (1998), Yin (2012) and Stake (1995), Creswell (2013) asserts his perspective on case study as that of a methodology, and describes it as being a particular type of design that may also be an object of study, in addition to being a product of an inquiry .

Bassey (1999), in his concluding remarks on case study definitions, stated that he could not form an overall framework on a definition of case study given the challenges associated with interpreting the varying viewpoints of the researchers. Meanwhile, Merriam (1998) notes that the difficulties relating to a definition of case study arises from the fact that the process and the case and the product tend to be "conflated" (p. 27) .

Despite the varying interpretations, suffice it to say that the case study has a unique place in the educational research literature in its role in exploring a phenomenon in a real life bounded context. The case study approach adopts data collection strategies which yield a rich data base, an analysis of which will lead to new insights about the phenomenon under study (Hamilton & Corbett-Whittier, 2013; Richards & Morse, 2013). The importance and value of the case study as a research method has been acknowledged previously and the work of Flyvbjerg (2011) and other researchers in progressing their work on case study to ensure that this approach will continue to receive the credibility it deserves in the research literature will be welcomed by advocates of case study (Yin, 2012).

4.7.3 Key characteristics

Case studies have defining features or characteristics (Creswell, 2013; Yin, 2012). Case studies must contain a *case* to study. The bounded case may be an individual, a group, an organisation, a specific project or a social phenomenon (Creswell, 2013; Stake, 2000; Yin, 2012). The *case* in the current study is special education teacher learning in mathematics. This incorporates the perspectives of the participants on their learning and the transfer to practice of their newly acquired skills. The case study may consist of a *single case* or of *multiple cases* whereby data arecollected and analysed from more than one case (Merriam, 1998). The current study consists of *multiple cases* i.e. a number of special education teacher participants. Applying a multiple case approach to this study permitted the examination of special education teacher learning in mathematics in a number of different settings. Rose and Shevlin (2014) suggest that this approach is useful to gain insights into the phenomena in a number of different schools and therefore establish what could be described as "typical" (p. 2) variables in special education teacher learning in mathematics.

Case studies are distinguishable by the focus or purpose of their study (Thomas, 2011). Three types of case study have been identified by Stake (2000). An *intrinsic case study* investigates a case which is of particular interest in its own right (Creswell, 2012; Stake, 1995; Stake, 2000) whereas an *instrumental case study* focuses on a specific case in order to gain insights into a phenomenon (Stake, 2000). A third type, *collective case study* (also referred to as multiple case study), has been defined by Stake (2000) as “an instrumental study extended to several cases” (p. 437). In this instance, the researcher uses data generated from a number of case studies to generate insights into a particular phenomenon (Creswell, 2012). Although Stake (2000)’s work focuses on the case study types outlined, he notes that additional types of case study have been identified in the literature. *Explanatory case studies* investigate cause-and-effect relationships (Yin, 2012). *Descriptive case studies* aim to present detailed reports of the phenomenon (Merriam, 1998) while *Evaluative case studies* and contexts for their use are discussed by Yin (2012) and Thomas (2011).

Multiple data sources are key features of all case studies regardless of their type and are deemed as necessary in order to generate an in-depth understanding of a phenomenon (Bassey, 1999; Creswell, 2013; Yin, 2009, 2012). Case studies will be identifiable by the *detailed descriptions* they provide of the case itself (Creswell, 2013). A *thematic data analysis* is a notable feature of case studies (Thomas, 2011), its purpose being not to generalize but to understand the issues and contexts of the case (Creswell, 2013). Analysis in a multiple case study may take the format of *within-case analysis* of the themes of each case and secondly of *cross-case analysis* of themes across cases (Creswell, 2013). In a case study, the researcher typically *generates conclusions or assertions* about the phenomenon under investigation (Stake, 2000).

4.7.4 Conducting a case study: The procedure

While many features of case study research will be typical of research methods generally (Yin, 2009), a number of clearly identified steps have been identified for conducting case study research (Creswell, 2013). The procedure currently in vogue is largely influenced by the work of (Stake, 1995; Yin, 2009, 2012).

The initial task for a researcher is to establish that the case study procedure is appropriate for their research (Creswell, 2013). A number of issues need to be considered in this decision. Firstly, the case study approach is relevant when the investigation requires an in-depth understanding of a real-life problem and when its particular situation is pertinent to the research study (Rose & Shevlin, 2014; Yin, 2009). An in-depth understanding of special education teacher learning in mathematics and the transfer of their adapted practice to the classrooms was required in order to address the research question in the current study. Secondly, in a case study, the "case" itself will be clearly distinguishable. The case, which will be bounded, may be a person, an organisation or a social phenomenon (Yin, 2012). The case in the current study, special education teacher learning in mathematics was clearly identifiable.

Having identified the research problem and the case, the researcher chooses a case study type which will best support the study (Creswell, 2013). The case study may be a single study or a multiple case study (Yin, 2012), with a focus on a case (intrinsic case) or on a phenomenon (instrumental case) (Stake, 1995). Multiple sources of data are an essential element of case studies (Yin, 2012). Direct observations, interviews, archival records, document analysis, participant-observation and physical artefacts are examples of data sources suggested by Yin (2012). To aid with the efficiency of this stage of the procedure, Stake (1995) suggests the formulation of a data-gathering plan which might include details regarding the data sources, data recording plans and the data storage system for example.

The current study took the form of a multiple or collective case study and focused on a specific phenomenon, special education teacher learning in mathematics. This approach enabled the researcher to "investigate and compare" special education teacher learning in mathematics and the subsequent transfer of adapted practices, "within a range of settings" (Rose & Shevlin, 2014, p. 2). The study's data-gathering plan outlined multiple data sources used to gather the relevant data.

The development of a general analytic strategy is recommended by Yin (2009) for all case study analyses. This strategy, he suggests, is best identified before the data collection stage and will allow the analysis to proceed without difficulty (Yin, 2009). Suggested strategies include developing a case description or the use of theoretical propositions to guide the analysis (Yin, 2009). Thematic analysis was used in the current study to describe, analyse and interpret the findings. Bronfenbrenner's (1979) ecological theory guided the analysis process.

Writing the case study report is the final stage in the procedure. A case study report must contain a rich, detailed account of the case (Merriam, 1998). This is typically followed by the analysis and interpretation of the data whereby assertions or generalisations will be presented (Stake, 2000). The structure of the report will depend on the type of study. Multiple-case studies could for example take a cross-case analysis format and be presented in a thematic format (Yin, 2009).

4.7.5 Issues for consideration in case study research

4.7.5.1 The participants

The distinctive nature of the case study approach necessitates some specific approaches to the associated data Yin (2009). It is first necessary to identify a sample, participants who are best suited to provide evidence to support the research question (Creswell, 2012). The choice of the sample in a case study is relatively straight forward as the case is generally clearly defined and as Stake (1995) declares “It is not unusual for the choice of case to be no “choice'' at all” (p. 3). Stake’s (1995) assertion was particularly relevant for the current study. The researcher’s choice of participants for the study was confined to the special education teachers undertaking the PGDSEN programme in the 2012/13 academic year. This approach to sampling has been identified in the literature as purposeful sampling (Creswell, 2012, 2013; Mertens, 2015) and is suitable for a case study researcher operating within the constructivist paradigm as it allows the researcher to identify cases that will yield a rich data base.

Further levels of sampling may occur within the selected case (Merriam, 2009). In this instance, additional sets of criteria are developed in order to purposefully select the participants of the within-case sample (Merriam, 2009). The researcher of the current study identified the primary and special school teachers from the 2012/13 PGDSEN programme as suitable participants for her study.

4.7.5.2 Data collection

Multiple sources of data collection are characteristic of case study research (Yin, 2009, 2012). While the emphasis is typically on qualitative data, quantitative data can also be used (Yin, 2012). The key data collection sources as identified by Yin (2009, 2012) are documentation, archival records, interviews, direct observation, participant-observation and physical artifacts. The specific sources applied in a study will be influenced by the theoretical perspective of the researcher, the research problem, the focus of the study and by the case itself (Merriam, 1998). Data collection procedures relevant to the current research will be presented and discussed in this context.

4.7.5.3 Interviews

Interviews are a central means of sourcing data in case study research (Yin, 2009). By accessing information which is not observable, the interview facilitates the researcher to interpret the case through the voice of the interviewee (Kvale, 2006; Marshall & Rossman, 2006; Perakyla & Russuvuori, 2011). Interviews are commonly used in qualitative research and are used in various contexts in different formats

(Fontana & Frey, 1994). An acceptable understanding of the term interview for the purpose of the current research is that of “a conversation with a purpose” (Kvale, 2006, p. 483), an “inter-change of views between two persons conversing about a theme of mutual interest” (Kvale & Brinkmann, 2015, p. 209) or a “guided conversation” (Yin, 2009, p. 106). Factors to be considered in using this approach in educational research include the type of interview (Creswell, 2013; Yin, 2009), the procedures to be followed in conducting interviews, the recording and transcription process, the quality of the data collected and the analytical framework (Bryman, 2004; Silverman, 2009). Interviews were the primary means of gathering the data for the current study.

The first step in the interview process is the decision regarding the type of interview best suited to the research context. Although time-consuming, *individual interviews* are the most common type (Fontana & Frey, 1994). One-to-one interviews are suitable for interviewing participants who have the ability to discuss and share their opinions (Creswell, 2012). Individual interviews were conducted with the participants of the current study. Interviews were conducted during two phases of the study.

There are three categories of interview – structured, unstructured and semi-structured (Merriam, 2009). These range along a continuum whereby the questions and their order are pre-set by the researcher who follows the interview script rigidly as in the case of a structured interview to that of an open-ended unstructured format, which is conversational in format (Fontana & Frey, 1994). Semi-structured interviews are popular in qualitative research (Merriam, 1998; Robson, 2002). In this instance, the researcher will have outlined questions and topics which will loosely direct the interview (Mertens, 2015). The researcher will be guided by the interviewee in terms of sequencing and wording of questions and the length of time spent on each topic (Robson, 2002). Open-ended questions are an important feature of qualitative interviews giving the interviewee the freedom to voice their personal perspective (Creswell, 2012). Telephone and e-mail interviews are useful in situations when due to geographical factors for example, participants are unable to be interviewed face-to face (Robson, 2002).

It is important to note, that regardless of the type of interview adopted, interviews in case study research are essentially qualitative and are therefore flexible in nature allowing the researcher to digress from a structured schedule as necessary (Bryman, 2004; Yin, 2009). However, interviews in multiple-case study research, such as the current study, will benefit from a semi-structured format to allow for standardisation in cross-case analysis situations (Bryman, 2004; Marshall & Rossman, 2006). The interview process in the current study took the form of individual semi-structured interviews in the participants' schools. Two interviews were conducted by phone due to the geographical location of the participants.

Having identified the type of interview relevant to the research, the next step involves planning and conducting the interview. Stake (1995) emphasises the importance of preplanning. An interview guide or schedule, also known as interview protocol, based on topics related to the research question will include general questions and open-ended questions (Bryman, 2004; Merriam, 1998). Factual, descriptive questions are best placed at the beginning of the interview and pave the way for the subjective questions (Merriam, 1998). Given that the quality of data yielded is dependent on the questions posed, due consideration is given in the literature to questioning techniques (Fontana & Frey, 1994). Brinkmann and Kavale's (2015) categorisation of nine types of questions is particularly useful in this regard as are the four types of questions used in a case study by Strauss et al (1981) and noted by Merriam (1998). Although the interview may be recorded, space should be allowed between the questions for reflections or comments of the researcher (Creswell, 2009). Interview schedules for Phases 2 and 3 of this research study were carefully prepared. Factual, contextual questions relating to the participants' schools were placed at the beginning. The questions were categorised. The semi-structured interview schedule for Phase 3 is to be found in Appendix A.

Stake (1995) suggests that the piloting of the questionnaire should be a routine element of the planning process and will allow for adaptions within the interview protocol if necessary (Creswell, 2013). It also allows for novice interviewers to gain experience (Merriam, 1998). A pilot interview will provide experience in interviewing skills for the researcher and also provide for clarification opportunities in relation to the questions themselves (Braun & Clarke, 2013). Two recent graduates of the PGDSEN programme kindly agreed to participate in a pilot interview for the current research study. This interviews were held in the researcher's office. The interview schedule was modified following feedback received.

Interviews are generally recorded using audio devices or by note taking or personal recall (Braun & Clarke, 2013; Kvale & Brinkmann, 2015). Recording interviews will enable the researcher to focus on the topic, to accurately record the data (Yin, 2009) and to examine it thoroughly (Merriam, 1998). A digital voice recorder was purchased for the purposes of the current study. Each interview was recorded and stored securely on an encrypted laptop.

The transcription of the interview which marks the first step in the analysis of the data is a slow, tedious process, taking some five to six hours for each recorded hour on tape (Braun & Clarke, 2013; Kvale & Brinkmann, 2015) and is best carried out by the researcher (Merriam, 2009). Stake (1995) notes, that given the time demands on transcription, an in-depth analysis is warranted. The literature suggests that data analysis, in the context of the analytical framework for the research begins during the transcription stage giving the researcher insights into emerging themes that may influence later data collection approaches (Bryman, 2004; Robson, 2002; Silverman, 2009). The quality of the data collected and transcribed needs to be considered (Merriam, 1998). Influences on the responses such as state of well-being, mood and interest in participation impact on the interviewee and should be noted where possible by the researcher (Merriam, 1998).

Interviews for the current research study were audio-taped with the permission of the participants. The researcher personally transcribed the interview data. While this process represented a considerable time investment, it was a valuable exercise and permitted the researcher to gain initial insights into the data.

4.7.5.4 Documentation

Documents provide valuable data for qualitative researchers and are particularly relevant to case study research both as a means of understanding the phenomena and in their role in the triangulation of data (Creswell, 2012; Yin, 2009). As an interpretative research approach, the use of documents follows the standard procedures of data collection, collation and analysis yielding a theoretical description, explanation or interpretation of the phenomenon (Fitzgerald, 2007; Stake, 1995).

Using documents in the research process requires the researcher to initially identify the documents relevant to the research questions (Marshall & Rossman, 2006). In a special education research context this may include IEPs, IEP meeting minutes, special education files, curriculum materials, school records and policies (Mertens, 2010). The required documentation may be developed for the purposes of the research or exist independently of the research (Merriam, 1998). Having identified the required documentation, the researcher is obliged to request permission for its use (Creswell, 2012).

The participants' planning documents are relevant to the current research study. They supported the researcher in her understanding of the various school contexts the participants were teaching in. They also permitted the researcher to gain insights into the participants' plans for teaching mathematics to pupils with SEN. The Phase 3 participants provided IEPs, short term planning documents and assessment records to the researcher. The participants also maintained a Reflective Journal during Phase 3 of the data collection. The purpose of this journal was to record their collaborations with class teachers, parents and SNAs, to document their reflections on their instructional approaches and future adapted practices, on ICT, assessment and pupil progress. The participants were invited to note the supports and challenges to their teaching of mathematics to pupils with SEN. The Reflective Journals were coded thematically (Appendix B).

While Bryman (2004) states that Scott's (1990) criteria for assessing the quality of the documentation is rigorous, it is useful to consider issues such as authenticity, credibility, representativeness, accuracy, and clarity when deciding to use documentation (Merriam, 1998). These issues will provide a focus for the researcher as the process of evaluation and analysis begins. This process involves the identification, analysis and interpretation of themes in the data (Fitzgerald, 2007). Qualitative content analysis is an approach which is typically used in qualitative documentary analysis (Bryman, 2004; Marshall & Rossman, 2011). It has been described as a "systematic procedure for describing the content of communications" (Merriam, 1998, p. 123) using a coding system which allows for the categorisation of the themes (Fitzgerald, 2007). The research question directs the initial analysis and in some instances the documentation itself may guide the process (Robson, 2002). Should there be a large volume of documentation, it will be necessary to apply a sampling strategy to select the documentation (Robson, 2002).

4.7.5.5 Questionnaire

Multiple sources of data collection are defining features of case study research (Creswell, 2012; Thomas, 2011; Yin, 2009). Qualitative sources of evidence such as interviews, observation and documentary evidence are commonly found in case study research (Yin, 2009). However, the literature notes the flexibility in the data collection procedures to include quantitative approaches such as surveys or questionnaires where relevant (Thomas, 2011; Yin, 2012). In the context of a case study, the use of a questionnaire will provide demographic, attitudinal and behavioural data (Hamilton & Corbett-Whittier, 2013), a valuable contribution for the researcher as she seeks to develop a rich, description of the phenomenon in this particular case study. Questionnaires were used in the current study for such purposes at each phase of the research process.

Questionnaires are written forms completed by participants in a research study (Creswell, 2012; Thomas, 2011) whereby attitudes, beliefs and demographic information relating to the central phenomenon are self-reported (Teddlie & Tashakkori, 2010). Traditionally pen and paper based questionnaires mailed to participants were popular in educational research (Bryman, 2004; Creswell, 2012; Teddlie & Tashakkori, 2010). Questionnaires can also be administered on a one-to-one basis, over the telephone and on a group basis (Robson, 2002). However, web-based questionnaires have become increasingly popular given their ability to reach a wider population efficiently (Creswell, 2012; Teddlie & Tashakkori, 2010). The advantages and disadvantages of both paper and web approaches require consideration with respect to the specific nature of the data (Marshall & Rossman, 2006) required in the research study having due regard for response rate, cost, anonymity and technology issues for instance (Bryman, 2004; Creswell, 2012; Robson, 2002). The current study will utilise paper questionnaires in the Baseline and Phase 1 and 2 stages.

Questionnaires can be categorised into three types namely; structured, semi-structured and unstructured (Cohen, Manion, & Morrison, 2007) with larger samples tending to be more structured and vice versa. The categories refer to the nature and quantity of the questions posed (Cohen et al., 2007). In a closed question context, the participant selects a response which has been pre-set by the researcher (Cohen et al., 2007; Creswell, 2012) in the form of a multiple-choice option, a true/false question, a rating scale or a checklist (Mertens, 2015). It is essential that the responses suggested are typical of what might be expected and that each is distinct from the other (Creswell, 2012). Closed questions in the above formats are relatively quick both to complete and to analyse (Cohen et al., 2007). A disadvantage of this approach lies in the inability of the participant to add comments or explanations to the question (Cohen et al., 2007). On the other hand, an open questioning style gives the participant the flexibility to respond freely within their own experiences, without the boundaries of suggested responses (Cohen et al., 2007) and are justifiable in contexts whereby the answers are not known to the researcher (Creswell, 2012). A challenge for the participant in open questioning is to document the specific information required in a succinct manner (Cohen et al., 2007). Questionnaires in an open question format are however, by their nature more difficult to analysis and require a thematic analysis by the researcher (Cohen et al., 2007; Creswell, 2012). Semi-closed questions provide an alternative option (Creswell, 2012), where in addition to a closed question style, an open-ended option is provided as the final option e.g. Other … In many instances, a combination of questioning styles will be used in the questionnaire (Mertens, 2015). The researcher will adopt this approach for the focus study.

In addition to the considerations outlined above, the researcher must consider the design of the questionnaire when constructing or adapting a questionnaire for the purposes of their research study (Mertens, 2015). This includes the construction of the questions themselves in addition to the physical layout of the questionnaire (Creswell, 2012). Creswell (2012) outlines a number of points in relation to the construction of the questions and these include the use of jargon in a question, the length of a question, a question containing multiple questions and a question which is unclear. It is essential for the researcher to bear in mind that the questionnaire must be designed in such a way as to elicit data which will answer the research question (Robson, 2002). Due consideration was given to the design of the questionnaires for the current study. The questionnaire distributed to the participants at Phase 1 of the current study is in Appendix C.

Having designed, adapted or acquired the questionnaire and developed a cover letter (detailing the nature of the research, the purpose of the questionnaire, the value of the participant's response, the voluntary nature of participation and the right to withdraw at any stage, an incentive, confidentiality issues, completion time and date (Bryman, 2004; Cohen et al., 2007; Creswell, 2012; Mertens, 2015), the questionnaire is piloted on a smaller number of participants who have similar characteristics to the proposed participants (Creswell, 2012; Marshall & Rossman, 2006). In so doing, the researcher receives written feedback which she analyses and makes adjustments as necessary (Mertens, 2015). The amended questionnaire is then distributed to the participants, follow-up notes are sent where necessary and the returns are stored in accordance with the study's data management plan in preparation for analysis (Mertens, 2015; Teddlie & Tashakkori, 2010).

Four recent graduates of the PGDSEN programme kindly agreed to pilot the questionnaires for the current study. They completed the Baseline questionnaire in September 2012. Their feedback was incorporated into the design of the questionnaire. Each of the subsequent questionnaires at the Phase 1 and Phase 2 stages were piloted by two graduates of the PGDSEN programme. Their feedback was applied to the questionnaire design.

Response rates are of concern to every researcher and it is acknowledged that some participants may never respond (Teddlie & Tashakkori, 2010). In some instances this may result in attrition leading to difficulties with generalizability (Teddlie & Tashakkori, 2010). Various response rates are presented in the literature and acceptable rates vary from 50% to 90% (Robson, 2002). Although response rate is important to the researcher, the issue of bias i.e. the responses not being representative of the participants, is of greater concern (Creswell, 2012). This is however, an unknown variable as it is also possible that a small return rate may be perfectly acceptable and not contain any bias (Creswell, 2012).

The response rates for the different phases of the current study are indicated in Table 4.1. The baseline phase generated the highest response. The decline in the response rate for Phase 1 was due to the participants' perceived difficulty of one of the four measures to be completed. This factor will be outlined in greater later in this chapter.

Table 4.1 Response Rate

Phase of study	Response rate	n
Baseline phase	94%	32
Phase 1	44%	15
Phase 2	44%	15
Phase 3	54%	8

Note. Eligibility in Phase 3 was dependent on participation in Phase 2.

In order to monitor bias, it is suggested that the researcher date the returned questionnaires and critically analyse the returns for bias, i.e. respondents who may be overly positive or negative (Creswell, 2012). This procedure has been identified by Creswell (2012) as wave analysis whereby the researcher checks the answers from chosen questions in each week of the study to see if the answers are similar regardless of the return date of the questionnaire. The researcher in this study will be cognisant of the likelihood of bias and will follow the steps as outlined above to ensure the validity of the study.

The first step in the analysis of the data is the editing of the questionnaires whereby the researcher checks the documentation for completeness, accuracy and uniformity (Cohen et al., 2007). Creswell's (2012) checklist for analysing questionnaire data identifies three steps beginning with the identification of the response rate and response bias, leading to a descriptive analysis of the data. The analysis identifies trends, demographic factors and descriptive answers to questions and descriptive statistics such as the mean, mode and standard deviation (Cohen et al., 2007). This checklist will be adopted by the researcher for the purposes of the current study. The final step is the compilation of a written report presenting the themes (Creswell, 2012).

4.7.5.6 Data management, analysis and interpretation

4.7.5.6.1 Overview of framework.

Having identified the case and the data collection procedures, the next stage of the research process is concerned with the *management, analysis and interpretation of* *the data*. While these elements are distinct from each other, they are connected (Miles & Huberman, 1994) and in some research studies will occur at the same time (Huberman & Miles, 1994; Merriam, 1998; Mertens, 2015).

1. Prepare and organise the data
2. Explore and code the data
3. Use codes to build description and themes
4. Represent and report the finding
5. Interpret the findings
6. Validate the findings

Figure 4.2 Analyzing and interpreting qualitative data: Six step framework (Creswell, 2012, p. 236).

The next step involves condensing and displaying the data and presenting validated conclusions (Miles, Huberman, & Saldaña, 2014). Creswell's (2012) six step framework for analysing and interpreting qualitative data will guide and support the researcher through this process (Figure 4.2).

The impact of the researcher herself is significant at each step of this framework given Patton's (1990) views that qualitative inquiry and analysis is dependent on the "analytical intellect and style of the analyst" (p. 372), a view shared by Miles et al. (2014).

4.7.5.6.2 Preparation and organisation of the data.

Given the volume of data typically found in qualitative research, it is essential that *a data management plan* to prepare and organise the data for analysis is established at an early stage in the research process (Creswell, 2012, 2013; Merriam, 2009). Data management has been defined by Huberman and Miles (1994) as a "systematic, coherent process for data collection, storage and retrieval" (p. 428). This plan will ensure that the data is collected, organised and stored in such a manner that it is both easily accessible and secure (Creswell, 2012, 2013; Huberman & Miles, 1994; Miles et al., 2014; Stake, 1995).

It will include an outline of the progress of the research noting work completed or to be completed at each stage (Huberman & Miles, 1994; Miles & Huberman, 1994;

Stake, 1995). Stake (1995) suggests that a "definition of the case, a list of the research questions, the data sources, the time allocation and the intended reporting" be included (p. 51). Visual (data) displays such as a matrix, a status board or a network can be helpful to the researcher in this regard as they allow for an overview of the entire data set on a single location thereby supporting the analysis of the data (Creswell, 2012, 2013; Miles et al., 2014; Stake, 1995). A system needs to be devised to document the personal insights of the researcher into the data (Lincoln & Guba, 2002; Merriam, 2009; Patton, 1990). This form of writing, acknowledged in the literature as analytic writing takes the form of thematic or theoretical memos and could be incorporated into the raw data or in a personal file such as a research journal for example (Marshall & Rossman, 2011; Merriam, 2009). Finally a data management plan will consider the process suitable for the transcription and analysis of the data in question (Creswell, 2012, 2013; Merriam, 2009).

The researcher of the current study implemented a comprehensive data management plan. This incorporated a data gathering plan, outline of data collection and storage procedures and an analytic framework. A research journal was maintained by the researcher throughout the research process. Personal insights and reflections of the researcher were documented.

4.7.5.6.2.1 Computer assisted qualitative data analysis software (CAQDAS).

A data management plan may consider the use of technology to support qualitative data analysis (Bazeley & Jackson, 2013; Darmody & Byrne, 2006). Features of such software programmes include the facility to store and organise data, to label and code data, to retrieve specific information or data easily and to produce visual models such as displays, concept maps or tables of the data (Gibbs, 2002; Lewins & Silver, 2007; Miles et al., 2014) and can aid the efficiency of the researcher considerably (Hesse-Biber & Leavy, 2011; Richards & Morse, 2013). Concerns have been expressed, however, regarding the use of software programmes in the data analysis process (Hesse-Biber & Leavy, 2011). The impact of the software on the relationship between the data and the researcher is a noted issue (Bazeley & Jackson, 2013; Flick, 2009; Hesse-Biber & Leavy, 2011) as is the time commitment to learn how to use the programme (Creswell, 2013). However, given that the functionality of the software is to aid the data analysis process and not to perform the analysis, the literature recognises the benefits of CADQAS as a methodological tool (Creswell, 2009, 2013; Darmody & Byrne, 2006; Gibbs, 2002; Richards & Morse, 2013).

NVivo has been selected as the software which will meet the needs of the current research study. The literature suggests that new users receive training in order to derive maximum benefits from the software programme (Richards, 2015; Richards & Morse, 2013; Robson, 2011). The researcher attended training workshops on NVivo in order to gain a working knowledge of the programme. NVivo formed a core element of the data management plan. All audio interviews were transcribed directly into NVivo. Coding was managed electronically. Reflective memos were managed using the software programme.

4.7.5.6.3 Exploring and coding the data.

Having satisfactorily prepared the data for analysis (Patton, 1990; Robson, 2002), the researcher subsequently familiarises herself with it by reading it carefully and by writing analytic memos and summaries (Braun & Clarke, 2006; Bryman, 2004; Miles et al., 2014). The memos contain reflections, thoughts and ideas that spring to mind during this initial exploration of the data set either in the field notes itself or in the margins of the transcript data (Creswell, 2009; Creswell & Plano Clark, 2007; Miles & Huberman, 1994; Ryan, 2006). Such memos form an initial first step in the development of codes or themes (Patton, 1990). Analytic memos were maintained in Nvivo for each phase of the research in the current study.

The analytic process proceeds with the coding or categorisation of the data (Creswell, 2012, 2013; Miles et al., 2014). This process involves separating the text into units (ranging from a single word to a sentence, a paragraph or a full page of text) which are linked to the research question (Braun & Clarke, 2013). Labelling each unit with a code describing the unit is the next step in a process referred to as *first cycle coding* (Miles et al., 2014; Richards, 2015). Units or datum relating to a specific code are known as text segments (Creswell, 2012). A code in qualitative research has been defined as “a researcher-generated construct that symbolizes and thus attributes interpreted meaning to each individual datum for later purposes of pattern detection, categorisation, theory building and other analytic processes” (Saldaña, 2013, p. 4).

In practice, the researcher selects the text by drawing a bracket around it and labels it with a code to indicate its meaning (Burnard, Gill, Stewart, Treasure, & Chadwick, 2008; Miles & Huberman, 1994). Codes which are similar are grouped and some may become redundant leading to a reduction in the overall number of codes (Burnard et al., 2008). It is likely that new codes will emerge following the initial coding of the data (Braun & Clarke, 2013; Richards, 2015). The codes may be derived from a number of sources (Creswell, 2013; Creswell & Plano Clark, 2007). In some instances, they may be the particular words or phrases as used by the participants themselves and these are referred to as *in Vivo* codes (Braun & Clarke, 2012; Miles et al., 2014; Saldaña, 2013).

A *descriptive code* acts as a summary for the main topic of the selected unit (Saldaña, 2013). *Process* coding uses words ending in "ing" to identify "observable and conceptual action in the data" (Miles et al., 2014, p. 74). While the three aforementioned codes are referred to as the "foundational approaches" to coding (Miles et al., 2014, p. 74), additional categories of codes are also noted and are discussed in greater detail by Saldaña (2013). Codes exist along a continuum in the analytic process ranging from descriptive to those which are inferential and are created at different stages in the process (Miles & Huberman, 1994).

Miles and Huberman (1994) suggest that codes be created before the analysis begins. Initial development of codes can begin during the data collection stage (Stake, 1995). A qualitative codebook contains codes that have been preselected or predefined by the researcher and evolves throughout the analysis (Creswell, 2009; Robson, 2002). The theoretical framework and the research question act as a guide to the researcher in the development of these predetermined codes in a deductive approach to the coding of the data (Braun & Clarke, 2012; Miles & Huberman, 1994; Miles et al., 2014).

On the other hand, inductive coding, codes which emerge during the data analysis is an approach which has been traditionally used by social scientists (Creswell, 2009). Grounded in the empirical data, the use of inductive coding gives a voice to the data leading to the development of codes which are reflective of the views of the participants (Braun & Clarke, 2012). It is also possible for the researcher to use both predetermined and emerging codes in the data analysis process (Braun & Clarke, 2012; Stake, 1995). Irrespective of the type of coding adopted for the study, it should be noted that codes will of necessity, be revised and changed during the analysis of the data (Braun & Clarke, 2013; Miles et al., 2014).

The current study developed a codebook prior to analysis of the interview data. Codes were predetermined by the research question and Bronfenbrenner's ecological model. In addition to the predetermined codes, the coding adopted an inductive approach. Additional codes which emerged during the first cycle coding process were added to the codebook. Each code was defined and recorded in a codebook (Appendix D).

4.7.5.6.4 Using codes to build descriptions and themes.

The third step in the Creswell (2012) framework for the analysis and interpretation of the data relates to the use of codes to build description and themes. Case study research demands a comprehensive in-depth description of the setting in which the research is conducted giving the reader an insight into the central phenomenon (Creswell, 2009; Merriam, 2009; Patton, 1990). The level of analysis required in this stage is focused on the decisions of the researcher regarding the inclusion or exclusion of data to best describe the case (Merriam, 2009). Using a coding process, an experienced researcher will produce an extensive narrative description of the setting, similar to what the reader might have written had they been present in the context themselves (Lincoln & Guba, 2002; Stake, 1995).

Following the description, a case study researcher will identify a number of *key themes* (also referred to as *categories)* which have emerged from the data (Burnard et al., 2008; Merriam, 2009). Themes are developed through the combination of similar codes and the elimination of redundant codes in the data base and are guided by the research question, the researcher and the participants (Marshall & Rossman, 2011; Merriam, 1998).

The development of themes is a reflective process necessitating several critical readings of the data by the researcher yielding themes that accurately represent the data (Braun & Clarke, 2012). The final themes (both major and minor) should be mutually exclusive and exhaustive with the name tags being sensitive to the content of the theme (Robson, 2002). Merriam (2009) notes the challenges associated with applying the criteria of conceptual congruence to the themes and suggests the use of data displays as a means of clarification. The identified themes must be validated by quotation and evidence from a number of sources (Creswell, 2009). Stake (1995) meanwhile suggests that in some situations "significant meaning is found in a single instance" although he further acknowledges that more important meanings will recur in the data (p. 74). It is important also for the researcher to identify the point (referred to as saturation point) when all major themes have been identified and further evidence does not lead to the development of additional themes (Creswell, 2012).

First cycle codes for Phase 2 of the current study are presented in Appendix E. Similar codes were subsequently merged. Some codes became redundant during the second cycle coding cycle. Guided by the research question, a number of themes became apparent. Second cycle codes and emerging themes for Phase 2 are presented in Appendix F and Appendix G.

Thematic analysis, can also be presented in the form of interrelated themes displayed chronologically or sequentially (Creswell, 2012). The identified themes and their interconnections are illustrated on a chart resulting in a clear visual display of the thematic data analysis (Merriam, 2009; Miles & Huberman, 1994). The emerging themes in the current study were displayed visually. The six key themes and sub-themes which emerged from the coding process for Phase 2 are displayed visually in Appendix H. The coding process was conducted using Nvivo.

These six themes were further refined and were reduced to four themes (Appendix I). The themes underwent further revisions. Finally, three themes emerged from the Phase 2 data (Appendix J). A similar coding process was undertaken for Phase 3 of the current study. These themes underwent a number of revisions during the process. While there was overlap between both phases, a notable feature of the Phase 3 data was the specific focus on individual pupils or small groups in the participants' caseloads. The final themes for the study are:

- Inclusive and special education: Policy and provision;
- Continuing professional development; and
- Translating the learning into practice: Teaching mathematics to pupils with SEN

These themes are visually presented in Figure 4.3. The themes were applied throughout the current study to structure the literature review, to present the findings and to frame the discussion.

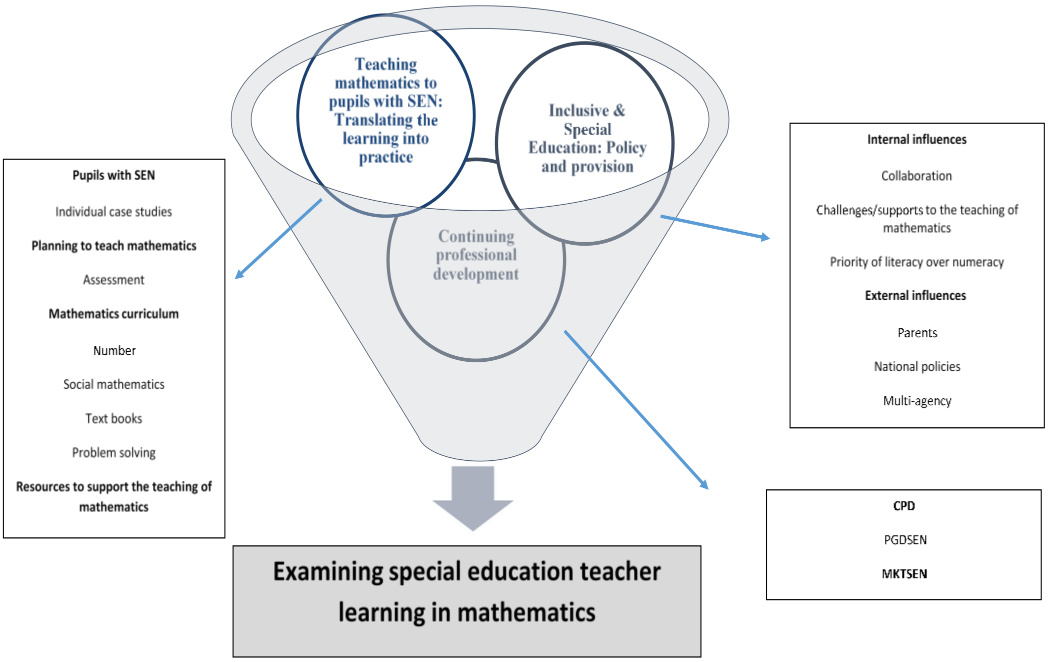

Figure 4.3 Final themes (Phase 3)

4.7.5.6.5 Representation and reporting of findings.

The fourth stage in the analysis and interpretation process of the data is representing and reporting the findings (Creswell, 2012). A narrative approach is commonly used in qualitative research to disseminate findings (Braun & Clarke, 2013). In order to support the interpretation of the data by the reader, researchers use strategies such as dialogue, detailed descriptions, metaphors and analogies when constructing narratives (Merriam, 2009). The narrative discussion may take a number of forms such as thematic, chronological or descriptive for example (Creswell, 2012), depending on the focus of the research and the database available. Vignettes are included in case study reports to present particular insights into issues associated with the case (Merriam, 2009; Miles et al., 2014; Stake, 1995). Direct quotes from interview data may be used to illustrate the experiences of the participants (Richards, 2015). Writing strategies also include evidence of multiple perspectives from the participants (Creswell & Plano Clark, 2007).

The use of visuals in the form of tables, figures, diagrams, matrices or networks is popular in qualitative research (Bazeley, 2009; Hamilton & Corbett-Whittier, 2013; Merriam, 2009) as a means of supporting the narrative discussions. In addition, a visual format provides structure to the researcher when analysing the data base (Miles et al., 2014). Visual maps and tables were used throughout this research study as an aid to the presentation, analysis and interpretation of the data at each phase of the study (Appendices E, F, G, H, I, J).

4.7.5.6.6 Interpretation of findings.

Creswell's (2012) fifth stage in his framework of analysis and interpretation focuses on the interpretation of the findings. In this stage of the analysis, the researcher bypasses the descriptive level to interpret the meaning of the data on a broad level influenced by her own culture, personal experiences and the research literature generally (Mertens, 2015; Patton, 1990). Positioned at the end of a research study, the interpretation will include a summary of the key findings in relation to the research questions and will include the personal reflections of the researcher (Creswell, 2012). The researcher may also raise questions arising from the data requiring clarification by further research (Creswell, 2012). The interpretation of the findings of the current study is presented in Chapter 6. The findings are interpreted thematically within an ecological perspective.

4.7.5.6.7 Validation of findings.

Given that the aim of research is to generate valid and reliable knowledge in an ethical fashion, it is appropriate to address these issues directly in the final stage of the analysis and interpretation framework (Creswell, 2012; Merriam, 2009). In order to validate her research, the researcher puts in place approaches to check the quality of both the data and the findings (Stake, 1995; Yin, 2011). This is an important aspect for qualitative research given its interpretative nature and the role of the researcher in the research itself (Miles et al., 2014; Patton, 1990). Is the data accurate and representative of that collected from the participants? (Creswell & Plano Clark, 2007). Is the data reliable, i.e. consistent in its approaches and methods and stable over time? (Miles et al., 2014; Yin, 2009). Was the research undertaken in an ethical manner? (Merriam, 2009). How does the case study measure with regard to construct validity, internal and external validity? (Yin, 2009). Given the role of the researcher as an instrument for both data collection and analysis in qualitative research, how credible is the researcher? (Patton, 1990). Merriam (2009) succinctly states that concerns about validity and reliability can be overcome by paying "careful attention to a study's conceptualisation and the way in which the data were collected, analysed and interpreted and the way in which the findings are presented" (p. 210). Issues relating to the credibility of the researcher in the process and their philosophical viewpoints are also considered by Patton (1990) in his discussions on the credibility of qualitative analysis.

A number of strategies have been documented in the literature to overcome validity and reliability concerns in qualitative research (Miles & Huberman, 1994; Miles et al., 2014; Patton, 1990). Researchers engaging in qualitative research will employ a number of strategies to ensure the validity of their research. Strategies include triangulation, member checking, long periods of engagement in the field, peer review, researcher's position/reflexivity, theory or perspective triangulation (Merriam, 2009; Patton, 1990). Creswell (2013) suggests that researchers use at least two strategies in their efforts to validate their findings.

4.7.5.6.7.1 Triangulation.

The issue of triangulation is covered extensively in the literature (Miles & Huberman, 1994; Miles et al., 2014; Patton, 1990; Stake, 1994; Yin, 2012). Its' meaning in qualitative research is generally accepted as that of a process which uses multiple means to verify the evidence in order to ascertain the reliability of the findings (Merriam, 2009; Patton, 1990; Stake, 1994). In practice, it is anticipated that researchers will identify at least three different means of verifying their data (Yin, 2011). It is possible to triangulate by *data source* (persons, time, places), by *method*, by *researcher* and by using *multiple perspectives* or theories to interpret the data (Miles & Huberman, 1994; Patton, 1990). Huberman and Miles (1994) add a fifth type of triangulation, *data type* to include qualitative texts, quantitative data and audio/video recordings. They also suggest that the triangulation process be built in from the outset of the study as a means of accessing data from multiple sources in addition to its function in verification. Although the researcher anticipates support for her findings from the triangulation process, this may not always be the case as in some instances inconsistent or conflicting findings evolve forcing the researcher to closely re-examine the data collection procedures and the data base itself (Miles et al., 2014).

4.7.5.6.7.2 Member checking.

Member checking involves asking the participants of the study to check the data and interpretations for accuracy (Merriam, 2009; Stake, 1995). This process could be undertaken a number of times during the study and may involve interviewing the participants to allow them to discuss and present their feedback (Creswell, 2009; Merriam, 2009). Stake (1995) described the variable responses he has received through the use of this validation exercise – ranging from those participants who chose not to give feedback to those who do. Nonetheless, he stated that all his research reports were improved by member checking.

4.7.5.6.7.3 Auditing the study.

An external audit will enhance the validity of a qualitative research study and is conducted by a person unconnected to the study (Creswell, 2013). The role of the auditor is to determine the accuracy of the process and product of the research study and to report their findings to the researcher. The validity of a qualitative research study will be enhanced by an independent audit such as this (Creswell, 2009; Huberman & Miles, 1994).

The current study employed a number of strategies to ensure the reliability and viability of the findings. The research design was carefully planned from the data collection stage through to the presentation of findings. A detailed audit trail tracked the data collection and the strategies applied to the analysis and interpretation of the findings. Triangulation was achieved through the use of multiple methods of data collection (individual interviews, focus groups, documentation, and reflective journal). The researcher engaged in member checking of the data. Four participants of the study were invited to review the transcriptions of their interview for accuracy. In addition, an academic colleague independently coded three interviews for standardisation purposes. The researcher participated in a peer review process and critically discussed the research process with a number of academic peers and with her supervisor. These discussions provided further clarity and interpretation of the findings. As the data collection phase ranged over a period of two and a half years, the researcher had a long period of engagement with some of the participants in the field. The phased structure of the study resulted in some participants having less contact than others with the researcher.

4.7.5.6.8 Generalisation/transferability.

External validity in qualitative research is concerned with the generalisation of the study's findings beyond the current study (Merriam, 1998; Yin, 2009). The generalisation of case study research has been the subject of considerable debate in the literature (Mertens, 2010; Miles et al., 2014; Patton, 1990; Rose & Shevlin, 2014; Yin, 2009). Typically the aim of case study research is to understand the central phenomenon of a specific case in depth (Stake, 1995) and not necessarily to know if the results are representative of other samples (Richards & Morse, 2013; Stake, 1995). Proponents state that as the phenomenon is variable and bound to the context, it does not allow for generalisation (Patton, 1990). This is particularly true of single case study research (Yin, 2012). However, researchers who view generalisation as a core component of research design consider that the inability to generalise in case study method is a limitation to the approach (Merriam, 2009). Yin (2009) argues that this view of generalisation is based on statistical generalisation and is not applicable to case study research. Generalisation in case studies, he says, is based on analytical generalisation where the findings are generalised to a broader theory which is tested by replicating the theory in other cases where it is anticipated that similar results would be found (Yin, 2009, 2012).

Merriam (2009) supports the generalisation of case studies by suggesting strategies which will aid transferability. This is a concept which implies that the findings of a qualitative study can be "transferred to other groups of people and contexts" (Braun & Clarke, 2013, p. 282). One strategy which a researcher can apply is the use of "rich, thick description" when describing contexts (Merriam, 2009, p. 227). This allows future readers of the study to ascertain if the findings can be applied to other contexts (Braun & Clarke, 2013). In the case of a multi-case study design, Merriam (2009) suggests selecting cases to ensure "maximum variation" within the sample as a means to aiding generalisation (p. 227). This issue was considered by Rose and Shevlin (2014), when developing a sampling procedure for schools in their case study on SEN provision in the Republic of Ireland.

The purpose of the current study was to understand and examine special education teacher learning in mathematics and the subsequent transfer of teacher learning to practice. Case study research has been widely used in special education for such purposes (Rose & Shevlin, 2014). The researcher of the current study developed procedures to enable her to describe the participants' contexts in depth. The findings of the study are supported by relevant quotes from the data. The data analysis incorporated multiple sources of data. The study sample comprised of special education teachers in LS/RT, special class and special school teacher roles. The demographic nature and wide geographic location of the schools ensured that a broad range of schools were included in the sample. These approaches ensured that readers of the current study have access to sufficient information to consider the relevance of the study for settings elsewhere.

4.7.5.7 Ethical considerations

In the absence of a consensus in the literature regarding a definition of ethics, it is accepted that ethics in a social research context is understood to mean "the study of what researchers ought and ought not to do, and how this should be decided" (Hammersley & Traianou, 2012). Researchers typically work within a *Code of Ethics* or rules of conduct and are guided by codes developed by professional associations such as the British Psychological Society, the American Educational Research Association or the British Education Research Association (Busher & James, 2007; Yin, 2011). The *Code of Ethics* for a specific research project will be approved by the ethics committee of the researcher's university/institution (Silverman, 2010; Yin, 2011). The qualitative researcher will be concerned with ethical issues at every stage of her research from decisions relating to collection of data to analysis for example (Yin, 2011). Ethical issues are becoming increasingly more common as researchers become sensitised to the needs of those who participate in their research (Creswell, 2009). In doing so, the researcher considers those who will benefit from the research, the time and energy of the participants, their anonymity and their privacy for example. Stake's (1994) statement that "qualitative researchers are guests in the private spaces of the world" reminds qualitative researchers of their obligations in this regard (p. 244).

Ethical considerations begin in the planning stages of the research (Robson, 2002). Research proposals provide an opportunity for the researcher to anticipate ethical issues and to plan accordingly (Creswell, 2009). While the main ethical concerns relate to data collection and the dissemination of the findings, Mertens (2015) suggests that ethics need consideration when writing the research problem, the purpose statement and the research questions.

From an ethical point of view, it is necessary that the research problem addresses an issue which will ultimately benefit the participants in the study (Creswell, 2009). This issue needs to be understood clearly by the participants and is generally explained to them in a cover letter (Creswell, 2009). An informed consent form, outlining the protection of the participants rights will be prepared by the researcher and signed by the participants at the beginning of the study (Creswell, 2009, 2013). The consent form will also indicate the purpose of the study, that participation is voluntary, the level of participant involvement, guarantees of confidentiality, benefits for participation in the research and a contact name for further information (Braun & Clarke, 2013). During the data collection phase, the researcher is required to be respectful of the site and the participants (Creswell, 2013). Interviews require particular consideration and the associated issues can be outlined in an ethical protocol or framework designed for the interview process (Kvale & Brinkmann, 2015; Patton, 1990). Specific ethical issues relating to interviews include confidentiality, data access and ownership, risk assessment and informed consent (Patton, 1990). The personal involvement of the researcher, in particular, if she is the primary instrument in the data collection process raises ethical challenges (Braun & Clarke, 2013; Merriam, 2009). The researcher is required to report accurately and this process may involve using additional strategies or data sources to support the validation process (Braun & Clarke, 2013). Issues in the dissemination of the findings relate to the accuracy of the data presented, to the challenges in bridging the gap between the rights to privacy for the participants and the right of society to be informed of the researcher (Busher & James, 2007).

The summary of the ethical issues in qualitative research outlined above provide evidence of the challenges in the research process. Ultimately, the researcher, with the support of an approved Code of Ethics will make informed ethical decisions throughout the research process (Busher & James, 2007).

The protection of the participants was considered at all stages of the current research study. A Code of Ethics (Appendix K) informed by the principles of the Ethical Guidelines for Educational Research published by the British Educational Research Association (2011) was developed for this study. Ethical approval to conduct the research was sought from the Ethics Committee, School of Education, Trinity College Dublin. Approval was received in September 2012. Approval was received from the Executive Team of the HEI hosting the PGDSEN programme to conduct research with their students in September 2012.

An information letter was distributed to the PGDSEN primary/special school cohort (Appendix L). Participants were invited to participate in Phase 1 of the research study. They were informed that their participation was voluntary and that they could withdraw at any time without giving a reason. They were also assured that their withdrawal would not have any adverse personal consequences. An overview of the requirements of participation at this stage of the research was provided. Participants were given the contact details of the researcher and her supervisor. A consent form was provided (Appendix M). The Phase 1 participants completed a contextual questionnaire (Appendix C). They also completed the following measures:

1. Mathematics anxiety scale – UK (MAS-UK) (Hunt, Clark-Carter, & Sheffield, 2011) (Appendix N)
2. Mathematics teaching efficacy beliefs instrument (MTEBI) (Enochs, Smith, & Huinker, 2000) (Appendix O)
3. Sentiments, attitudes and concerns about inclusive education revised (SACIE-R) scale (Forlin, Earle, Loreman, & Sharma, 2011) (Appendix P)
4. Diagnostic teacher assessment in mathematics and science (DTAMS) – Whole number and computation assessment (CRiMSTeD, 2016a) (Appendix Q)

Due to the low response rate at Phase 1, the data collection was reconfigured. The four measures outlined above remained in Phase 1. The individual/group reflections on issues relating to the teaching of mathematics to pupils with SEN formed the Baseline phase. Letters of invitation and consent forms were issued to the non-responders. Participants in the Baseline phase completed a number of individual reflections of their learning throughout the academic year (Appendix R, Appendix S, and Appendix T). These reflections provided contextual data for the study.

All participants were invited to participate in Phase 2 of the study. Invitations were issued by letter. The participant information letter and consent form gave the participants the option of participation at three levels (Appendix U). Permission to participate in the study was sought from the Principal teachers of the participants. The letter to the Principals and the Consent Forms are in Appendix V. All Phase 2 participants completed a contextual questionnaire (Appendix W).

Phase 2 participants were invited to participate in Phase 3 of the data collection. The participant information form is in Appendix X. Information letters were issued to the principal teachers of the participants. Phase 3 participants agreed to participate in an interview (Appendix A). They also agreed to track their teaching of mathematics to either an individual pupil or a group of pupils over a four month period. They maintained a reflective journal (Appendix Y) and completed a pupil profile template (Appendix Z).

4.8 Outline of Current Research Study

4.8.1 Overview of data set

The Combined Post-Graduate Diploma Programme of Continuing Professional Development for Teachers involved in Learning Support and Special Education

(PGDSEN) 2012/13 cohort of a Higher Education Institute (HEI) in Ireland, provide the data base for this research. There were fifty two primary and post primary teacher participants on the PGDSEN programme in the 2012/13 academic year. The cohort of teachers teaching pupils between the ages of four and twelve years were the focus of this research (n= 34). Thirty three of the teachers taught in primary schools and one teacher taught in a special school for pupils with mild general learning disabilities. One of the teachers taught a special class for pupils with Mild to Moderate General Learning Disabilities in a mainstream school and another teacher taught in a dedicated speech and language class. The remainder of the teachers worked in learning support/resource posts in their schools. Two of the thirty four teachers were male. The teachers taught in schools in a wide geographical area in the Republic of Ireland.

4.8.2 PGDSEN programme

The PGDSEN programme is designed to provide learning support teachers, resource teachers, learning support/resource teachers, teachers in special schools and in special classes with "substantial theoretical and practical continuing professional development" (Department of Education and Skills, 2012a, p. 12). It is offered in seven Higher Education Institutes in Ireland and is funded by the DES (Department of Education and Skills, 2012a). Two hundred and ninety five places are available nationally on the programme. It is a requirement of the course that the primary school applicants have completed their probation and hold a sanctioned special education or learning support position for the duration of the course. The programme runs over one academic year (September to May) and involves a block release of eight weeks from the participants' schools. Attendance over four weekends is also necessary. The Master of Education in SEN programme is open to successful participants meeting the entry requirements who wish to pursue their studies further. The aims and objectives of the PGDSEN programme are:

- To give participants an in-depth understanding of the theory and research relating to the education of pupils with special educational needs including those in the high incidence and low incidence of special educational needs and those experiencing learning difficulties
- To equip participants with the knowledge, skills and attitude necessary to respond effectively to the special educational needs of pupils.
- To develop an understanding in participants of the principles and practices involved in the education of pupils with SEN.

- To provide a specialist academic qualification for Resource teachers, Learning Support teachers and those teaching in special educational settings.
- To enable participants to undertake critical analysis of paradigms relating to SEN
- To provide participants with the opportunity to develop specialist expertise in a chosen area of SEN
- To provide the skills and knowledge necessary to enable participants to conduct research at Graduate Diploma and Master's level in the area of special educational needs and learning support. (*PGDSEN programme handbook 2012/13*, 2012, p. 10)

There are ten modules on the PGDSEN programme. An overview of the modules is provided in Appendix BB. The modules and associated assignments are designed to ensure that the participants gain a knowledge of theory on special education and to develop the practical expertise to apply it in their own classroom settings. This is achieved through a permeated model of delivery throughout the academic year.

4.8.3 PGDSEN programme: Mathematics

The input on the teaching of mathematics to pupils with SEN on the PGDSEN programme is drawn from a number of modules. The *Exploring Influences on Child Development, Learning and Behaviour* module refers to the development of an "understanding of various disabilities e.g. Down syndrome, Autism, Dyslexia and ADHD and the educational implications associated with such disabilities" (*PGDSEN programme handbook 2012/13*, 2012, p. 11). It also states that teachers will "identify a range of appropriate teaching methodologies, strategies and resources" (*PGDSEN programme handbook 2012/13*, 2012, p. 11). Mathematics is specifically referred to in the *Curricular Provision – meeting the holistic needs of pupils'* module. This module aims to provide the teachers with "theory, research and practice regarding curricular inclusion for pupils with SEN" (*PGDSEN programme handbook 2012/13*, 2012, p. 12). The syllabus includes a focus on the development of numeracy skills (*PGDSEN programme handbook 2012/13*, 2012). The *Practicum* modules allow the teachers the opportunity to apply the knowledge and skills acquired in their own classroom settings. Teachers may choose to teach a lesson on mathematics for the purposes of this module. Teachers may also experience the teaching of mathematics in this module as part of their two day placement in a special education setting. The *Enabling role of Information and Communications Technology (ICT)* module examines the role of ICT to support teaching and learning in special education including mathematics. Planning for the teaching of mathematics is included in the *Roles and responsibilities in relation to SEN* module. Whole school approaches, individual education plans and professional collaboration across all areas of SEN including mathematics are the focus of this module. All ten modules are assessed in six assignments throughout the academic year. Mathematics for SEN is not assessed specifically.

The input on *Teaching mathematics to pupils with SEN* is taught over the course of ten two-hour lectures spanning both semesters in the academic year. These lectures aim to provide the teachers with the expertise to adequately support the curricular needs of the child with SEN in mathematics. An overview of the lecture content for the primary and special school teacher cohort presented in the Appendix CC.

4.8.4 Phases of the research study

Table 4.2 Overview of Research Phases

Phase	PGDSEN participants		Time line
Baseline n=32	Baseline data cohort *n = 32* *Individual/Group reflections from the PGDSEN class of 2012/13 on issues relating to the teaching of mathematics to pupils with SEN*		September 2012 ↓ May 2013
Phase 1 n=15	Cohort 1 *$n = 15^{a}$* *Questionnaire & measures[d]*		September 2012
Phase 2 n=15	Cohort 1 *$n = 8^{a}$* *Interview & questionnaire*	Cohort 2 *$n = 7^{b}$* *Interview & questionnaire & measures[c]*	May/June 2014
Phase 3 n= 8	Cohort 1 *$n = 4^{a}$* *Interview & reflective teaching log & planning documentation*	Cohort 2 *$n = 4^{b}$* *Interview & reflective teaching log & planning documentation*	September 2014 ↓ December 2014

Note: [a] Participants recruited at Baseline data stage

[b] Participants recruited at Phase 2

[c]MAS-UK; MTEBI; SACIE-R

[d]MAS-UK; MTEBI; SACIE-R; DTAMS.

There were four phases of data collection in this research study, Baseline, Phase 1, Phase 2 and Phase 3. Table 4.2 provides an overview of the phases, the participating cohorts, the nature of the data collection and the timeline for the study.

4.8.5 Baseline data phase

This phase provided the foundation for the detailed thick description of the phenomenon which is commonly associated with case study research (Merriam, 2009). The baseline data phase (n = 32) was designed to provide contextual data for the study. The participants held special education teaching posts in primary and special schools in the Republic of Ireland. Table 4.3 provides a brief overview of the baseline data set.

Table 4.3 Overview of Baseline Data Set

PGDSEN 2012/13	**N**
Primary/special school participants	34
Primary/special school participants in Baseline data phase	32
Teaching positions:	
LS, RT, LS/RT	30
Teaching positions:	
Special school, special class	2
Number of participants who teach mathematics to pupils with SEN on their case loads	30

All but two of the participants teach mathematics to pupils with SEN. Approximately one third of the participants used the co-teaching model when teaching mathematics to pupils with SEN. Most of the participants stated that they differentiate the mathematics curriculum. However, less than one quarter of the participants used diagnostic measures to inform their instructional programme.

Data in the form of individual and group responses relating to the teaching of mathematics to pupils with SEN was gathered at six points throughout the academic year. Table 4.4 provides a detailed overview of the baseline data collected from the PGDSEN participants both on an individual and on a group basis.

Table 4.4 Overview of Baseline Data Collection

Lecture number	Data Collection	Lecture title	Focus of data collected	Type of response
1.	October 5th 2012	Teaching mathematics to pupils with SEN: An overview (1)	Key issues impacting on how the PGDSEN teachers teach mathematics to pupils with SEN. Suggested topics for lectures	Small groups (flip chart responses) n=32
2.	October 10th 2012	Teaching mathematics to pupils with SEN: An overview (2)	Why do some pupils find it hard to learn mathematics?	Whole group (flip chart responses) n=32
6.	February 18th 2013	Approaches to number for pupils with SEN (1)	KWL grid – what I know, what I want to know	Individual written responses n=24
7.	February 19th 2013	Approaches to number for pupils with SEN (2)	KWL grid – what I have learned about teaching number to pupils with SEN	Individual written responses n=24
8.	February 21st 2013	A social mathematics programme for pupils with SEN	The influence of this lecture on the teaching of social mathematics by the PGDSEN programme participants	Individual written responses n=24
10.	April 9th 2013	Effective instruction in mathematics for pupils with SEN	Teaching mathematics to pupils with SEN. What difference can we make?	Small group (flip chart responses) n=32
10.	April 9th 2013	Effective instruction in mathematics for pupils with SEN	End of lecture block evaluations	Individual written responses n=32

4.8.6 Phase 1

The purpose of Phase 1 of the research study was to provide an in-depth insight into the mathematics anxiety levels, mathematics teaching efficacy beliefs, content and pedagogical content knowledge in whole number/computation and the sentiments, attitudes and concerns about inclusive education of the participants prior to the commencement of their learning on the PGDSEN programme (September 2012). Fifteen participants (Cohort 1) accepted the invitation to participate at Phase 1 of the research study. All participants participated in the Baseline data phase (Table 4.2). Participation in Phase 1 involved the completion of a background questionnaire to provide contextual information (Appendix C) and the completion of the measures as outlined in Table 4.5.

Table 4.5 Measures (Phase 1)

Measure	Source	Appendix
Mathematics Anxiety Scale- UK (MAS-UK)	(Hunt et al., 2011)	Appendix N
Mathematics Teaching Efficacy Beliefs Instrument (MTEBI)	(Enochs et al., 2000)	Appendix O
Sentiments, Attitudes, and Concerns about Inclusive Education Revised (SACIE-R)	(Forlin et al., 2011)	Appendix P
Diagnostic Teacher Assessment in Mathematics (DTAMS) - Whole Number & Computation Assessment	(CRiMSTeD)	Appendix Q

It was anticipated that the data generated by these instruments would further support the contextual data. The instruments were presented to the participants prior to the commencement of the lectures in mathematics for SEN on the PGDSEN programme in September 2012. Three of the fifteen participants who participated in this phase did not return the DTAMS measure. Anecdotal evidence provided by the participants suggested that the lower than anticipated response rate related to the DTAMS measure, a validated instrument measuring teachers' content and pedagogical content knowledge (Saderholm, Ronau, Brown, & Collins, 2010). The informal responses of the participants included comments such as "*couldn't do it", "it was much too long", "awful", "too hard"* were noted in the researcher's Reflective journal (20/12/12).

4.8.6.1 Measures.

Participants at Phase 1 of the data collection completed four measures. It was anticipated that the data would provide insights into individual teacher factors relating to special education teacher learning. The measures are outlined in detail in the following section.

4.8.6.1.1 Mathematics Anxiety Scale-UK (MAS-UK) (Hunt et al., 2011).

Mathematics anxiety is defined as a "feeling of tension and anxiety that interferes with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations" (Richardson & Suinn, 1972, p. 551). The Mathematics Anxiety Scale-UK (MAS-UK) (Appendix N) is a reliable and validated measure of mathematics anxiety (Hunt et al., 2011). This measure has been designed to reflect mathematical situations relevant to preservice teachers in the British context (Hunt et al., 2011). The MAS-UK is also suitable as a means of measuring mathematics anxiety levels in adults (Hunt, Clark-Carter, & Sheffield, 2015) and owes its origin to the original instrument designed by Richardson & Suinn (1972) to measure mathematics anxiety (Hunt et al., 2011; Núñez-Peña, Guilera, & Suárez-Pellicioni, 2014). Participants are asked to indicate their response relating to the level of anxiety they would experience when using mathematics in everyday situations. A five point Likert scale ranging from *Not at all* to *Very much* is used to structure the responses. The MAS-UK consists of three subscales:

- mathematics evaluation anxiety
- everyday/social mathematics anxiety
- mathematics observation anxiety (Hunt et al., 2011).

It's internal reliability has achieved a Cronbach's alpha score of 0.96 (Hunt et al., 2015).

4.8.6.1.2 Sentiments, Attitudes, and Concerns about Inclusive Education Revised (SACIE-R) Scale (Forlin et al., 2011).

Research indicates that attitudes, beliefs and concerns of pre-service teachers in relation to inclusion be considered in their training (Sharma et al., 2006). The test developers suggest that the information gained using this measure will assist teacher educators to focus on more specific training to meet the needs of pre-service teachers for teaching a diverse pupil population (Forlin et al., 2011). Although the scale was designed to measure the perceptions of pre-service participants, the authors refer to its application and future uses with in-service teachers (Forlin et al., 2011).

This validated scale (Appendix P) was designed to measure the perceptions of the participants on three constructs of inclusive education:

- Sentiments or comfort levels when engaging with people with disabilities
- Acceptance of learners with different needs
- Concerns about implementing inclusion.

In addition to an overall score, the SACIE-R yields subscale scores for each of the three constructs. The validation process measured the internal reliability

(Cronbach's alpha) for the combined SACIE-R scale (α = .74) and for the three subsets – sentiments, attitudes and concerns (Forlin et al., 2011).

4.8.6.1.3 Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) (Enochs et al., 2000).

The MTEBI (Enochs et al., 2000) (Appendix O) is an established, validated instrument designed to measure the mathematics teaching efficacy beliefs of preservice elementary (primary) teachers (Can, Gunhan, & Erdal, 2012; Enochs et al., 2000). Its results are used by teacher educators to identify the mathematics teaching efficacy beliefs of preservice teachers (Bingham Brown, 2012; Can et al., 2012; Gresham, 2008), to modify the content of courses for them according to their identified needs (Kieftenbeld, Natesan, & Eddy, 2011) and as pre and post-test measures of mathematics teaching efficacy beliefs (Goodson-Espy et al., 2014). The MTEBI is also used to measure the mathematics teaching efficacy beliefs of in-service teachers following their participation in mathematics programmes (Kuchey, Morrison, & Geer, 2009). Research indicates that the quality of instruction in mathematics is dependent on teachers' self-efficacy beliefs about mathematics (Enochs et al., 2000).

The MTEBI is a 21 item measure consisting of two subscales, the Personal Mathematics Teacher Efficacy (PMTE) scale (13 Items), which is a measure of the personal belief of participants of their ability to teach mathematics successfully and the Mathematics Teaching Outcome Expectancy (MTOE) scale (8 items), a measure of the participants' belief that their teaching will impact positively on the ability of their pupils to learn mathematics (Enochs et al., 2000). PMTE and MTOE are measured using a 5 point Likert scale (ranging from strongly disagree to strongly agree with ratings from 1 to 5 respectfully). The alpha coefficient is 0.88 for the PMTE scale and is 0.75 for the MTOE scale (Enochs et al., 2000). Other studies established the consistency of these scores (Kieftenbeld et al., 2011; Newton, Leonard, Evans, & Eastburn, 2012). Scores on the PMTE range are likely to range from 13 to 65 and from 8 to 40 on the MTOE scale (Enochs et al., 2000) with scores at the upper range at the scale indicating stronger efficacy beliefs (Hinton, Flores, Burton, & Curtis, 2015; Swars, Hart, Smith, Smith, & Tolar, 2007). A study by Kieftenbeld et al. (2011) suggests that the subscales be reported separately given the small correlation between them (Pearson's r = .14) and the nature of the two-dimensional construct of teaching efficacy. Their study also suggests that the test reliability of the MTEBI requires further research.

The MTEBI owes its origin to the Science Teaching Efficacy Belief Instrument (STEBI) (Riggs & Enochs, 1989) developed in 1989 for elementary science teachers and later modified for pre-service teachers (Enochs & Riggs, 1990). Given that the

MTEBI was designed for preservice teachers, slight modifications of the wording were made to nine of the variables for the purposes for this research study.This modification was similar to the differences in the variables between the STEBI – A (in-service teachers) and the STEBI – B (pre-service teachers) (Enochs & Riggs, 1990; Riggs & Enochs, 1989). The modification related to a change in tenses e.g. "*I will generally* teach mathematics ineffectively" was reworded to "*I generally* teach mathematics ineffectively". In addition to finding the scores on both subscales, the mean, mode and standard deviation were calculated for the current research study. Eight items on the scale were reverse scored (Enochs et al., 2000).

4.8.6.1.4 Diagnostic Teacher Assessment in Mathematics and Science (DTAMS).

The Diagnostic Teacher Assessment in Mathematics and Science (DTAMS) (CRiMSTeD, 2016a) assessments are validated measures of teachers' content and pedagogical knowledge developed by the Centre for Research on Mathematics and Science Participant Development (CRiMSTeD) in the University of Louisville (Saderholm et al., 2010). The DTAMS for elementary (primary) teachers of mathematics is the focus of this research study. The assessments are used to measure growth in teacher mathematical knowledge (pre-service and in-service) during mathematics courses in professional development (Copur-Gencturk & Lubienski, 2013; Lim & Guerra, 2013) with participants in some research studies receiving financial rewards for their participation (Copur-Gencturk & Lubienski, 2013). Although not normed to the general population (CRiMSTeD, 2016a), the DTAMS is a useful and popular measure for both teachers and teacher educators (Copur-Gencturk & Lubienski, 2013; Saderholm et al., 2010) providing benchmarks for teachers of their mathematical knowledge and of their mathematical growth for teacher educators (CRiMSTeD, 2016a; Saderholm et al., 2010). A Cronbach's alpha score of 0.7 confirmed the internal reliability of the measure (Lim & Guerra, 2013). The average time for completing the DTAMS is sixty minutes. However CRiMSTeD note that this may vary by fifteen minutes at either end.

Consisting of four subsections; whole number and computation, rational number and computation, geometry and measurement, probability, statistics and algebra. The whole number and computation subsection proved relevant to this study. The DTAMS is a pen and paper assessment measuring four types of mathematical knowledge (Table 4.6) in twenty multiple-choice and open-ended questions.

Table 4.6 Types of Knowledge Assessed in the DTAMS (CRiMSTeD, 2016a)

Type	Description
Type I	Memorised/factual knowledge
Type II	Conceptual understanding
Type III	Problem solving/reasoning
Type IV	Pedagogical content knowledge

4.8.7 Phase 2

This phase was designed to understand the perceptions and experiences of the participants, of the influence of the mathematics input on the PGDSEN programme on their acquisition of new knowledge and skills and their understandings of the subsequent transfer of this learning to practice. Facilitating factors and barriers to the implementation of new practices were elicited. Individual interviews were held in the participants' classrooms. The semi-structured interview schedule in Appendix AA guided the interviews.

An overview of the data set is provided in Table 4.7. Phase 2 comprised of two cohorts, Cohort 1 and Cohort 2. Both cohorts had participated in the baseline phase. However, Cohort 2 did not participate in Phase 1.

Table 4.7 Overview of Phase 2 Data Set

Phase	PGDSEN participants		Timeline
Phase 2 n=15	Cohort 1 *n= 8[a]* *Interview[c] & questionnaire[d]*	Cohort 2 *n = 7[b]* *Interview & questionnaire & measures[e]*	May/June 2014[f]

Note [a] Participants recruited at Baseline data stage

[b] Participants recruited at Phase 2

[c] Interview schedule (Appendix AA)

[d] Questionnaire (Appendix W)

[e] MAS-UK; MTEBI; SACIE-R (Appendices N, O, P)

[f] 12 months following completion of PGDSEN programme

Given the difficulties which arose during Phase 1 of the data collection in relation to the DTAMS (CRiMSTeD, 2016a) measure, Cohort 2 participants were invited to complete the Phase 1 measures (MAS-UK, MTEBI and SACIE-R) excepting the DTAMS at this point in the data collection. All Cohort 2 participants completed the three measures.

4.8.8 Phase 3

The final phase of the research study, Phase 3 (n = 8) focused specifically on the teaching of mathematics to pupils with SEN by the participants and was undertaken between September and December 2014. In addition, this phase examined the influence of contextual factors such as policy and provision in special education on the practice of the participants. It also explored the participants' perceptions of their acquisition of skills and knowledge in mathematics following their completion of the PGDSEN programme.

The primary focus of this phase, is however, on the understandings of the participants of the transfer of their new knowledge and skills to practice through the lens of a case study, a specific focus on their teaching of mathematics to a pupil or a group of pupils in their case load. The participants agreed to track their teaching of mathematics to a pupil or a small group of pupils from September 2014 to December 2014. A reflective journal was provided to each participant. They were asked to note their collaborations with the class teacher, parents and SNA. Their reflections in instructional approaches, content, resources, ICT, assessment and pupil progress were to be noted. General comments on their teaching of mathematics to pupils with SEN was welcomed also. Documentation relating to their teaching of mathematics was provided to this research study. IEPs, short term plans, assessments and samples of pupil's work were examined. The documentation provided the researcher with insights as to how the participants intended to adapt their practices in relation to the teaching of mathematics to pupils with SEN.

Data collection for this phase began at the beginning of the second school year following the participants' completion of the PGDSEN programme. The data collection for Phase 3 occurred over a four month time frame. Individual interviews were held in the participants' schools during the months of November and December 2014. The semi-structured interview schedule in Appendix A guided the discussion.

Table 4.8 Overview of Phase 3 Data Set

Phase	PGDSEN participants		Timeline
Phase 3 n= 8	Cohort 1 *n = 4*[a] *Interview*[c] *& reflective teaching log*[d] *& planning documentation*	Cohort 2 *n = 4*[b] *Interview & reflective teaching log & planning documentation*	September 2014 ↓ December 2014

Note: [a] Participants recruited at Baseline data stage
[b] Participants recruited at Phase 2
[c] Interview schedule (Appendix A)
[d] Reflective log example (Appendix B)

An overview of the data set for Phase 3 is presented in Table 4.8. Phase 3 comprised of two cohorts, Cohort 1 (n = 4) and Cohort 2 (n = 4). All participants had participated in the baseline phase. However, Cohort 2 were recruited at Phase 2 of the data collection.

4.9 Chapter Conclusion

This chapter established the research approach for the current study. Set within a constructivist paradigm, the case study design proved to be an appropriate means of gaining an in-depth insight into the phenomenon, special education teacher learning in mathematics. The sample, the pilot studies, and the data collection instruments have been presented. The procedure for data analysis has been discussed as have further issues for consideration such as validation of the findings and ethical concerns. The following chapter presents the findings of the study. Presented thematically across each phase of the study, it will provide a rich description of the individual and contextual factors relating to special education teacher learning in mathematics. The influence of the mathematics input on the PGDSEN programme on the acquisition of new knowledge and skills will be examined. The participants' understandings of their adapted practices in their classrooms will form a core element of the next chapter.

Chapter 5: Presentation of Findings

5.1 Introduction

This study examined special education teacher learning in mathematics. A PGDSEN programme provided the context for the study. A four phase data collection over a period of 30 months sought to establish the individual and contextual factors influencing special education teachers' acquisition of knowledge and skills in mathematics and their understandings of the transfer of this learning to classroom practice. The research also sought to examine the perceptions and experiences of the special education teachers on the influence of the mathematics input on the PGDSEN programme on their acquisition of knowledge and skills in mathematics.

The findings of each of the four phases (Baseline, Phase 1, Phase 2 and Phase 3) of this study will be presented separately. Table 4.2 provides the reader with an outline of the phases of the study. Each phase begins with an overview of the demographics of the participants. This will establish the context of each phase for the reader. Secondly, the findings of the quantitative measures (MAS-UK, SACIE-R, MTEBI, DTAMS) completed by the participants at Phases 1 and 2 follow. Thirdly, the core section of each phase is presented thematically. The three themes, Inclusive and special education: Policy and provision; Continuing Professional Development and Translating learning into practice: Teaching mathematics to pupils with SEN are central to this research study and provide a framework for the presentation of the findings at each phase of the study.

5.2 Findings: Baseline Phase

This chapter begins with the presentation of findings from the baseline data for the purpose of contextualising the data within the research setting. The context for this study is set in the baseline data provided by the PGDSEN programme participants (n = 32). An overview of the baseline data set is provided in Table 4.3. The data for this phase was collected at six points during the academic year 2012/13. Insights were provided by the PGDSEN programme participants on issues impacting on the teaching of mathematics to pupils with SEN in their schools, on the knowledge and skills acquired by them through their participation on the PGDSEN programme and on their perceptions on the future implementation of this knowledge in their classrooms. The findings are presented thematically.

5.2.1 Theme 1: Inclusive and special education: Policy and provision

The emergence of this theme from the data refers to policy developments at national level and factors both internal and external to the school which influence special education teachers' teaching of mathematics to pupils with SEN. National policies reported by participants include for example, the National Literacy and Numeracy Strategy (Department of Education and Skills, 2011f), Whole School Evaluations (WSEs) (Inspectorate, 2010), the DES policy on standardised testing (Department of Education and Skills, 2011e) and the Guidelines for teachers of pupils with MGLD issued by the NCCA (National Council for Curriculum and Assessment, 2007). The role of parents in the mathematical education of their children is considered an external influence in this context. Internal influences include school policies on SEN/Mathematics, availability of resources to teach mathematics and whole school approaches towards the teaching of mathematics to pupils with SEN.

At the commencement of the PGDSEN programme, the participants were primarily focused on factors occuring within their schools relating to the provision of additional teaching support in mathematics for pupils with SEN. Data relating to issues impacting on the teaching of mathematics to pupils with SEN was elicited through focus group discussions (n = 7) during the first lecture in mathematics for SEN (5/10/2012). The key themes which emerged from the data and the number of group occurances are presented in Table 5.1.

Table 5.1 Issues Impacting on the Teaching of Mathematics to Pupils with SEN

Issue	Number of group responses
Assessment	4
Inadequate time allocation	4
Class teacher	4
Mathematical knowledge for teaching	3
Availability of resources	3

While aware of the importance of diagnostic assessments to "*find out where they are at"* (Grp2L5) and *"to know where to begin"* (Grp6L32), participants stated that they did not always have *"access to diagnostic tests"* (Grp1L1). Inadequate time allocation was mentioned by four of the seven groups in a negative context (Reflective Diary 12/12/12). The "*expectations of the class teacher"* (Grp4L22, Grp3L11) including the fact that class teachers wanted to "*cover the curriculum"* (Grp2L4), was perceived by the participants as a negative impact on their teaching of mathematics to pupils with SEN (RD 12/12/12). Some participants experessed concern at the level of their own mathmatical knowledge for teaching (RD 12/12/12). The lack of resources to support the teaching of mathematics was identified as a factor which hindered the teaching of mathematics effectively by three of the seven focus groups.

Internal and external influences relating to the teaching of mathematics have been briefly outlined above. This theme will be further developed in later phases of the research.

5.2.2 Theme 2: Continuing professional development

The PGDSEN programme (Department of Education and Skills, 2012a), a CPD programme for participants involved in learning support and special education provided the focus for this research study. Data were gathered at the baseline phase to identify the existing knowledge base of the participants in relation to the teaching of mathematics to pupils with SEN and to identify knowledge which was acquired during their participation in the PGDSEN programme programme. Two lectures focussed on Number and provide a specific focus for this theme.

5.2.2.1 A focus on new learning

An analysis of topics suggested by the participants for inclusion in the mathematics lectures provided an early indicator of their mathematical knowledge for teaching in special education. These topics emerged following focus group discussions (n = 7) during the second of ten lectures in mathematics (10/10/2012. Assessment (n = 4) and ICT (n = 3) were the most frequently requested topics. Other topics suggested by the participants included Social mathematics, Intervention programmes and number. The input on number on the PGDSEN programme was designed to build on existing special educator knowledge to support the teaching of number to pupils with SEN.

The participants completed individual graphical organisers – referred to in the literature as KWL frameworks (What I **K**now, What I **W**ant to Know, What I **L**earned) (Ogle, 2009) (Appendix S), on the teaching of number to pupils with SEN. The first two sections – *What I know* and *What I want to know* were completed at the beginning of the first lecture (18/02/12) on number. Twenty four participant responses were received from a total of 32 participants (n = 32). A thematic analysis of the answers was undertaken (Figure 5.1).

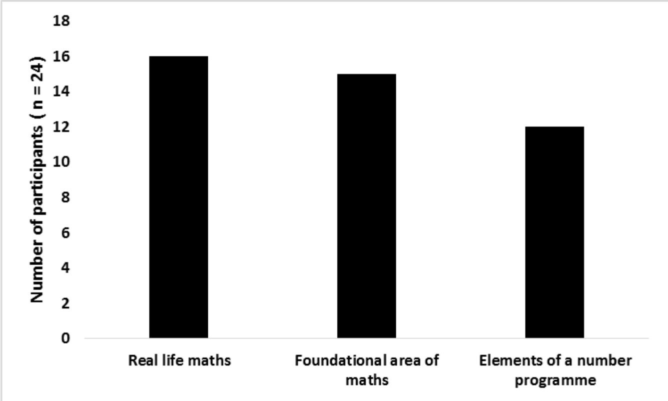

Figure 5.1 KWL grid – What I know about teaching number to pupils with SEN

Participants knew that number was “a life-skill and extremely important to children” (T5K9), was an “essential life-skill as part of everyday life” (T14K31) and that “IT and WWW resources have had an impact on the need for number knowledge” (T19K46). The challenges of learning number was acknowledged and a participant said that learning number was a “significant difficulty for children with SEN” (T19K46) and that some children “can’t grasp the concept at all” (T5K12). Participants were aware of the importance of using “concrete materials to teach the abstract concept of number” (T7K15) and of the importance of “activity – based learning” (T2K3).

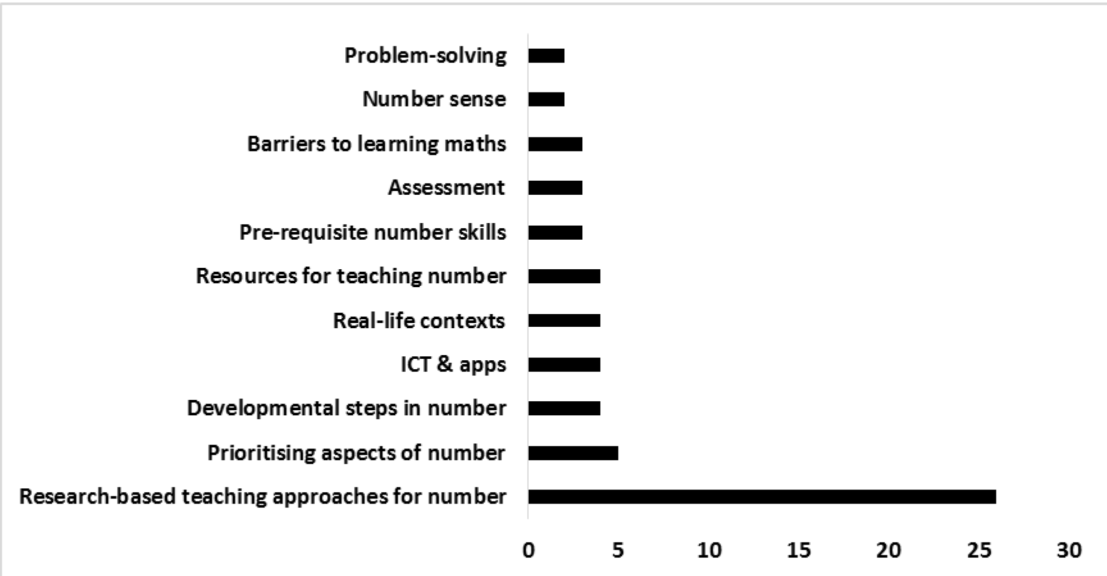

Figure 5.2 KWL grid – What I want to know about teaching number to pupils with SEN

A thematic analysis of the responses to the section on the KWL grid “What I want to know about teaching number to pupils with SEN” yielded the codes as indicated in Figure 5.2. Participants wanted information on "*effective strategies to teach number well"* (T11W19) and strategies "*to make the learning of number easier for my pupils"* (T19W39). Participants wanted to know *"how to improve children's understanding of number"* (T10W18) and what *"methodologies and approaches to use with these pupils (with SEN) and particularly when the pupil has a diagnosis of dyscalculia"* (T24W54). Interestingly a number of participants (n = 4) wanted to learn "*the developmental steps in acquiring number knowledge"* (T1W1).

Table 5.2 KWL grid: What I have Learned about Teaching Number to Pupils with SEN

Code	Frequency of occurrence*
Procedural fluency	5
Differentiation	6
Resources for teaching number	6
Counting	8
Visual supports	8
Conceptual understanding	10
Number sense	11
Numicon	13
Evidence based strategies	23

Note: Multiple response option n = 24

The final section of the KWL framework revealed special educator learning in number. A thematic analysis of the participant responses to this section revealed that the category "Evidence based strategies" was referred to by all but one of the participants (Table 5.2). The findings indicate that this lecture had been responsive to the learning needs of the participants in the area of number.

The input in this lecture on Number sense provided the response to the requests by the participants for upskilling as outlined in their *What I want to learn* section of the KWL grid. They learned that number sense "*is essential"* (T23L65), is the "*best window to fact mastery"* (T6L17) and is "*important and must be developed"* (T6L15). Participants clarified for themselves their understandings of conceptual and procedural fluency in relation to the teaching of number to pupils with SEN. They learned that *"procedure and understanding should be included in every lesson"* (T6L16) and that *"if children understand the concept, they will internalise it"* (T22L63).

The overall comments for the lecture on number suggested that the number lectures were "*very participant based with practical strategies"* (T15KC19), were *"very useful sessions*" (T14KC18) and "*the look at the resources"* (T19KC24) was appreciated. Participants recognised that number *“is a hugely important area which participants require CPD for”* (T17KC20) as there are “*many misconceptions about teaching number”* (T17KC21).

This section has outlined the participants’ pathway of learning on the topic of number. Number was identified by the participants as an area requiring additional professional support. While they were aware that number was an essential component of a mathematics programme for pupils with SEN, they requested input on the content and pedagogical aspects of number interventions. The findings indicated that the participants acquired new knowledge on the teaching of number including research based interventions, which they acknowledged would be applicable to their future teaching of this topic.

5.2.2.2 Reflections on new learning

As this research study sought to identiy the perceptions and experiences of the participants on their acquisition of knowledge and skills in mathematics and on their understandings of the transfer of their learning to classroom practice for pupils with SEN, the participants were given opportunities to reflect on their learning at the conclusion of the mathematics lectures.

The relevance of the lectures in mathematics to the academic needs of the participants is indicated in Figure 5.3. The findings noted the personal enjoyment and satisfaction of the participants from their attendance at the lectures. They stated that they “*really enjoyed the lectures on maths”* (T10E1016) and that they found it to be an “*excellent course”* (T21E1031). Others found the lectures to be “*very informative*” (T14E1022) and *“practical and useful”* (T32E1045). One participant noted that she *“had learned a lot”* (T20E1040) and that it would benefit her *“as an SEN teacher and also when I go back to class”* (T20E1040). The lectures influenced mathematical knowledge for teaching and a participant stated that she felt “*more confident in terms of my own knowledge of tests and teaching methods”* (T26E928).

Participants expressed their wish to have “*more time”* (T9E810, T18E1026) devoted to lectures on mathematics on the PGDSEN programme as *“Maths is very important for LS/RTs and needs to have more course time dedicated to it”* (T18E819). Suggestions included a Practicum where the teaching of maths was mandatory “*just as there is a specific one (practicum) for language and literacy”.* While there was an acknowledgment of workshop type sessions in the PGDSEN programme – *“the workshop element when they occurred were very relevant”* (T1E81), a number of participants (n = 12) sought further workshop type inputs as there was a *“lot of* *information to take in"* (T2E83) and that *"more hands on activities"* (T15E816) were required.

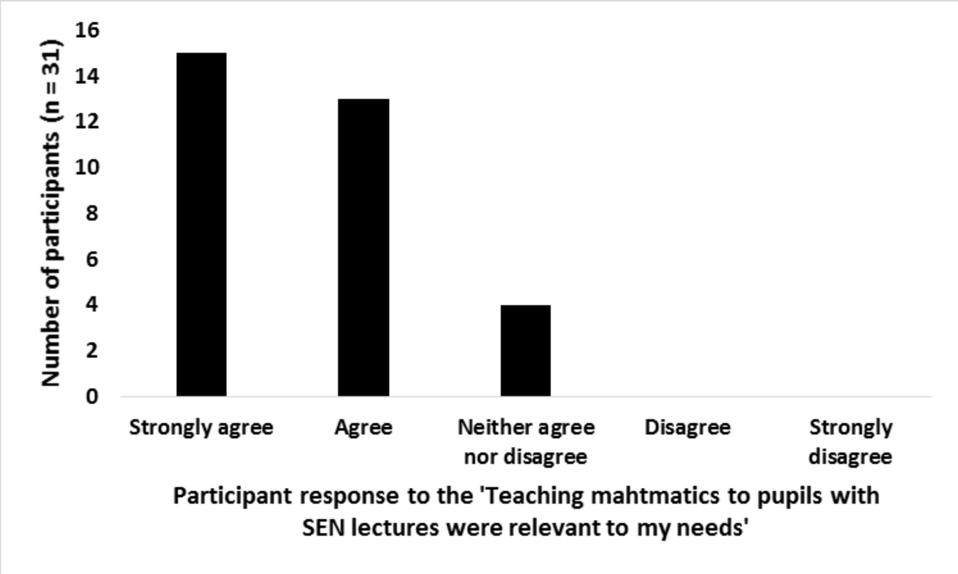

Figure 5.3 Relevance of lectures on mathematics to the participants' needs. .

At the end of the ten lectures, the participants were asked to identify the lecture of most relevance to their particular needs. Figure 5.4 presents the findings.

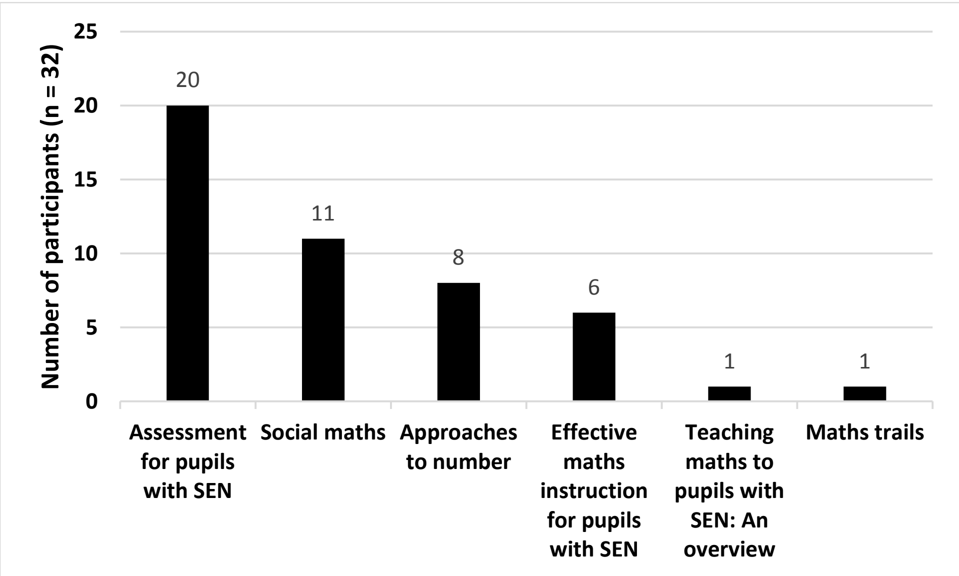

Figure 5.4 Lecture of most relevance to the PGDSEN programme participants

Note: Some participants ticked multiple responses. Each response was included.

Assessment for pupils with SEN, a topic requested by most participants at the beginning of the academic year (Figure 5.4) was identified by twenty of the participants (n = 32) as the lecture of most relevance to their needs. Participants appreciated the opportunity of getting "*the names of various tests which could be purchased"* (T24E270) and said that *"it was nice to get an opportunity to look at the tests and evaluate them before buying"* (T29E292*).* Participants referred to assessment as an area where they required additional knowledge as it as *"an area which I knew very little about"* (T20E254).

The participants identified the lectures which were of least relevance to their particular needs in their school settings (Figure 5.5). While the findings suggest that participants may have had prior content and pedagogical knowledge of Maths Trails, it is evident that the lectures presented were relevant to the needs of the participants – "all lectures held some relevance and every lecture contained useful information" (T2E35).

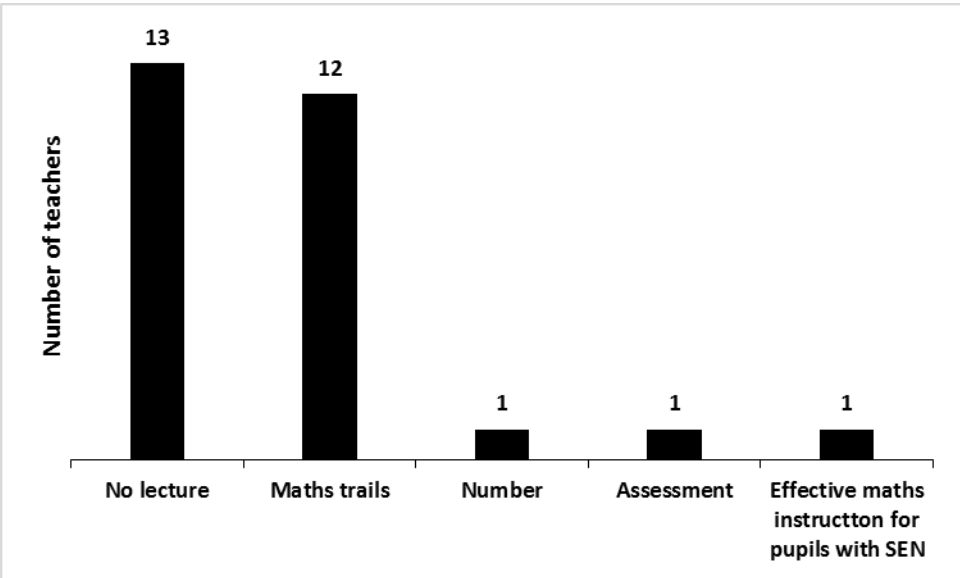

Figure 5.5 Lecture of least relevance to the PGDSEN programme participants

Note. Some participants ticked multiple responses. Each response was included.

5.2.2.3 Summary

This theme, identified the existing knowledge base of the participants in relation to the teaching of mathematics to pupils with SEN with a particular focus on Number. Subsequent teacher learning was also identified.

Maths Trails was identifed as an area of prior knowledge for the participants. The findings indicated that the participants had an understanding of core elements of an intervention programme in number in mathematics. They expressed their knowledge of Number as a component in a Real Life mathematics programme, of the foundational aspect of number and were aware of the elements of intervention programmes in number. Most of the participants identified evidence based strategies in number as an area they required upskilling in. Participants also requested additional support on the developmental steps of number, on assessment in number and on resources to support the teaching of number.

The reflections of the participants on their new learning suggest that they recognised the extent of the knowledge and skills they acquired from the lectures. Assessment, a topic identified by the participants for upskilling, and social mathematics were the two key areas in which expertise was acquired. The participants acquired knowledge on evidence based strategies for teaching number to pupils with SEN, increased their conceptual understanding of number and number sense and became familiar with resources including Numicon to support their teaching in number. Additional inputs in mathematics and more workshop type presentations were suggested by the participants for consideration in future CPD in this area.

5.2.3 Theme 3: Translating the learning into practice: Teaching mathematics to pupils with SEN

This theme seeks to identify the perceptions and experiences of the participants of their understandings of the transfer of their learning to the classroom following their participation in the lectures in mathematics on the PGDSEN programme programme. Findings at baseline level will focus on participant perceptions. Similar to themes 1 and 2, the data were collected during the course of the Academic Year 2012/13. The lecture on Social mathematics for pupils with SEN provided a core context for the baseline findings. Findings from the evaluations undertaken at the end of the ten lectures on mathematics relating to the transfer of participant learning to the classroom will also be presented.

5.2.3.1 Social mathematics

The **Social mathematics** lecture (21/2/2013) focused on evidence based strategies for teaching money, time, length, weight and capacity to pupils with SEN, key components of a programme in social mathematics (National Council for Curriculum and Assessment, 2007). The participants' individual written responses (n = 24) to the question, *How will this lecture influence my teaching of mathematics to pupils with SEN*? (Appendix R) provided the data for this section. The responses indicated the new knowledge and skills acquired by the participants and also suggested how they anticipated teaching Social mathematics to pupils with SEN on their return to their classrooms.

Participants learned that “*teaching time is critical as a life skill”* (T18S64) and that it is “*an essential focus in the maths programme”* (T24S93). They noted that “*when teaching time start with a clock with one hand”* (T19S69) and that it was beneficial to “*use a real clock”* (T9S29). To aid the understanding of the concept of the *“passing of time”* (T4S14) or “*time moving on”* (T22S82), it would be necessary to “*relate time to real-life situations e.g. brushing teeth = one minute”* (T17S59) and to encourage pupils “*to create their own visual of this”* (T4S14).

Horstmeier’s (2004) evidence based strategy for teaching the identification of notes and coins to pupils with Down syndrome (DS) suggests teaching pupils with SEN to identify notes before the recognition of coins. The participants readily empathised with this approach and made several references to Horstmeier’s (2004) strategy that “*pupils with SEN will benefit from working with notes first rather than with coins”* (T16S52) in their evaluations. One participant stated “*I will definitely adapt my teaching of money to start with notes”* (T24S87) and “*It's a relief to know that calculating change is not a vital skill”* (T24S88).

Participants also empathised with the Dollar First Strategy (Gurganus, 2007; Snell & Brown, 2000; Westling & Fox, 2009), an evidence based strategy to support the purchase of items by pupils even when they do not understand the value of coins or notes. Over half of the participants referred specifically to the Dollar First Strategy in their responses – “*Dollar first strategy. I'd like to try it”* (T2S4), and “*I will definitely adapt my teaching of money … and use the Dollar First Strategy”* (T24S87). Entries in the Reflective diary (21/02/2012) refer to the enthusiastic response of the participants to the Dollar First Approach. The participants “*had never heard of this before”* and there was a “*palatable sense of relief in the room”* that the Dollar First Approach represented a realistic strategy to support pupils with SEN to purchase items independently.

A recommendation made by the National Council for Curriculum and Assessment (2007) that social maths be prioritised was referred to as participants acknowledged that this element of the curriculum *“needs to be taught as a priority to children with special needs”* (T11S34). One participant stated that she had learned to “*teach what matters”* (T10S31) while another noted that following this lecture she would *“redefine priority learning needs and look at essential skills for life”* (T14S42).

The findings suggest that the participants had acquired new knowledge and skills to teach social mathematics to pupils with SEN which they intended on implementing in their classrooms following completion of the PGDSEN programme.

5.2.3.2 Participants perceptions on changes to classroom practice

When asked to identfiy the lectures which had the greatest influence on their teaching of maths to pupils with SEN, the areas of assessment (n = 14) and social maths (n = 10) were noted most frequently by participants. The lectures also influenced participants with regard to their planning to teach mathematics to pupils with SEN (n = 6) and on their understanding of Dyscalculia and mathematical learning difficulties (n = 5).

The lecture input on assessment afforded the participants the opportunity to become "*familiar with some assessments in maths which could help identify areas of specificy difficulty for individual pupils with SEN*" (T24E645) and gave participants the "…*confidence to assess mathematical needs"* (T2E63) to "*find out what they (the pupils) know (assessment) and build on this"* (T32E667). One participant stated that she would *"spend more time on assessment"* (T13E625) and would *"now be able to follow a set plan of assessning, intervention, strategy and evaluating using all research based methods"* (T30E659).

It was aparent that the lectures enabled the participants to reflect on their personal understandings of mathematical difficulties and their responses to this. The lectures enabled participants to understand *"why children have difficulties with maths"* (T9E615) and increased their *"awareness of dyscaclulia*" (T15E628). This understanding has implications for teaching maths to pupils with SEN and participants spoke of "*making maths more visual"* (T26E651) and of *"finding ways to transfer the skills to everyday living"* (T7E613). Participants generally agreed that their "*teaching of maths to pupils with SEN has totally changed since doing the course"* (T10E619) as they felt "*more knowledgable"* (T3E65) and "l*ooked forward to implementing principles and ideas"* (T4E66). They commented on the value of the lectures and on the contribution they would make to their future teaching of mathematics to pupils with SEN – *"this is an area in which I had previously received little CPD. Therefore I gained a lot from the series of lectures"* (T22E163).

The vast majority of the participants either agreed or strongly agreed that their CPD in mathematics would influence pupil attainment levels in mathematics in their schools (Figure 5.6). This finding suggests that increased participant knowledge and confidence in this area would have a positive impact on pupil attainment levels. A participant stated "*I feel more informed about how to tackle maths and hope for better outcomes as a result"* (T5E73). Another participant stated that she felt "*more knowledgeable about the areas to be concerned with"* (T7E75).

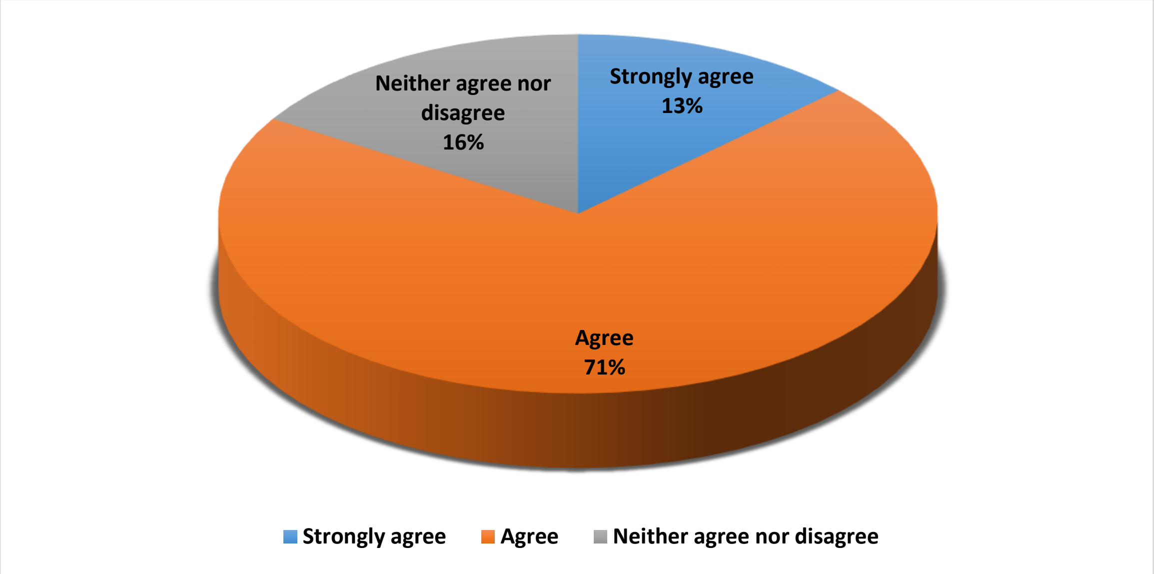

Figure 5.6 "The CPD I have received on teaching mathematics to pupils with SEN will influence pupil achievement levels in mathematics in my school"

5.2.3.3 Summary

This section has explored participant perspectives on the influence of the mathematics lectures on their practice. The findings suggest that the participants have gained content and pedagogical knowledge which they feel will inform their future teaching. In addition to gaining in knowledge, the lectures have influenced participant attitudes and motivation to mathematics itself – *"These lectures, ideas etc. have reduced my own maths anxiety. I am actually looking forward to approaching maths now"* (T5KC6).

5.2.4 Baseline phase: Summary of findings

The baseline phase has provided the contextual data for the research study *Examining special education teacher learning in mathematics.* Presented under three themes, Inclusive and special education: Policy and provision, Continuing professional development and Translating the learning into practice: Teaching mathematics to pupils with SEN, the data were collected throughout the period of participant engagement with the PGDSEN programme, the Academic Year 2012/13. The findings provided insights into the teaching of mathematics in the participants' schools, on the prior knowledge of the participants, on the knowledge and skills acquired through their participation in the PGDSEN programme and on their perceptions of the transfer of their new knowledge on teaching mathematics to pupils with SEN to their classroom practice.

The first theme, Inclusive and special education: Policy and provision referred to influences on the teaching of mathematics such as national policies initiatives including the National Literacy and Numeracy Strategy (Department of Education and Skills, 2011f) and the SSE process (Inspectorate, 2012). Influences within the school such as the lack of relevant assessment measures, time for planning and class teacher expectations were briefly discussed and will be developed in the further phases of the research study.

The second theme, Continuing Professional Development, focused on the identification of the existing base level knowledge of the participants and on the new skills and knowledge they acquired with a particular focus on Number. The participants were aware of the necessity of providing their pupils with a solid foundation in number and of the importance of teaching number within a real life context. They had prior knowledge of Maths Trails. Assessment of attainment levels in mathematics and evidence based strategies for teaching number were identified by the participants as areas for upskilling. The findings suggest that the participants' knowledge base on number was enhanced and developed through their participation in the mathematics lectures on the PGDSEN programme. They acquired an in-depth knowledge on the barriers to learning mathematics, including Dyscalculia, experienced by pupils with SEN. Pedagogic knowledge in relation to the teaching of number using evidence based practices and other areas including time and money for example was acquired by the participants. Participants indicated that they would like more time to be devoted to mathematics on the PGDSEN programme and also indicated their preference for more workshop type lectures. The lecture on assessment was identified as being of most relevant to the needs of the participants.

The third theme, Translating the learning into practice: Teaching mathematics to pupils with SEN, focused on the perceptions of the participants on the expected transfer of their learning to their classroom practice on their return to their classrooms. A lecture on Social mathematics provided the focus for this theme at the baseline data phase. Participants acquired knowledge of evidence based strategies to support the teaching of time and money to pupils with SEN (Horstmeier, 2004; Westling & Fox, 2009). Participants stated that they would adapt their teaching to prioritise the teaching of social mathematics using evidence based strategies. Assessment, an area which had been highlighted for additional professional development, was identified by the participants as the area that would have the greatest influence on their teaching. The participants gained both content and pedagogical knowledge on the assessment of pupils experiencing difficulties in mathematics. Overall, the participants were in agreement that the changes in their teaching practices resulting from their participation on the PGDSEN programme would result in an increase in pupil attainment levels in mathematics in their schools.

The next phase, Phase 1 will present the findings from Cohort 1 and will provide an insight into the mathematics anxiety levels, mathematics teaching efficacy beliefs, content and pedagogical content knowledge in whole number/computation and the sentiments, attitudes and concerns about inclusive education of this cohort of participants.

5.3 Findings: Phase 1

The primary school cohort of the PGDSEN programme 2012/13 cohort (n = 34) were invited to participate in Phase 1. Fifteen participants (Cohort 1) engaged with Phase 1 of the data collection. The data were collected prior to the commencement of the PGDSEN programme lectures in mathematics (September 2012). The participants completed a contextual questionnaire (Appendix C) and four measures (MAS-UK, MTEBI, SACIE-R, DTAMS) (Appendices N, O, P, and Q). Data from Cohort 1 provided demographic information such as the participants education background, teaching position, teaching experience, gender, age group and details of CPD undertaken by them in the three years preceding this study. Data from the four measures yielded information on their mathematics anxiety levels, their sentiments when engaging with people with disabilities, their acceptance of learners with different needs, their concerns about implementing inclusion, their mathematics teaching efficacy beliefs and a measure of their content and pedagogical content knowledge in relation to whole number and computation. It was anticipated that the data would provide a rich description of the Cohort 1 participants thereby providing insights into individual and contextual factors relating to their learning how to teach mathematics to pupils with SEN prior to their commencement of the PGDSEN programme. The demographic information and the findings from the four measures (MAS-UK, MTEBI, SACIE-R, DTAMS) will be presented.

5.3.1 Overview of data set (Cohort 1, Phase 1)

The fifteen female participants taught pupils with SEN (Cohort 1). One participant taught in a special school, one taught a special class in a mainstream school and the remaining participants held either LS, RT posts or LS/RT posts in mainstream primary schools (Table 5.3)

Table 5.3 Teaching Positions (Cohort 1, Phase 2)

Teaching Post	N
LS/RT	9
RT	3
LS	1
Special Class	1
Special School (MGLD)	1

The Phase 1 participants were experienced teachers. All the participants were in teaching positions for more than five years and the majority for more than ten years. However, they were relatively less experienced in special education with the majority holding teaching positions for less than five years (Figure 5.7).

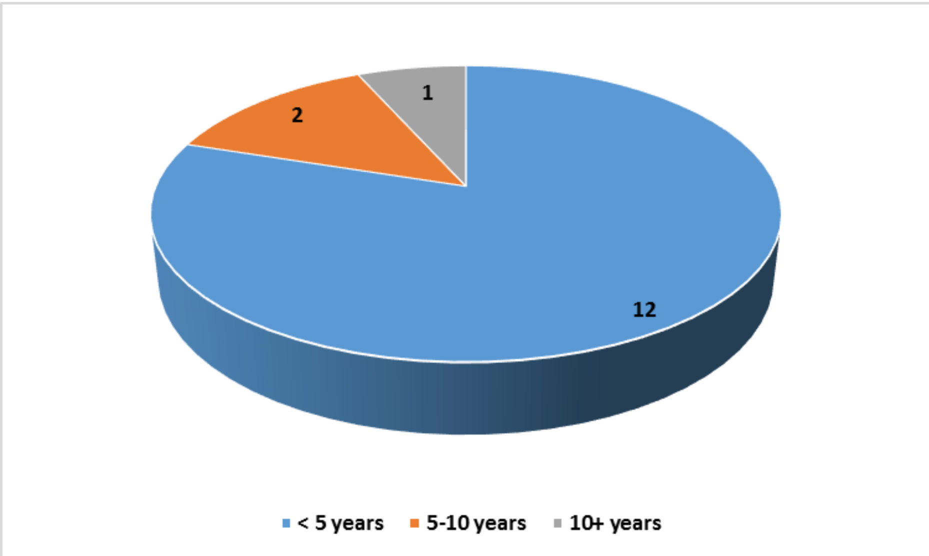

Figure 5.7 Participants' teaching experience in special education

The participants had high levels of competence in mathematics themselves with over half of the cohort achieving A grades in either ordinary or higher level papers in their Leaving Certificate mathematics examinations. The participants were actively involved in CPD and the majority had participated in courses offered by the SESS, the INTO, NEPS in the three years prior to their participation in the PGDSEN programme. Three participants stated that they had participated in courses such as Mata sa Rang and Maths Recovery, programmes designed to support learners with additional needs in mathematics. Four participants held qualifications at Master degree level.

5.3.2 Sentiments, Attitudes and Concerns about Inclusive Education (SACIE-R)

All fifteen participants completed the Sentiments, Attitudes and Concerns about Inclusive Education Revised Scale (SACIE-R) (Forlin et al., 2011) (Appendix P), at the commencement of the PGDSEN programme. This 15 item internationally validated scale (Forlin et al., 2011) measured the perceptions of the participants on the following constructs in relation to inclusive education:

- *Sentiments* or comfort levels when engaging with people with disabilities
- Acceptance of learners with different needs *(Attitude)*
- *Concerns* about implementing inclusive practices

The mean and standard deviation for each of the three subsets (Sentiments, attitudes, concerns) together with the overall scores are presented in Table 5.4. The mean scores are presented in Figure 5.8.

Table 5.4 SACIE-R Scores (Phase 1, Cohort 1)

SACIE-R	N	Mean	(SD)
Total	15	2.66	(0.80)
Sentiments	15	2.91	(0.90)
Attitudes	15	2.91	(0.44)
Concerns	15	2.17	(0.74)

The SACIE-R overall mean response for the three subscales was 2.66 (SD 0.80, Mode 3). This indicates that the participants were generally positive about interacting with people with disabilities (M = 2.91, SD = 0.9) and in their attitudes towards including pupils with disabilities in their classrooms (M = 2.91, SD = 0.44). However, they were less positive about inclusive education (M = 2.17, SD = 0.74) and had concerns about their role in inclusive classrooms.

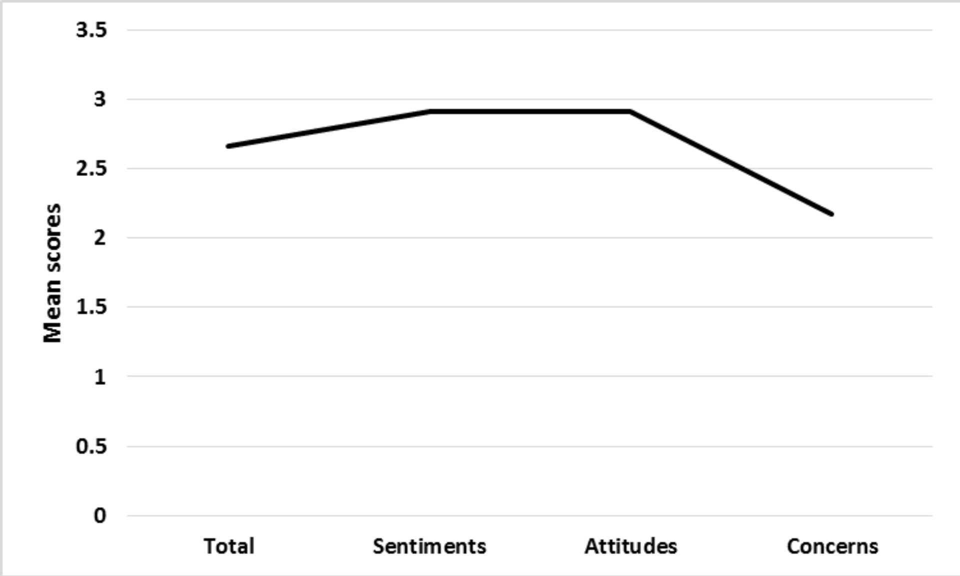

Figure 5.8 SACIE-R – Subscale mean scores (Cohort 1, Phase 1)

The participants were very positive in their *sentiments* relating to their interactions with people with disabilities with mean scores of 3.5 (Item 11) and 3.2 (Item 13). The participants *attitudes* to pupils who have additional learning needs in inclusive settings was very positive (M = 2.91, SD = 0.44) and the majority of participants agreed that pupils with additional needs should be included in mainstream classrooms. The findings indicate that participants have *concerns* about inclusive education (M = 2.17, SD = 0.74. Fourteen out of the fifteen participants agreed that they were concerned about the difficulties of giving appropriate attention to all pupils in the classroom (M = 1.73, SD = 0.60 while most were also in agreement about increases in their personal stress levels arising from the inclusion of pupils with disabilities in their classes (M = 2.13, SD = 0.83). Eleven of the fifteen participants in this study agreed that they were concerned about increases in their workload arising from the inclusion of pupils with disabilities (M = 2.1, SD = 0.83). Nine participants expressed their concerns about their lack knowledge and skills for teaching pupils with disabilities (M = 2.33, SD 0.62).

5.3.2.1 Summary of SACIE-R findings

The SACIE-R measure indicated that the Cohort 1 participants of Phase 1 of the data were favourably disposed to communicating and interacting with people with disabilities, were receptive to the inclusion of pupils with SEN in mainstream schools but had concerns about aspects of inclusion relating to their own skills and knowledge in this area, the resulting increase in their workload and of the acceptance of pupils with SEN by their peers in the classroom.

5.3.3 Mathematics Teaching Efficacy Beliefs Instrument (MTEBI)

The Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) (Enochs et al., 2000) is an established, validated instrument designed to measure the mathematics teaching efficacy beliefs of preservice elementary teachers (Can et al., 2012; Enochs et al., 2000) and of in-service teachers following their participation in mathematics programmes (Kuchey et al., 2009). It consists of two subscales, the Personal Mathematics Teacher Efficacy (PMTE) scale. The PMTE scale is a measure of the personal belief of teachers of their ability to teach mathematics successfully. The second scale, the Mathematics Teaching Outcome Expectancy (MTOE) scale, is a measure of the teachers belief that their teaching will impact positively on the ability of their pupils to learn mathematics (Enochs et al., 2000).

The MTEBI (Appendix O) was completed by the fifteen teachers in Phase 1 (Cohort 1) at the commencement of the PGDSEN programme to identify their mathematics teaching efficacy beliefs. The overall MTEBI scores are presented in Table 5.5. Scores for the PMTE scale fell between 19 and 61 which is within the expected range of 13 to 65 (Enochs et al., 2000). However, there was one outlier, scoring at 19. The remaining scores fell between 35 and 61. Scores for the MTOE scale fell between 21 and 34 which is within the expected range of 8 to 40. Table 5.5 presents the overall MTEBI scores for Cohort 1. Figure 5.9 presents the mean scores for each of the two subscales.

Table 5.5 MTEBI Overall Scores (Phase 1, Cohort 1)

Subscale	N	Mean Rating	Standard deviation	Mode	Overall mean	Overall standard deviation
PMTE	15	3.54	1.01	4	46.33	9.71
MTOE	15	3.34	0.78	4	26.73	3.03
Combined subscales	15	3.48	0.94	4		

The findings indicate that the participants believe that they are effective teachers of mathematics. They have a slightly stronger belief in their own ability to teach maths successfully (M = 3.54, SD 1.01) than in their belief that their teaching will result in pupil learning (M = 3.34, SD 0.78). Given that the highest achievable score on the PMTE subscale is 65, the mean and standard deviation scores in this subscale indicates the strong confidence of the participants in their personal teaching abilities (M = 46.33, SD = 9.71). The highest achievable score on the MTOE subscale is 40.The overall mean revealed a consensus in the participants' views of the impact of their teaching and provided an indication that although they believed in the positive impacts, they were less confident of this (M = 26.73, SD = 3.03).

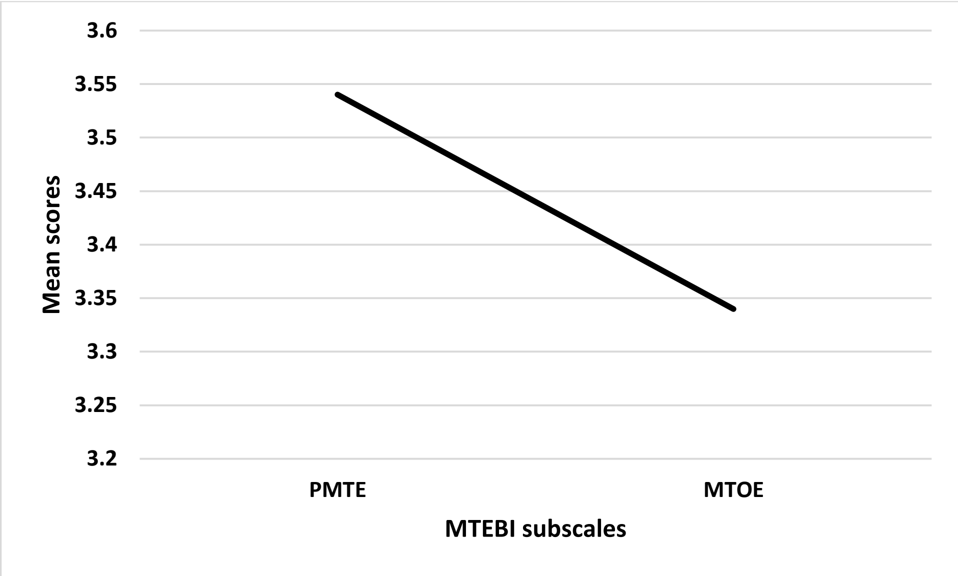

Figure 5.9 MTEBI subscale mean scores (Cohort 1, Phase 1)

The thirteen PMTE variables provide an insight into the personal beliefs of the participants to teach effectively. All of the scale variables are of particular interest to this study. The findings indicate that the participants believe that they can teach mathematics successfully (mean scores ranging from 2.8 to 4). The participants are positively disposed towards applying new approaches in their teaching of mathematics with twelve of the fifteen participants agreeing that they continually find new ways of teaching mathematics (M = 4, SD = 1.07). The data suggests that the participants are confident in their ability to understand concepts in mathematics in order to teach mathematics effectively with eleven of the fifteen participants in agreement on this variable (M = 3.8, SD = 0.78) and similarly, eleven participants agreed that they were able to help their pupils having difficulties understanding such concepts (M = 3.5, SD = 0.99). Participants agreed that they did not have difficulties using manipulatives when teaching mathematics (M = 3.6, SD = 0.82).

The eight MTOE subscale variables provide an insight into the beliefs of the participants on the impact of their teaching. The participants possess similar views on the potential outcomes of their teaching with means ranging from 3.07 to 3.6 and standard deviations ranging from 0.63 to 0.92 indicating their uncertainty with regard to the outcomes of their teaching in mathematics.

The variable with the highest scoring mean in this subscale relates to the relationship between teaching and pupil progress (Item 10, M = 3.6, SD = 0.63) with ten of the fifteen participants agreeing that the progress of low-achieving pupils in mathematics was usually due to extra attention given by the teacher. Ten of the fifteen participants also agreed that good teaching could overcome the inadequacy of a pupil's background (Item 9, M = 3.53, SD = 0.64) and that the teacher is generally responsible for the achievement of pupils in mathematics (Item 12, M = 3.47, SD = 0.92). Participants were not as confident that pupil achievement in mathematics was directly related to the effectiveness of their teaching (Item 13, M = 3.27, SD = 0.8) with seven of the fifteen participants agreeing that there was a link and the remaining eight either uncertain or disagreeing. The finding of this variable was similar to that of Item 1 which also linked pupil performance to teaching (M = 3.07, SD = 0.88) with four participants agreeing that there was a link and the remaining eleven either uncertain or in disagreement.

Therefore it may be concluded that while this study presents evidence to suggest that the participants acknowledge the impact of their teaching on pupil performance in mathematics, it is possible that variables other than teacher performance impact on pupil achievement.

5.3.3.1 Summary of MTEBI findings

The MTEBI instrument sought to measure the mathematics teaching efficacy of the participants. The overall findings indicate that the participants have high personal beliefs in their ability to teach successfully and believe that their teaching will have a positive impact on the ability of their pupils to learn.

5.3.4 Diagnostic Teacher Assessment in Mathematics and Science (DTAMS)

The DTAMS assessments are validated measures of content and pedagogical knowledge in science and mathematics providing benchmarks of participants' knowledge and growth (CRiMSTeD, 2016a; Saderholm et al., 2010) during pre-service and in-service professional development (Copur-Gencturk & Lubienski, 2013; Lim & Guerra, 2013). The DTAMS (Whole number/computation) assessment for elementary participants in mathematics is the focus of this research study.

Mean scores and standard deviations for each of the four knowledge types including the overall score for the whole number/computation subsection are presented in Table 5.6 for the twelve Phase 1 participants who completed the DTAMS. There was one outlier who achieved the maximum score in each of the knowledge type subsets.

Table 5.6 DTAMS Scores (Cohort 1, Phase 1)

DTAMS	N	Mean	Percentage %	Standard Deviation
Overall*	12	24.75	61.87	7.74
I. Memorised, factual knowledge	12	7.58	75.8	1.88
II. Conceptual understanding	12	7.33	73.3	1.72
III. Problem solving, reasoning	12	4.92	49.2	2.71
IV. Pedagogical content knowledge	12	4.92	49.2	2.5

Note: * whole number/computation subsection

The overall DTAMS (whole number/computation subsection) indicate the considerable variation that exists in the content and pedagogical knowledge of this cohort of PGDSEN programme participants in this area (Figure 5.10). The raw scores out of a possible 40 marks range from 13 to 40 (SD 7.74) with one participant achieving the maximum score and four of the twelve participants scoring 20 marks or less. The findings suggest that there is potential to develop the content and pedagogical knowledge of the participants in whole number and computation.

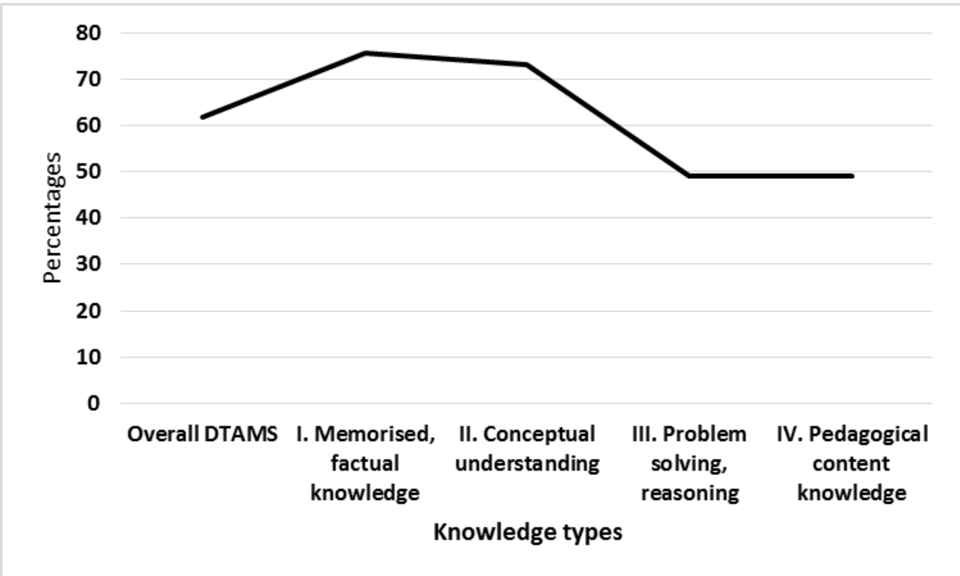

Figure 5.10 DTAMS Mean scores (Cohort 1, Phase 1)

The mean scores of the four knowledge types in the whole number/computation subsection of the DTAMS measure indicate the all of the participants have strengths in the areas of memorised knowledge (M = 7.58, SD = 1.88) with all participants achieving 50% or more of the available score (Figure 5.10). The participants therefore have successfully acquired mathematical knowledge of definitions, procedures and rules through rote learning and memorisation (CRiMSTeD, 2016b) and can apply their learning to “rotely perform skills, apply rules and give definitions” (CRiMSTeD, 2016b). Scores for the conceptual understanding knowledge subset indicates strengths in this area also (M = 7.33, SD = 1.72). Similarly all participants achieved 50% or more of the available score. Strengths in the conceptual understanding knowledge subset indicates the depth of the participants’ mathematical knowledge in their “understanding of mathematical concepts, procedures, laws, principles and rules” (CRiMSTeD, 2016b).

The mean scores for the third and fourth knowledge types, problem solving/reasoning and pedagogical content knowledge have identical mean scores of 4.91 and standard deviations of 2.71 and 2.50 respectfully. As is evident from Figure 5.10, the participants are less skilled in these areas relative to the previous two knowledge subsets. The standard deviation for the problem solving/reasoning subset indicated the considerable variation in the scores achieved by the participants with raw scores ranging from 0 to the maximum score of 10. Seven of the twelve participants achieved scores of 50% or less in problem solving/reasoning. Although the mean for the pedagogical content knowledge was identical to that of problem solving/reasoning, a slightly lower standard deviation of 2.50 was achieved. None the less, seven participants scored 50% or less in this subset also.

5.3.4.1 Summary of DTAMS

The findings of the whole number/computation section of the DTAMS for elementary participants suggests that there is both scope to further increase participant content and pedagogical knowledge and that considerable variation exists in the strengths of this cohort of participants in this area of mathematics. The findings also suggest that all of the participants have strengths in the memorised knowledge and conceptual understanding areas of whole number and computation. However, a notable finding of this research was the low performance of the participants in the problem solving/reasoning and pedagogical content knowledge assessments. These two knowledge subsets present as areas for development.

5.3.5 Mathematics Anxiety Scale-UK (MAS-UK)

The Mathematics Anxiety Scale-UK (MAS-UK) (Appendix N) is a reliable and validated measure of mathematics anxiety (Hunt et al., 2011) and is a valid means of measuring mathematics anxiety levels in adults (Hunt et al., 2015) . Descriptive statistics for the MAS-UK scale are presented in Table 5.7. Figure 5.11 presents the mean scores. The findings suggest that this cohort of participants do not experience mathematics anxiety (M = 1.85, SD = 1.04).

Table 5.7 MAS-UK Scores (Cohort 1, Phase 1)

Mathematics Anxiety Scale-UK	N	Mean	Mode	Standard deviation
Overall mathematics anxiety	7	1.58	1	0.67
Mathematics observation anxiety	7	1.36	1	0.58
Everyday/social mathematics anxiety	7	1.49	1	0.57
Mathematics evaluation anxiety	7	1.81	2	0.74

Further analysis of the three subsections suggests that the participants felt most anxious in mathematics situations where they were examined or tested (Maths evaluation anxiety subset: M = 2.09, SD = 1.26) with the variables relating to mathematics tests (Items 6 & 18) yielding the highest mean scores in this subsection (M = 3.06 SD = 1.22, M = 3.2 SD = 1.21). These mean scores indicate that the participants experienced “a fair amount” of anxiety on these test items. Being given a telephone number that they had to remember was the variable in the social mathematics subset that caused participants to be most anxious (M = 2.53, SD = 1.06). Mathematical situations such as adding a pile of change (Item 2 M = 1.45, SD = 0.83) or working out how much your shopping bill is (Item 22 M = 1.6, SD = 0.91) did not cause anxiety. The mathematics observation anxiety subset caused the participants the least amount of stress.

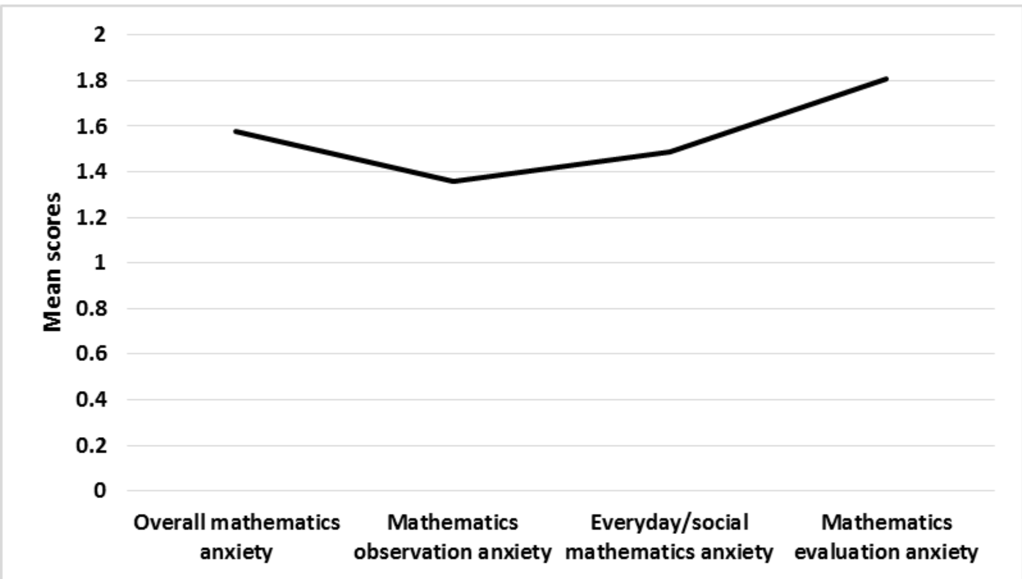

Figure 5.11 MAS-UK scores (Cohort 1, Phase 1)

5.3.5.1 Summary of MAS-UK

The findings of this instrument clearly indicate that the participants do not experience anxiety in mathematics (M = 1.85, SD = 1.04). An analysis of the three subscales of this instrument indicated that the participants found the mathematics evaluation items most stressful.

5.3.6 Phase 1: Summary of findings

The Phase 1 data set has provided a measure of individual teacher factors influencing the acquisition of skills and knowledge on the teaching of mathematics to pupils with SEN. Findings from this research study provided an insight into the sentiments, attitudes and concerns of the Cohort 1 participants about inclusion, their mathematics teaching efficacy beliefs, their content and pedagogical content knowledge in whole number and their mathematics anxiety levels.

The fifteen Cohort 1 participants were experienced teachers with the majority having more than ten years teaching experience. The participants were less experienced in special education with most having less than five years special education teaching experience. They had high personal standards in mathematics and were active participants in CPD programmes. Three of the fifteen participants had undertaken CPD in the *Maths Recovery* and *Mata sa Rang* programmes, initiatives designed to support learners with additional needs in mathematics. Four of the participants held post graduate qualifications at master's level.

While the Cohort 1 participants expressed positive attitudes towards the inclusion of pupils with additional learning needs in schools, they were however concerned about their role as educators in inclusive settings. A common concern amongst the participants was their lack of knowledge and skills for teaching pupils with SEN and the likelihood of their increased workloads arising from the inclusion of pupils with SEN. Although the participants expressed concern over their efficacy as special education teachers, the findings clearly indicate that they had high personal beliefs in their ability to teach mathematics successfully and believed that their teaching would have a positive impact on the ability of their pupils to learn. The participants did not experience anxiety in mathematics. There was considerable variation amongst the Cohort 1 participants in their content and pedagogical knowledge in whole number/computation. While all participants had strengths in the memorised knowledge and conceptual understanding areas of whole number/computation, the findings clearly indicate that there is scope to develop their problem solving and reasoning skills in addition to their pedagogical content knowledge in whole number/computation.

5.4 Findings: Phase 2

This section presents the findings of Phase 2 of the research study. This phase sought to examine the individual and contextual factors which influenced the participants' acquisition of knowledge and skills in mathematics, to identify their perceptions and experiences of the influence of the mathematics lectures on the PGDSEN programme on their acquisition of knowledge and skills in mathematics and to identify their understandings of the transfer of their learning to their practice.

Demographic information for both Cohorts 1 and 2 will be presented. The sentiments, attitudes and concerns of the Cohort 2 participants towards inclusive education, their mathematics teaching efficacy beliefs and their mathematics anxiety levels will be outlined and discussed. Three themes - Inclusive and special education: Policy and provision; Continuing professional development and Translating the learning into practice: Teaching mathematics to pupils with SEN provide the framework for the presentation of the key Phase 2 findings.

5.4.1 Overview of data set (Cohort 1 and Cohort 2, Phase 2)

Phase 2 (n = 15) comprised of two Cohorts, Cohort 1 (n = 8) and Cohort 2 (n = 7) (Table 4.2). While both cohorts had participated in the baseline phase, Cohort 1 also participated in Phase 1. Upon rejoining the research at Phase 2, Cohort 2 participants completed three measures (MAS-UK, MTEBI, SACIE-R) (Appendices N, O, P). All Phase 2 participants (Cohort 1 and Cohort 2) completed background questionnaires (Appendix W) and participated in an interview (Appendix AA). Data collection for this phase took place at the end of the first school year following the completion of the PGDSEN programme (May/June 2014).

5.4.1.1 Cohort 1

All eight Cohort 1 participants held permanent posts in their schools. Two participants taught in the same school. Teaching experiences of the participants ranged from eight years to thirty four years and experience in special education ranged from two to nine years. The participants teaching positions are outlined in Table 5.8.

Table 5.8 Teaching Positions (Cohort 1, Phase 2)

Teaching Post	N
LS/RT	2
RT	3
LS	1
Special Class	1
Mainstream Class	1

Six of the eight participants were in the 30-39 age bracket. The remaining two were aged between 40 and 59. Two of the eight participants held Master of Education degree and one held a Master’s Degree in ICT. There were six primary schools and one special school in Cohort 1.

Profiles of the seven schools are presented in Table 5.9. Two of the schools had a significant number of pupils for whom English was an additional language (EAL) (P6 & P7, P11). One participant stated that *“about one third of our population is EAL at this stage*” (P11). About 20% of the pupils in the second school were also described as EAL pupils. This school had a diverse pupil population representing twenty eight different nationalities (P6 & P7).

Table 5.9 Profile of Schools (Cohort 1, Phase 2)

Participant	Pupil enrolment	Teaching staff	LS/RT		EAL teacher	SNA
			FT	PT		
P2	270	14	3	-		1 (FT)
P6 and P7	485	27	7(1Shared)	-	1	
P11	225	14	3(1Shared)	-	1	2 (FT)
P14	180	7	2	2	-	1 (PT)
P17	279	14	3(2 Shared)	-	-	3 (FT)
P23	104	6	2	-	-	-
P25	180	22	-		-	44

Five of the participants had caseloads ranging from eight to eighteen pupils. One participant had fifty pupils on her learning support caseload, one had a special class with eleven pupils and one participant had a mainstream class of junior and senior infants. While the withdrawal model of support was the predominant model for the participants, (excepting the two with whole classes), three participants were engaging with co-teaching approaches such as *Aistear* and in early intervention programmes in literacy and maths. One participant (mainstream class teacher) completed the interview but did not complete the questionnaire.

5.4.1.2 Cohort 2

All seven of the Cohort 2 participants held permanent posts in their schools. They had teaching experiences ranging from seven years to thirty two years. Four of the seven participants were relatively inexperienced in special education and had been in these posts for less than three years. Three of the seven participants had experience in special education ranging from ten to twelve years. Their teaching positions are outlined in Table 5.10. Two of the seven participants were in the 20-29 age bracket, two in the 30-39 age bracket and the other three were aged between 40 and 59. None of the participants held Master's Degrees. The participants had caseloads ranging from eight to thirty four pupils which included one mainstream first and second class and a special class. Three participants were engaging with co-teaching approaches such as Aistear and in early intervention programmes in literacy and maths. All of the participants (excepting the two class participants) were withdrawing pupils from their classes.

Table 5.10 Participants Teaching Positions (Cohort 2, Phase 2)

Teaching Post	N
LS/RT	3
RT	0
LS	2
Special Class	1
Mainstream and LS	1

The Cohort 2 participants taught in seven primary schools ranging in size from five participants to thirty nine participants. A profile of each school is presented in Table 5.11**.**

Table 5.11 Profile of Schools (Cohort 2, Phase 2)

Participant	Pupil enrolment	Teaching staff	LS/RT		EAL participant	SNA
			FT	PT		
P9	720	39	12	-	-	6 (FT)
P10	146	12	4	-	1	3 (FT)
P15	110	12	4	2	2	3 (FT)
P18	87	5	2 (Shared)	-	-	1 (FT)
P21	116	7	1	1	-	1 (FT)
P22	92	5	1	1	-	2 (PT)
P28	289	19	2	-	1 (Shared)	9 (FT)

Two of the Cohort 2 schools had significant enrolments of pupils for whom English was an additional language (P10, P15). One of the two schools also had a high incidence of SEN and was supported by a resource teacher allocation of 95 hours for its enrolment of 110 pupils. Enrolments in both schools had dropped significantly in recent years. Both schools had DEIS (Band 2) status.

The largest school in Cohort 2 had a team of twelve teachers supporting pupils with additional learning needs. Two teachers in the school were described as "floating teachers" and had been released from classroom duties to support the development of literacy and numeracy initiatives within the school. They had received CPD for example in programmes such as *Thinking in Maths* and *Attainment in Maths*. They shared their expertise in the school and "*now the participants would be doing the strategies themselves"* (P9) and implementing the programmes independently. One of the participants taught in a special class for pupils with ModGLD in a mainstream school. This school also had an ASD unit with three classes for pupils with ASD. The nine pupils in her class had multiple disabilities and were aged between 6 and 12 years old.

The data set of the Phase 2 schools were representative of schools of all sizes in Ireland. Two of the schools in the sample had pupil enrolments of less than 100 pupils. There were six schools with pupil enrolments of between 100 and 200 and six schools with enrolments greater than 200. The special school in the sample with an enrolment of 180 pupils was considered to be one of the bigger schools of this type in Ireland. The schools were also representative of the urban/rural divide with three of the fourteen schools located in rural settings.

5.4.2 Sentiments, Attitudes and Concerns about Inclusive Education Revised Scale (SACIE-R)

The SACIE-R (Forlin et al., 2011) (Appendix P), was completed by the seven Cohort 2 participants in Phase 2 of the data collection phase. A descriptive data analysis with the support of EXCEL was conducted. Table 5.12 presents the mean and standard deviation for each of the three subsets (Sentiments, Attitudes, Concerns) together with the overall scores for the Phase 2 participants. The mean scores are presented in Figure 5.12.

Table 5.12 SACIE-R Scores (Cohort 2, Phase 2)

SACIE-R	N	Mean	(SD)
Total	7	2.81	(0.70)
Sentiments	7	3.11	(0.80)
Attitudes	7	2.91	(0.28)
Concerns	7	2.40	(0.60)

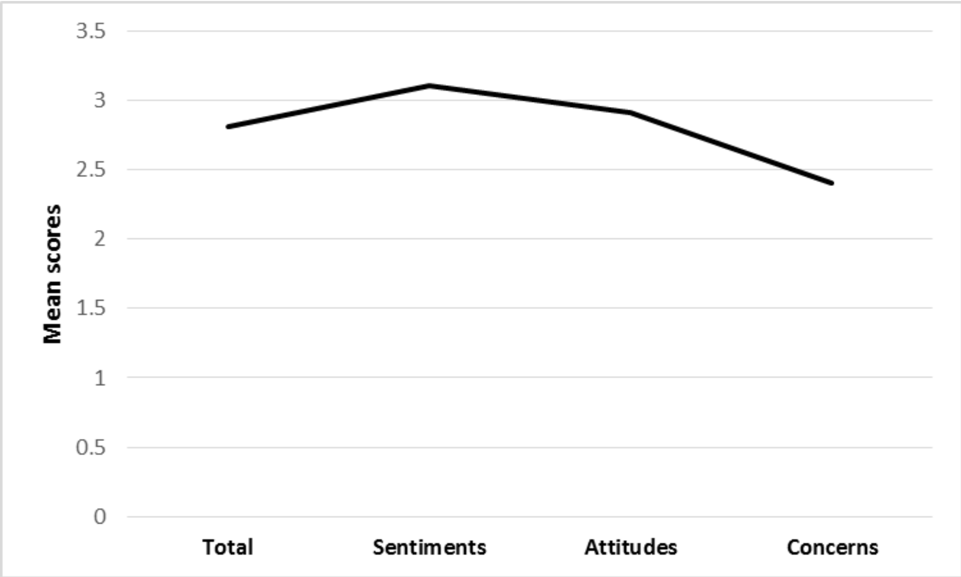

Figure 5.12 SACIE-R – Mean scores (Cohort 2, Phase 2)

The SACIE-R overall mean response for the three subscales was 2.81 (SD 0.70). The findings indicate that the participants had positive sentiments towards their interactions with people with disabilities (M = 3.11, SD = 0.80) and in their attitudes towards including pupils with disabilities in their classrooms (M = 2.91, SD = 0.28). However, they were less positive about inclusive education (M = 2.40, SD = 0.60) and had concerns about their role in inclusive classrooms. While the variance for each subscale was low, the relatively small variance in the attitudes subscale indicates the consensus of the participants in their positive attitudes towards including pupils with disabilities in their classrooms.

The participants were in agreement in their positive *sentiments* relating to their interactions with people with disabilities (M = 3.71, SD 0.49). The participants' *attitudes* to pupils who have additional learning needs in inclusive settings was very positive (M = 2.91, SD = 0.44) and the participants are strongly united in their acceptance of pupils with additional needs in mainstream classrooms. The findings indicate that participants have concerns about inclusive education (M = 2.4, SD = 0.70). Although six of the seven participants had no concerns about their own knowledge and skills for teaching pupils with disabilities (M = 3.14, SD = 0.69) the participants agreed that they were concerned about the difficulties of giving appropriate attention to all pupils in the classroom (M = 1.71, SD = 0.49). All but one of the participants were in agreement about increases in their personal stress levels and in their workload arising from the inclusion of pupils with disabilities in their classes (M = 2.14, SD = 0.38; M = 1.71, SD = 0.49).

5.4.2.1 *Summary of SACIE-R findings*

The SACIE-R measure indicated that the Cohort 2 participants were favourably disposed to communicating and interacting with people with disabilities, were receptive to the inclusion of pupils with SEN in mainstream schools but had concerns about aspects of inclusion relating to appropriate provision for all pupils and the impact on both their workload and their stress levels in so doing.

5.4.3 Mathematics Teaching Efficacy Beliefs Instrument (MTEBI)

The MTEBI (Enochs et al., 2000) is an established, validated instrument designed to measure the mathematics teaching efficacy beliefs elementary teachers (Can et al., 2012; Enochs et al., 2000). The MTEBI (Appendix O) was completed by the seven Cohort 2 participants in Phase 2 at the end of the academic year following their completion of the PGDSEN programme. Scores for both subscales fell at the upper levels of the expected ranges. Table. 5.13 presents the mean, standard deviation and overall scores for each of the two subscales. Figure 5.13 presents the mean scores.

Table 5.13 MTEBI Scores (Cohort 2, Phase 2)

Subscale	N	Mean	Standard deviation	Mode	Overall mean rating	Overall standard deviation
PMTE	7	3.86	0.91	4	50.14	3.90
MTOE	7	3.30	0.97	4	26.43	6.70
Combined subscales	7	3.45	1.03	4		

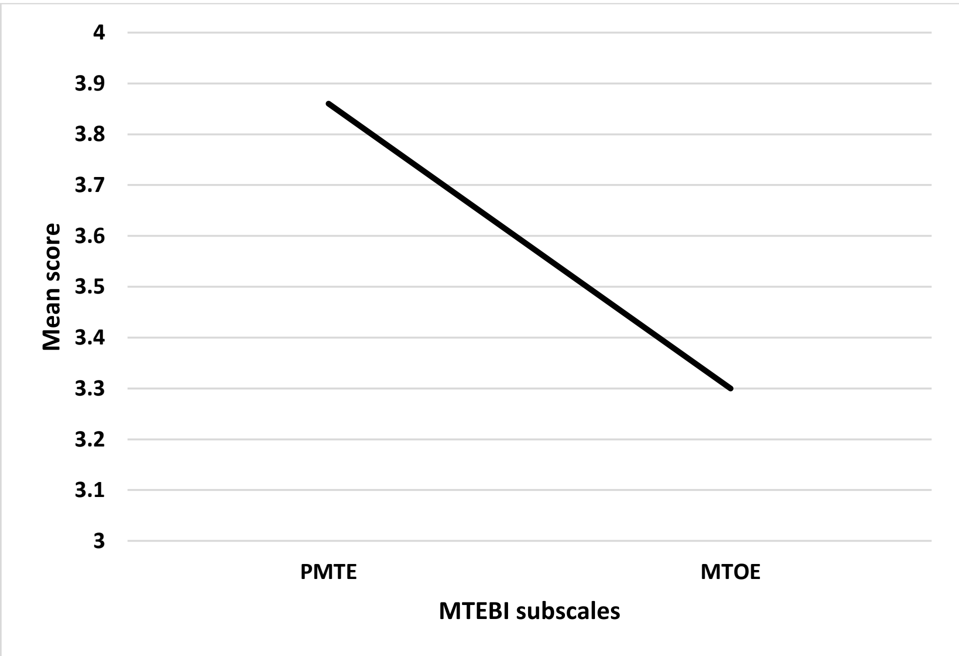

Figure 5.13 MTEBI mean scores (Cohort 2, Phase 2)

The findings indicate that the participants have a slightly stronger belief in their own ability to teach maths successfully (M = 3.86) than in their belief that their teaching will result in pupil learning (M = 3.3). Given that the highest achievable raw score on the PMTE subscale is 65, the overall mean and standard deviation scores in this subscale indicates the strong confidence of the participants in their personal teaching abilities (M=50.14, SD=3.90).

The PMTE variables provide an insight into the personal beliefs of the participants to teach effectively. All seven participants agreed that they knew how to help pupils who have difficulties understanding mathematics concepts how to understand it better (M = 4, SD = 0). There was a strong consensus amongst the participants that they are effective teachers of mathematics (M = 4.14, SD = 0.38).

The MTOE subscale variables provide an insight into the beliefs of the participants on the impact of their teaching. The participants are slightly more positive than negative of the positive impact of their teaching for their pupils. The variables with the highest scoring mean in this subscale relates to the relationship between teaching and pupil progress (M = 3.71, SD = 0.95) with five of the seven participants agreeing that good teaching can overcome inadequacies in the pupil's mathematics background and that the progress of low-achieving pupils in mathematics is usually due to the extra attention given by the teacher. The participants disagreed that underachievement in mathematics was likely to be due to ineffective mathematics teaching (M = 2.86, SD = 0.90) or that achievement in mathematics was directly related to the effectiveness of the teaching they experienced (M = 2.86, SD = 0.90). This suggests that the participants may be of the view that there are factors other than teaching which impact on pupil performance in mathematics.

5.4.3.1 Summary of MTEBI findings

The MTEBI instrument sought to measure the mathematics teaching efficacy of the participants. The overall findings indicate that the Cohort 2 participants have high personal beliefs in their ability to teach successfully. Although they believed that their teaching will have a positive impact on the ability of their pupils to learn, they were less confident of this.

5.4.4 Mathematics Anxiety Scale-UK (MAS-UK)

The Mathematics Anxiety Scale-UK (MAS-UK), a reliable and validated measure of mathematics anxiety (Hunt et al., 2011) is used to measure the mathematics anxiety of both preservice and in service participants (Hunt et al., 2015).

Findings from the Cohort 2 (n = 7) participants of Phase 2 for the MAS-UK and its three subscales are presented in Table 5.14 and graphically in Figure 5.14.

Table 5.14 Mathematics Anxiety Scale-UK: (Cohort 2, Phase 2)

Mathematics Anxiety Scale-UK	N	Mean	Mode	Standard deviation
Overall mathematics anxiety	7	1.58	1	0.67
Mathematics observation anxiety	7	1.36	1	0.58
Everyday/social mathematics anxiety	7	1.49	1	0.57
Mathematics evaluation anxiety	7	1.81	2	0.74

The findings suggest that this cohort of participants do not experience mathematics anxiety (M = 1.58, SD = 0.67). Further analysis of the three subsections suggests that the participants felt most anxious in mathematics situations where they were examined or tested (M = 1.81, SD = 0.73). This cohort of participants did not experience anxiety in the area of everyday social mathematics (M = 1.48, SD = 0.57). The mathematics observation anxiety subset caused the participants the least amount of anxiety.

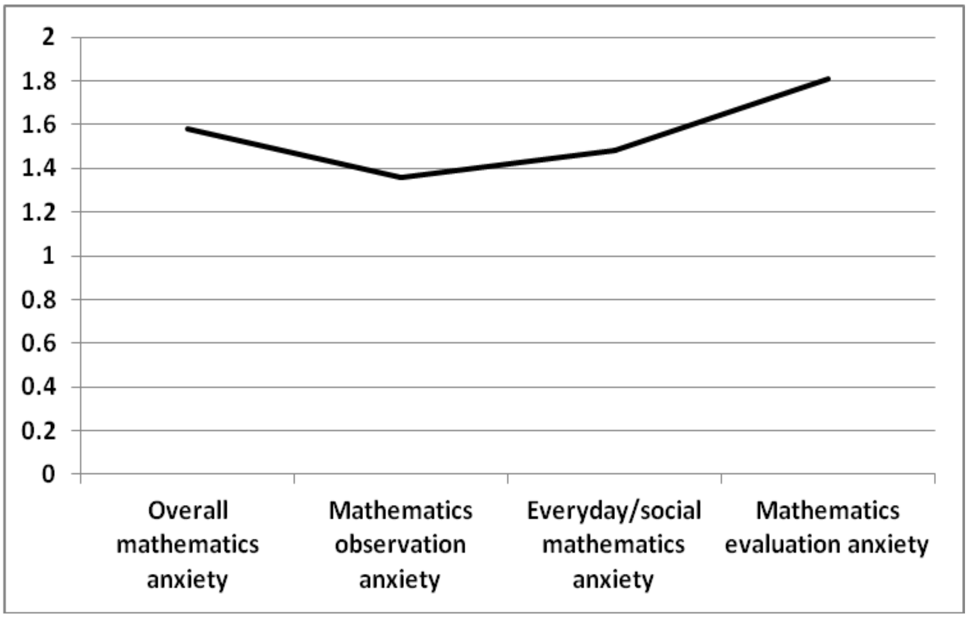

Figure 5.14 Mathematics Anxiety Scale-UK (Cohort 2, Phase 2)

5.4.4.1 Summary of MAS-UK

The findings of this instrument clearly indicate that the participants do not experience anxiety in mathematics (M = 1.58, SD = 0.67). An analysis of the three subscales of this instrument indicated that the participants found the mathematics evaluation section most stressful.

5.4.5 Phase 2: Summary of measures (Cohort 2)

Findings from Phase 2 of this research study provided an insight into the sentiments, attitudes and concerns of the Cohort 2 (n = 7) participants about inclusion, their mathematics teaching efficacy beliefs and their mathematics anxiety levels one year following their completion of the PGDSEN programme.

The SACIE-R measure indicated that the Cohort 2 participants at Phase 2 of the study expressed positive dispositions to socially interacting with people with disabilities, were receptive to the concept of including pupils with SEN in mainstream schools but had concerns about some elements of inclusion such as the provision of appropriate education for all pupils. The participants also had some concerns about the resulting impact on their workload and on their personal stress levels. The participants have high personal beliefs in their ability to teach successfully. Although they believed that their teaching would have a positive impact on the ability of their pupils to learn, they were less confident of this.

The Cohort 2 participants believe that they are effective teachers of mathematics. They also believe that their teaching will have a positive impact on the ability of their pupils to learn mathematics. This cohort of participants did not experience mathematics anxiety on a personal level.

5.4.6 Over view of measures (Cohort 1, Phase 1; Cohort 2, Phase 2)

Table 5.15 presents an overview of the measures of the participants' sentiments, attitudes and concerns about inclusive education, mathematics teaching efficacy beliefs, mathematics anxiety levels and their content and pedagogical knowledge in relation to the teaching of whole number/computation (Phase 1 only). It is important to note that ***Cohort 1*** participants completed the measures ***before*** undertaking the PGDSEN programme and the ***Cohort 2*** participants completed the measures twelve months ***after*** completing the programme.

Table 5.15 Overview of Measures (Cohort 1, Phase 1; Cohort 2, Phase 2)

Measures	Cohort 1		Cohort 2	
	N	Mean (SD)	N	Mean (SD)
Sentiments, attitudes and concerns about inclusive education revised scale (SACIE-R)				
Overall SACIE-R	15	2.66 (0.80)	7	2.81 (0.70)
Sentiments	15	2.91 (0.90)	7	3.11 (0.80)
Attitudes	15	2.91 (0.44)	7	2.91 (0.28)
Concerns	15	2.17 (0.74)	7	2.40 (0.60)
Mathematics teaching efficacy beliefs instrument (MTEBI)				
Personal mathematics teacher efficacy (PMTE)	15	3.54 (1.01)	7	3.86 (0.91)
Mathematics teaching outcome expectancy (MTOE)	15	3.34 (0.70)	7	3.30 (0.97)
MTEBI subscales combined	15	3.48 (0.94)	7	3.45 (1.03)
Mathematics anxiety scale – UK (MAS-UK)				
Overall MAS-UK	15	1.85 (1.04)	7	1.58 (0.67)
Mathematics observation anxiety	15	1.56 (0.81)	7	1.36 (0.58)
Everyday/social mathematics anxiety	15	1.77 (0.93)	7	1.49 (0.57)
Mathematics evaluation anxiety	15	2.09 (1.26)	7	1.81 (0.74)
Diagnostic teacher assessment in mathematics and science* (DTAMS)				
Overall DTAMS	12	24.75 (7.74)		
Memorised, factual knowledge	12	7.58 (1.88)		
Conceptual understanding	12	7.33 (1.72)		
Problem solving, reasoning	12	4.92 (2.71)		
Pedagogical content knowledge	12	4.92 (2.5)		

Note:* whole number/computation subsection

Findings from the SACIE-R suggest that both cohorts had positive dispositions with regard to inclusive education, the slightly higher overall mean score indicates that Cohort 2 had more positive dispositions and less concerns about inclusive education than Cohort 1.

Findings from the MTEBI suggest that both cohorts believed that they were effective teachers of mathematics. The Cohort 2 participants had a slightly higher belief in the effectiveness of their teaching of mathematics and there was a stronger consensus amongst them of their effectiveness as teachers. Both cohorts shared similar dispositions on the impact of their teaching on the ability of the pupil to learn mathematics. The findings indicate that the Cohort 1 and Cohort 2 participants believe that their teaching of mathematics impacts positively on the ability of their pupils to learn mathematics.

Findings from the MAS-UK measure indicate that neither cohort experienced mathematics anxiety. However, Cohort 2 participants had slightly lower levels of mathematics anxiety than their Cohort 1 counterparts. The lower SD for the Cohort 2 participants indicates that all participants are likely to have similar low levels of mathematics anxiety. Findings from the DTAMS measure indicates that there is considerable variation in the Cohort 1 participants with regard to their content and pedagogical knowledge of mathematics. The participants had strengths in the area of memorised, factual knowledge and in their conceptual understanding of mathematics. However, the findings suggest that there is potential to develop the content and pedagogical content knowledge of the participants in whole number and computation

This concludes the presentation of the quantitative data findings for the Phase 2 participants. The three core themes provide the framework for the presentation of the core findings of Phase 2 (Figure 5.1). Findings for Cohorts 1 and 2 will be presented separately under each theme.

5.4.7 Theme 1: Inclusive and special education: Policy and provision

This theme presents the contextual factors influencing special education teachers' transfer of their learning in mathematics to classroom practice. Influences both internal and external to the school influence the teaching of mathematics to pupils with SEN by the participants. External influences include national policies such as the Literacy and Numeracy Strategy (Department of Education and Skills, 2011f), the Whole School Evaluation (WSE) (Inspectorate, 2010), and the School Self Evaluation (Inspectorate, 2012). Internal factors include the demographics of the school, school policies on mathematics, co-ordination of mathematics/SEN in the school, class teacher expectations in mathematics, collaborative approaches to teaching mathematics and supports within the school for teaching mathematics to pupils with SEN. Parental attitudes and expectations are also considered.

5.4.7.1 External influences on provision

This section discusses factors, external to the school which impact on the ability of the participants to transfer their newly acquired skills and knowledge into practice.

5.4.7.1.1 National policies.

All schools were participating in the SSE process, an initiative which enabled schools to evaluate teaching and learning internally and to develop and implement improvement plans mainly in literacy or numeracy over a three year time frame

(Inspectorate, 2012). Numeracy initiatives such as *Maths Recovery*, *Mata sa Rang* and Ready, Set Go Maths were in place in the participants schools in the 2012/13 school year. The *Aistear* programme, while not numeracy specific, was also in place in the infant classrooms. This section discusses the impact of these initiatives on the teaching of mathematics in the schools of both the Cohort 1 and Cohort 2 participants.

The *Mata sa Rang* programme was being implemented in four of the six Cohort 1 schools. Participants had received training, some of which was on-site during Croke Park hours and schools had purchased the required resources to accompany the programme. One participant noticed that the pupils in her school had become *"really excited about maths"* following their participation in *Mata sa Rang* (P7). Two participants mentioned the impact of the *Aistear* programme on mathematics, in particular on the language of mathematics in their schools. One of the mainstream schools was focusing on numeracy as part of their school's SSE development plan. The special school participant felt that the SSE process would validate the work they do in mathematics and change the perception that exists whereby *"some people still think that maybe in a special school that we don't teach maths"* (P25).

Four of the seven schools of the Cohort 2 participants chose to work on numeracy for their SSE and it was "*structured to target school improvement in specific areas"* (P22). This participant stated that the fact that her school had focused on mathematics for their SSE, resulted in class teachers requesting support from her with regard to the teaching of mathematics to pupils with SEN. Problem solving was a common focus throughout the schools involved. Teaching initiatives to improve problem solving were designed for all pupils. Programmes such as *Maths Recovery*, *Aistear, Ready, Set Go Maths* and the SSE were implemented in the schools in this cohort. All participants referred to the benefits of each to the teaching of mathematics. The two DEIS schools were implementing the *Maths Recovery* programme. Other schools had the *Aistear* programme in place. Both of the participants from the DEIS schools referred to the school DEIS mathematics plan on a positive note.

The Cohort 1 and Cohort 2 participants reported on the value of the SSE process to the development of literacy initiatives in their schools and anticipated that similar benefits would be experienced in turn by numeracy. Schools focusing on numeracy in this process tended to implement specific interventions such as whole school approaches to problem solving in schools. Other national programmes such as *Maths Recovery, Mata sa Rang* and *Aistear* supported the teaching of mathematics in schools and offered professional development opportunities for participating teachers. The national programmes enhanced the ability of the participants to transfer their new learning to practice due to the resulting increased focus on mathematics in the schools. The SSE directed schools towards the development of initiatives to support numeracy in the schools. The expertise of the PGDSEN programme participants in mathematics was acknowledged and their contributions to the school development plans in mathematics welcomed. The establishment of the M*ata sa Rang* and *Maths Recovery* programmes in schools, for example, served to create a school climate for support in mathematics.

5.4.7.1.2 Standardised testing in mathematics.

Standardised testing in mathematics is now a requirement of all schools (Department of Education and Skills, 2012e). Schools use either the *SIGMA-T* (Wall & Burke, 2007) or the *Drumcondra Primary Mathematics Test-Revised (DPMT-R)* (ERC, 2005) measures of mathematics attainment to measure the ability of pupils in 2nd, 4th and 6th classes annually.

The Cohort 1 schools used the *SIGMA-T* to identify pupils in need of additional support in mathematics. One school identified problem-solving as an overall area of weakness in their *SIGMA-T* results and consequently focused on developing this area in the following school year.

It was clear that standardised testing in mathematics influenced the teaching of mathematics in most of the Cohort 2 schools. Screening and allocation of additional teaching support in mathematics and in one school, streaming of mathematics classes was based on the results of the standardised tests. The test itself also impacted on the mathematics programme taught to the pupils in three of the seven schools of the Cohort 2 participants. Class teachers also felt under pressure to have their pupils with SEN prepared to take the test – *"class teachers have to face that and that is the reality come May or June"* (P21) and were seeking support from the LS/RT prior to it saying "*they don't know any of this and they don't know any of that"* (P21). The implications of this for the LS/RTs were that class teachers "*just plough on"* (P9) through the curriculum regardless of the fact that some pupils do not have "*the foundation behind them"* (P21).

All schools in Cohorts 1 and 2 (excepting the special class and the special school) based their allocation of their teaching resources in mathematics on the results of the standardised testing. It was evident that some class teachers expected the additional support in mathematics to enhance the attainment levels of pupils' standardised scores in mathematics. This directed the focus of some intervention programmes to meeting the requirements of the test as opposed to meeting the specific needs of the pupil – a situation which hindered the participants implementation of their new skills and knowledge.

5.4.7.1.3 Staged approach to assessment, identification and programme planning

Participants views on the implementation of the staged approach to assessment, identification and programme planning (staged approach) (Department of Education and Skills, 2003) in their schools varied. Some schools routinely followed the approach and actively implemented each step of the process. In other schools the staged approach was applied to providing additional provision in literacy only.

While the staged approach was used to support learning in three of the seven schools (excepting the special school) in Cohort 1, two of the participants reported that it applied to literacy only. If a class teacher "*noticed a problem* (in mathematics), *they landed it on my door step. They wanted them gone. Take them out"* (P2). This indicated that the class teachers in this school perceived that it was the role of the LS/RT to provide the additional support required by pupils experiencing difficulties with mathematics. Two of the participants were actively promoting the implementation of the staged approach in mathematics. One participant was supporting her participants in this matter and encouraging them to develop interventions in the classroom (P2).

Schools in Cohort 2 also varied in their implementation of the continuum of support. Four schools routinely followed the approach and actively implemented each step of the process. Two participants described how they would encourage their class participants to "*do something in the classroom"* (P9) before referring pupils directly to learning support. One school had regular staff meetings to discuss the stages of the approach in relation to the pupils. Another participant gave a presentation to her staff during a Croke Park hour. Two participants stated that their staff members would not be aware of the continuum of support, although one acknowledged that *"they probably understand the methodology but they wouldn't have the terminology or they wouldn't realise what they were doing"* (P28).

The findings suggest that the implementation of the staged approach to support mathematics is not actively in place in all schools. The participants may be required to adapt their teaching approaches accordingly. Some schools require additional CPD to upskill all participants in this process.

5.4.7.1.4 Summary: External influences on provision

A number of factors external to the schools influence the teaching and learning of mathematics to pupils with SEN. The SSE process, was being implemented in all schools. While most schools focussed initially on the development of literacy, the forthcoming focus on numeracy was expected to enhance the teaching and learning of mathematics for all pupils in the schools. *Maths Recovery* and other national initiatives such as *Aistear, Mata sa Rang* and *Ready, Set, Go Maths* provided additional support to pupils particularly in the early stages of their learning. The results of standardised testing in mathematics guided the allocation of additional resources to those who needed them. However, in some instances, the standardised testing had a negative impact on the mathematics curriculum taught to some pupils with SEN and directed the focus of interventions to the test as opposed to the specific needs of the child. While the Continuum of support provided a useful framework for interventions in literacy, participants noted that generally support in mathematics did not adhere to this framework. It was evident that some schools required additional support to ensure its' full implementation in mathematics.

The findings suggest that the external influences on provision have the potential to enhance the teaching and learning of mathematics for pupils with SEN in schools. Initiatives such as the SSE provide an opportunity for the participants to share their knowledge and expertise with their colleagues and to implement new approaches in mathematics. The Continuum of Support for example provides the framework for supporting pupils with additional learning needs in mathematics.

5.4.7.2 Internal influences on provision

This section presents the findings of internal in the schools which impact on the ability of the participants to transfer their newly acquired skills and knowledge on the teaching of mathematics to pupils with SEN into practice.

5.4.7.2.1 SNAs

Pupils in thirteen of the fourteen schools of the Cohort 1 and Cohort 2 participants were supported by SNAs. The school without an SNA had a person on a *JobBridge* scheme fulfilling this role.

In all but one of the Cohort 1 schools, SNAs supported the work of the participants in mathematics. Their responsibilities included supporting participants in an early intervention mathematics programme and assisting pupils with both school based mathematics activities and to "*redo mathematics homework"* (P6). One SNA supported a 6th class pupil with a visual impairment in mathematics and the LS/RT described her as being "*a great support to the child, guiding her and moving her on"* (P14). However the SNA admitted that she had difficulty with the content of the mathematics programme herself. She did however seek advice from the class participant to overcome her personal difficulties with the mathematics curriculum (P14).

The SNAs played a significant role in the implementation of the mathematics curriculum in the special school of a Cohort 1 participant. In her reception class of eleven five to seven year olds, of whom seven had DS in addition to intellectual disabilities, the special class participant had the support of two SNAs who had been working with her for a number of years. They were both familiar with the routine of the mathematics class and were informed of the focus of the lessons at the beginning of each week. They were involved in the set-up of the mathematics lesson and through their care role were in a position to "*bring the maths into all aspects of the day"* (P25) using concepts such as one to one correspondence for example when "*helping the child to set up their table at lunch time"* (P25).

SNAs in the Cohort 2 schools provided additional support in mathematics to pupils when necessary. This included using *Numicon*, concrete materials, keeping pupils on task during mathematics class and they were also a "*go to kind of a buddy really"* (P10) in mathematics. The Cohort 2 participant in the special class acknowledged the contribution her SNAs made to her teaching of mathematics. This participant provided guidance to her SNAs – *"I would go thorough it with them every morning. This is what you need to do. This is what you are looking for. This is how you are going to do it"* (P28) and *"Given four or five months with me, they know exactly how I want things done"* (P28). She admitted that if she "*didn't have that support from the SNAs"* (P28) that it would be challenging to teach mathematics effectively to the pupils in her special class.

While all participants expressed the value of the supporting role of the SNA in the teaching and learning of mathematics, the participants in the special class and in the special school particularly acknowledged their key role. Both of these participants adopted a proactive role in upskilling the SNAs they work with to support their pupils. There was evidence to suggest that SNAs required CPD in both mathematics and in their supportive approaches to mathematics in order to undertake their role in assisting with learning in mathematics successfully. The study indicates that the SNA can play a key role in supporting the participants of the PGDSEN programme deliver the mathematics intervention programmes in the classroom.

5.4.7.2.2 Role of the principal

The supportive role of the principal to the participants in their special educator roles was acknowledged by the majority of the participants in both Cohorts 1 and Cohorts 2. Firstly, the Cohort 1 participants were appreciative of the encouragement and support given to them to undertake the PGDSEN programme. One participant expressed an interest in undertaking the PGDSEN programme but was refused the opportunity by a previous principal who *"didn't feel the need* (for the CPD) *and said 'you're grand' and you weren't supported"* (P2). Whereas this same participant said *"I was very lucky with the new principal that she is very supportive of CPD and people going for it. So I just mentioned it* (PGDSEN programme) *and she had the form downloaded and signed within an hour of mentioning it"* (P2). Participants felt that their principals recognised the value of the PGDSEN programme by, for example, providing them time to work on their assignments in two instances, by offering LS/RT posts because the participant had the PGDSEN programme completed or had gained expertise in SEN through other professional development courses, by purchasing resources for SEN, facilitating meetings with class teachers and creating opportunities through staff meetings perhaps for dissemination of new knowledge acquired. One participant noted however the difficulties in implementing change in her school. She said *"I would have liked station teaching. And you would have needed permission and that is not always easy to get"* (P23). This participant felt that the principal was a barrier in her school to implementing new approaches as she can't *"always see the value in changing things" (P23)* and therefore did not allow the participant to implement co-teaching which resulted in a situation whereby *"we just had to do whatever we could then" (P23).*

It is evident that the Principals valued the SEN expertise of the Cohort 2 participants. While retaining responsibility for SEN, the principal had delegated the role of SEN coordinator to four of the seven participants in this cohort. Principals were supportive of their participation on the PGDSEN programme and one participant noted *that "if I needed time to go anywhere I got it. There was no problem"* (P28).

This research concluded that the principal is a key agent in facilitating both the acquisition and implementation of new skills and knowledge acquired through professional development. Participants also noted their principal's recognition of their expertise in whole school discussions relating to mathematics in SEN contexts.

5.4.7.2.3 EAL pupils

There was a marked increase in the numbers of EAL pupils in Irish primary schools from 2002 to 2006 (Murtagh & Francis, 2012). Support to meet their needs is now provided for under the *General Allocation Model* (GAM) and EAL teachers are appointed only to schools with a significant enrolment of these pupils (Department of Education and Skills, 2012d)

Two of the Cohort 1 schools had high enrolments of pupils with EAL (P11, P6&P7). One third of the intake in the junior and senior infant classes were pupils with EAL in one school. One in five pupils were in this category in a second school.

Although mathematics appeared to be a relative strength for many of these pupils, difficulties with the language of mathematics posed difficulties.

Two of the seven schools in Cohort 2 had a significant population of pupils with EAL. In one school, the ratio was 50/50 in the senior school and 25/75 in the junior school in favour of EAL pupils. While both schools had the support of EAL teachers, they agreed that language posed additional difficulties in mathematics for their pupils.

Participants teaching in schools with high populations of EAL pupils stated that these pupils experienced additional difficulties in mathematics, in particular with the language of mathematics. It was necessary for the participants to place additional supports in place within the intervention programmes to accommodate the specific needs of the EAL pupils.

5.4.7.2.4 Priority of literacy over numeracy

The majority of schools in both Cohort 1 and Cohort 2 prioritised additional support in literacy over numeracy. This was evident from their selection of literacy in the first stage of their SSE process and from internal school structures relating to the allocation of additional support to both literacy and numeracy.

Support in literacy over mathematics was prioritised in the Cohort 1 schools for varying reasons. One school had not given any support in mathematics the previous year due to time constraints imposed by LS/RTs travelling to other schools in shared posts. Providing support in mathematics was a new feature in one school as it was felt *"that the STENs were fine in maths"* (P17). Support in literacy was also prioritised over mathematics because the "*literacy needs are greater"* (P14) in the school. Six of the seven schools in Cohort 1 chose to focus on literacy in the first stage of their SSE process and all reported that numeracy would be their second focus.

The Cohort 2 schools also prioritised support in literacy over numeracy and presented a number of reasons for this. Because the standards of mathematics in one school were very good, mathematics was not a priority issue (P18). Another school supported mathematics when pupils had identified learning needs in this subject. One participant stated that her principal was very supportive of mathematics and that they were "*lucky that there is a big emphasis put on maths in this school. We do an hour of maths every day"* (P28). In this school additional support in mathematics was given through the streaming of the mainstream mathematics classes from First class upwards. The advantage of this approach was that the pupils were in smaller classes for mathematics and that it was *"people with the same ability. They are not afraid to ask questions. They are in a safe environment"* (P28). Despite this intervention, the participant noted that *"you would <u>never</u> see a major increase in their STEN. If they start* *out with a two or a three, they seem to remain at that level all the way up. And it's kind of sad"* (P28).

While there were initiatives such as *Maths Recovery* and *Ready, Set, Go Maths* in place in the two Cohort 2 DEIS schools in this cohort, both participants acknowledged that given the range of additional needs in their schools, mathematics was not taking priority. This was partly due to the fact that "*there is such an emphasis on trying to get language and literacy going"* (P10). The second DEIS school in this cohort experienced similar needs and the participant noted that "*traditionally we have great needs and so our support tends to be given to literacy rather than maths"* (P15). Apart from an early intervention programme in the infant class and perhaps a small number of pupils receiving additional support before their SIGMA-T tests, this DEIS school did not provide additional support in mathematics.

The findings suggest that additional support in literacy and other areas such as language and behaviour tended to be prioritised over numeracy in some of the schools of the Cohort 1 and Cohort 2 participants. The participants were aware of the impact of the precedence of literacy over numeracy and of the resulting consequences. It results for example in larger groups in the mathematics support groups in one school and the participant found that *"the groups were too diverse in ability"* (P2). There was evidence to suggest however, that the ongoing implementation of the SSE process would necessitate more specific approaches to mathematics in the forthcoming school years.

5.4.7.2.5 Collaboration with class teachers

LS/RTs are required to collaborate with class teachers to plan and implement additional support for pupils with SEN in mathematics (Department of Education and Skills, 2003). The nature and extent of this collaboration varied from school to school and was influenced by factors such as time for collaboration and the attitudes and expectations of class teachers to the intervention programmes in mathematics for pupils with SEN. In some instances, the LS/RT participants collaborated with their colleagues to share their knowledge and expertise in mathematics. Co-teaching, a feature of practice in all schools (excepting the special school) in mathematics facilitated such sharing of expertise.

5.4.7.2.5.1 Intervention programmes in mathematics: Cohort 1.

All but one of the Cohort 1 participants (excepting the special school participant) collaborated with class teachers to plan intervention programmes in mathematics. The participant who did not collaborate with class teachers said that there was "*no time for planning"* and that she *"knows the way the class teacher follows the book"* (P17) and that this determined the structure of the intervention programme in mathematics. One participant felt that collaborations with class teachers were essential in order for both the class teacher and LS/RT to *"have a shared vision"* (P14) of the intervention programme.

While class teachers have primary responsibility for teaching the mathematics programme, there was divided opinion amongst the Cohort 1 participants as to the division of this responsibility between the LS/RT and the class teacher. Two participants teaching in the same school agreed that in their school that while the class teachers would be *"pretty clear that ultimately they are responsible but in reality a lot of maths work for children who are not working at class level is done at learning support or resource"* (P6&P7). This view was echoed by a participant who queried if class teachers were differentiating to support individual needs (P17). One participant acknowledged that in her school *"the class teachers are very conscious of moving on and on"* (P2) and that "*it is a relief valve for them and it is usually quite a positive thing for them…when you come to the door to collect them and you have your plan made"* (P2).

While participants in Cohort 1 reported that they collaborated with class participants to plan intervention programmes, it was evident that in some cases, a tension existed between the expectations of the class teacher to complete the mathematics text book and those of the LS/RT to teach priority learning needs in mathematics. A participant described the scenario whereby "*you're sent a maths text out with kids coming to learning support for maths"* (P23). The participant stated that the class teacher expected to have the mathematics books completed and that this "*causes a bit of tension"* because class teachers *" don't like it when you kind of suggest that you might prefer to do it some other way"* (P23). To overcome these dilemmas, it was suggested by two of the six participants that class teachers require CPD in order to understand for example why "*John will only get ten of the questions done and that's fine"* (P17).

In some instances, principals facilitated collaboration by releasing class teachers from their teaching duties (P11). There was a strong spirit of collaboration evident in the special school. The school had an agreed whole school plan in mathematics which was implemented by all classes. This enabled the teachers to share resources and the participant felt that they "*had a good system"* (P25) going and she said that "*we lean on each other"*. Eight or nine of the teaching staff in this special school had completed the PGDSEN programme recently and therefore formed a core group within the school whereby strategies, useful websites and relevant resources were shared.

5.4.7.2.5.2 Co-teaching: Cohort 1.

Three of the Cohort 1 schools delivered the *Mighty Maths* and *Mata sa Rang* interventions through the co-teaching service model. Two other schools taught all or part of the standard mathematics programme using this approach. While the Cohort 1 participants were spoke positively of the co-teaching model, they had both positive and negative co-teaching experiences in mathematics. One participant described how she worked with a sixth class teacher and *"It worked really well. We could do a sum on the board and I would see one way of doing it and she would see one way of doing it. We would link in together"* (P17). However, this participant had a less positive experience when co-teaching with a new teacher to the school and suggested that perhaps the lack of planning before the lesson had impacted negatively on the outcomes. Similarly, another participant co-taught with a teacher whom she felt wasn't "*very comfortable with it"* (P2) which she felt may have been due to the fact that he was new to co-teaching. A participant noted that in her school, it was possible that the LS/RT would take the lead in the co-teaching lesson resulting in a situation where *"the (class) teacher can end up sitting correcting or you know, not as interactive as they should or could be"* (P17).

Two Cohort 1 participants who taught in the same school described a particular co-teaching model in place currently for teaching mathematics to the 6th class (P6&P7). This station teaching approach involved the two 6th classes and five teachers. The co-teachers *"meet and plan beforehand"* to plan the lessons (P7). The two 6th classes were divided into ability groupings and allocated to one of the five teachers in a separate classroom. The two participants from this school agreed that the co-teaching model would "*get better with time and with more experience of it"* (P7) but that they still hadn't "*figured it"* (P6) and that it still needed to be tightened up. Two Cohort 1 participants made reference to the need for upskilling for all teachers using the co-teaching model. One participant felt that upskilling would help with the planning process and would overcome organisational and structural difficulties associated with co-teaching (P17).

5.4.7.2.5.3 Interventions programmes in mathematics: Cohort 2

There was evidence of collaboration between the participants in Cohort 2 and their teaching colleagues. While the Cohort 2 participants spoke of collaborating with class teachers to plan intervention programmes in mathematics, it appeared that such collaborations took place perhaps at "*break time"* (P9) or during Croke Park Hours. One of the participants, the SEN coordinator in her school, referred to the importance of planning with the class teacher in her discussions with the SEN team – "*You have to* *tell them what you are doing, you have to show them what you are doing"* (P9). However, time to do so was not available.

Class teachers and LS/RTs sometimes held different opinions with regard to the content of intervention programmes in mathematics for pupils with SEN. This occasionally resulted in a certain amount of tension between them. One participant in Cohort 2 aptly described her reaction to the class teacher who held out the text book as the group of children were leaving the classroom saying "*Would you ever finish that bit or He needs more of….*" The participant would have liked to have replied "*Well, he doesn't get A and so why would we be doing Z now!" (*P10). Other participants had similar experiences. A Cohort 2 participant working with a class participant who was "*focussed on the SIGMA- T"* expected the LS/RT to work on a page she sent out because "*they really need to work on decimals, they haven't a clue of decimals".* The participant however, recognised that these pupils did not have a foundation in number and "*you have to kind of go back to the start with them"* (P21). Another said of the expectations of class teachers – "*well, you are in a mainstream school and everyone is supposed to be on number five"* (P9) or the expectation of a class teacher who stated "*I don't care what you want to teach them but this is what they have to do by the time they get to me*!" (P9). This approach taken by these class teachers was contrary to the intervention programme one participant had intended to implement following the PGDSEN programme – "*I came back in September and I said I am not going there this year. No way am I bringing a group out and going through the text books. I was focussed and I was going to do my own thing and that"* (P21). The participants however, generally recognised the need to have positive relationships with class teachers and as one said *"you kind of have to, you have to think of where your bread is buttered a small bit and relationships"* (P10) and therefore, tended to marry the expectations of the class teacher into their intervention programme.

5.4.7.2.5.4 Co-teaching: Cohort 2.

Two of the Cohort 2 participants described the practice of teaching mathematics in their schools in 'split classes'. In this context, the LS/RT taught the entire mathematics programme to one class in a multi class setting and the class teacher taught the other class. Another Cohort 2 school was planning to use this approach in the coming school year. Three participants referred to the practice of in class support whereby the LS/RT joined the class teacher to support the teaching of mathematics in the classroom – *"They will both teach at the same time"* (P9). Another participant described how she supported the class teacher in this context and said "*when she was working with seniors, I was helping juniors"* (P18). Planning for co-teaching did not take place but rather the LS/RT stated that she “*would have gone in on the class teacher’s plans”* (P18).

Some resistance by class participants was experienced by Cohort 2 participants wishing to introduce station teaching in their schools. This model was introduced by one participant as part of a Maths for Fun programme following her completion of the PGDSEN programme. This school operates the withdrawal model predominantly for both literacy and numeracy. Class teachers were resistant to the new approach – “*there’s an awful lot of work in this and we don’t have the manpower”* (P21). However, following a six week block of Maths for Fun station teaching, the participant noted that “*it made a difference”* and that the pupils *“really enjoyed it”* (P21). Another participant successfully co-taught with one teacher in her school but found that the same approach did not work successfully with another teacher in her school – *“I tried it with an older man in my class this year. But he wouldn’t do what I asked! He was taking over instead of, instead of doing what I said to do with the groups”* (P18). The participant had initiated this approach following her completion of the PGDSEN programme and was disappointed at having to resort to the withdrawal model – “*I didn’t want to do that”* (P18). A participant noted that some class teachers “*feel intimidated when the likes of us come in”* (P9). She had found that occasionally a LS/RT could go to the classroom for a planned co-teaching lesson and be informed by the class teacher that “*I don’t need you today”* (P9).

It is evident that schools need to facilitate structured meetings between class teachers and LS/RTs to enable collaboration when planning interventions in mathematics and to accommodate the sharing of expertise. The findings suggest that in some instances, a conflict of interests exists between the expectations of the class teachers and of the LS/RT participants with regard to the nature of intervention programmes in mathematics for pupils with SEN. It is clear from the findings presented that co-teaching has become a popular approach to support the teaching and learning of mathematics and is as one participant stated “*creeping in”* (P6). While it is viewed positively by the PGDSEN programme participants, it is an evolving collaborative process however. The introduction of co-teaching as a new approach for supporting pupils with SEN in mathematics by the PGDSEN programme participants was challenging for some as not all teachers shared similar educational philosophies. There is scope for CPD to ensure that class teachers have the necessary skills and knowledge themselves to play an equal part in the design and implementation of intervention programmes in mathematics.

It is evident that the participants are returning to their schools with newly acquired skills and knowledge. The class teacher could be described as being a *gatekeeper* in the translating the learning into practice process. Where collaborative opportunities exist and where class teachers share similar educational philosophies towards the provision of additional support in mathematics, the participants can implement their new skills and knowledge readily. However, the findings suggest that some participants experience difficulty implementing new approaches due to internal constraints within the school.

5.4.7.2.6 Challenges to the teaching of mathematics to pupils with SEN

The participants in both cohorts cited several challenges to their teaching of mathematics to pupils with SEN. Key challenges reported were the nature of the pupils disabilities, time to teach mathematics, the curriculum text book, the lack of resources to support the teaching of mathematics and negative parental attitudes to mathematics.

Six of the seven Cohort 1 participants remarked on the difficult task of teaching mathematics to pupils with SEN. Some described it as "*tedious*" (P23) or "*frustrating*" (P11) or that it was *"difficult to know what to teach and how to teach it"* (P14). The participants recognise that the abstract nature of mathematics, the broad curriculum content of the mathematics curriculum and the diversity of the learning styles of the pupils' impact on their teaching. Although the participants focus on social mathematics and teach key core skills such as telling the time using a number of different strategies, pupils "*still find it so difficult"* (P11) and *"it takes a long time to teach one concept*" to some pupils (P25). One participant found it "*a constant challenge to be able to set up the activities or to explain it so that the pupil can understand it"* (P14).

Six of the seven Cohort 1 participants felt under time pressure to teach everything the pupils needed to learn within the allocated time. The time allocated to supporting mathematics did not equal the time given to literacy in some instances. Participants spoke of the advantage of timetabling which would facilitated daily inputs in literacy by comparison to two or three weekly inputs in mathematics (P2, P23).

Four of the seven Cohort 1 participants spoke of the impact of negative parental expectations in mathematics as being a challenge to their teaching. The *"I was never any good at maths"* attitude dictated parental expectations for their children and one parent was quoted as saying "*I couldn't learn my tables, he probably won't learn them either"* (P14). While acknowledging that this parental attitude "*would not be wholesale across the board"* (P14), where it did exist, it posed an additional challenge to the participants and also led to situations where pupils received less support in mathematics at home. As one participant noted *"I send home little maths games and* *little maths exercises and I honestly don't feel that they are done a lot of the time"* (P2). Pupils also experienced negative attitudes to mathematics and in some instances adopted a *"I can't do it"* (P14) to mathematics which inevitably led to a situation where "*a child had closed off from maths"* (P14).

The mathematics text book was cited as a challenge to the teaching of mathematics to pupils with SEN by five of the eight Cohort 1 participants. In some schools, class teachers were under pressure to complete the text book. One participant pointed out that *"we would definitely be guilty here of being text book led"* (P2). This sentiment was echoed by others who said that class teachers "*were led and said by the text book"* (P7) and that "*most class teachers teach to the book"* (P23). Consequently, the teaching/intervention cycle being text led and less time was available for approaches such as constructivism or for the teaching of core social mathematics or foundational mathematics concepts (P23, P6&P7). The LS/RT participants clearly understood the requirements of a mathematics text book but the majority of them would prefer some flexibility and in their teaching approaches.

A number of the Cohort 2 participants (n = 4) stated that they required additional resources to support pupils in mathematics. One participant did not have access to ICT due to the nature of the prefab structure of her school and the associated security issues with this (P15). She also stated that her classroom was too small to take a group of children and this was something she was reviewing for the next school year.

It was suggested by the Cohort 2 participants that negative parental attitudes to mathematics impacted on the attitude of their children towards learning mathematics. The lack of mathematics experiences in the home was cited by one participant as impacting on the attitudes of the pupils. She said that "*there is no counting, measuring, anything going on"* (P10) in the home. Another participant empathised with this and said that parents who have negative attitudes and who are thinking *"I can't do it. I can't help you. I don't do maths. I don't like maths. Maths is a waste of time*" do not make the connection between learning mathematics in school and the necessity for this skill in real life (P22). Another participant noted that parents in her school were more concerned about the fact that their children happy and making friends and able to read than in their progress in mathematics (P9).

The two participants in Cohort 2 who had a large enrolment of pupils for whom English was an additional language recognised the impact of this on the development of their skills in mathematics. It was difficult to get text books that were accessible for the pupils. One school had a lot of intervention programmes in place and time to teach mathematics was therefore reduced.

Four of the seven Cohort 2 participants reported that while there was a growing awareness of teaching mathematics using other approaches, the teaching of mathematics remained strongly influenced by the text book in their schools. One participant stated that at the end of the school year the participants in her school would "*be doing nothing only the books"* and that they would be "*flying through them"* (P9) in their efforts to complete them before the end of the school year. This sentiment was supported by another participant admitted that there was a culture in the school that "*we need to get through the book"* (P10). Participants "*who had been in the school a long time"* were more likely to be "*very text based"* as opposed to less experienced participants in one school (P28). Empathising with their Cohort 1 colleagues, the Cohort 2 participants also felt that the emphasis the mathematics text book impacted on their ability to teach an intervention programme which was based on the prior assessment of the needs of the pupil.

Other factors mentioned by the Cohort 2 participants as negating their ability to teach mathematics included the large numbers of pupils with difficulties in mathematics, the negative attitude of pupils to mathematics, the limited time available for support in mathematics and the lack of class teacher expertise in mathematics – *"they wouldn't know the way we did it on the* PGDSEN programme" (P9).

The challenges experienced by the participants when teaching mathematics to pupils with SEN were significant. Negative parental attitude to mathematics resulted in their children also having negative attitudes. Some schools did not have adequate resources (assessment tests, ICT, manipulatives) to support their teaching of mathematics. The participants reported that teaching mathematics to pupils with SEN was a difficult and challenging task given the abstract nature of mathematics and the level of disabilities experienced by the pupils. Pressure to complete the mathematics text book was identified as a negative influence on pupil attainment levels in some instances. The PGDSEN programme participants adapted their teaching approaches to overcome the challenges they experienced while attempting to implement their new expertise. As one participant stated – *"you have to think of where your bread is buttered a small bit''* (P10) and in some instances, participants married the expectations of the class teacher into their intervention programme. Overcoming the challenges outlined will involve whole school approaches to accommodate the diverse learning styles of these pupils in mathematics.

5.4.7.2.7 Summary: Internal influences on provision

Internal factors within schools influence the teaching and learning of mathematics to pupils with SEN. This section focused on specific factors influencing the transfer of new knowledge and skills acquired by the LS/RT participants to practice. The supporting role of the SNA was recognised and valued in all schools but particularly in the special school and special class where their role was seen as invaluable and essential in supporting the participants implement the mathematics programme. There was some evidence to suggest that SNAs required CPD to upskill in both content and supportive pedagogical knowledge in mathematics. The research study concluded that the principal is a key agent in facilitating both the acquisition and implementation of new skills and knowledge in mathematics. The impact of language difficulties on the acquisition of skills in mathematics was noted in particular by the three schools who had a predominant enrolment of EAL pupils. Such language difficulties placed additional teaching demands on the participants. Schools generally appeared to be prioritising additional support in literacy and behaviour for example, over numeracy. It was anticipated that the ongoing implementation of the SSE process would address this issue in the coming years. The LS/RT participants and the class teachers collaborated to develop and implement intervention programmes in mathematics. Such collaboration was sometimes facilitated by principals. Some tension existed between the expectations of the LS/RT participants and the class teachers with regard to the focus of intervention programmes. The provision of CPD to upskill class teachers may ease such tensions. While the practice of co-teaching was becoming more prevalent, and was considered to be a support to the teaching of mathematics, it was evident that CPD for all those involved in it was essential. The participants cited negative parental attitudes as a factor negating the acquisition of mathematics by pupils with SEN. Class teacher expectations with regard to the completion of the mathematics text book was noted as a factor impacting on the ability of the participants to teach an assessment driven intervention programme. The participants were aware of the challenges of teaching an abstract subject such as mathematics to pupils with SEN. Participants admitted finding it "*frustrating*" (P11) and "*tedious*" (P17) and "*difficult to teach those who can't understand*" (P14). They were however, positively disposed to finding teaching strategies to ensure pupils' success.

5.4.7.2.8 Summary - Theme 1: Inclusive education: Policy and provision

A number of factors both external to schools and within schools impact on the teaching and learning of mathematics. These factors influence the ability of the participants to transfer their new knowledge and skills to practice in the classroom.

National initiatives such as the SSE process and intervention programmes in mathematics such as *Mata sa Rang* and *Maths Recovery* were perceived by the participants to positively influence the teaching of mathematics in the schools. They created a new awareness on the teaching of mathematics and afforded the participants the opportunity to implement new approaches in the school. While the results of standardised testing in mathematics guided the allocation of additional resources to those who needed them, it did however, have a negative impact on the mathematics curriculum taught to some pupils with SEN. Participants noted the influence of parental attitudes and expectations on their children's attainment levels in mathematics. Generally it can be said that some parents of children with SEN did not have high expectations in mathematics for their children but rather prioritised other aspects of the curriculum such as language, social skills and care needs. Participants in the schools required additional support in the Continuum of support in order to ensure its full implementation in schools. The participants recognised the differing expectations of the class teacher and of themselves with regard to planning and implementing intervention programmes in mathematics. Co-teaching was identified as a new approach to supporting the teaching of mathematics. The participants recognised the need for whole school approaches to CPD in mathematics in special education contexts.

5.4.8 Theme 2: Continuing professional development (CPD)

This section presents the findings of the second theme, Continuing professional development. The aim of this theme is to present the individual teacher factors which influence the participants' acquisition of knowledge and skills in mathematics for SEN through their participation in CPD. Such factors include participant attitude and perceptions of CPD, reasons for undertaking the PGDSEN programme, and their perspectives on teaching mathematics to pupils with SEN. The perceptions and experiences of the participants of the influence of the mathematics input on the PGDSEN programme will also be presented. Findings from both Cohorts 1 and 2 will be presented. The findings will be presented thematically.

5.4.8.1 Teaching mathematics to pupils with SEN – teacher perspectives

All of the participants teach mathematics to pupils with SEN. Individual and group withdrawal are commonly used teaching models. Some participants now co-teach mathematics in their schools. Participant perspectives on the teaching of mathematics to pupils with SEN will be explored.

Two of the eight Cohort 1 participants expressed some concern over their ability to teach mathematics. One participant was of the opinion that she was *"a poor maths teacher"* (P7) and that she *"just didn't get it sometimes how the children are thinking when it comes to maths processes"* (P7). She also admitted to having difficulties with teaching word problems and overcame this in her preparation before the lesson (P7). This participant attributes failures in mathematics by her pupils to her teaching – *"When they don't get it, OK, what am I doing wrong?"* (P7). Of note, this participant scored 32.5% on the DTAMS measure of content and pedagogical knowledge in whole number and computation, the lowest score of the twelve participants who completed it. Another Cohort 1 participant, despite having expertise as a facilitator in mathematics, also queried her skills as a teacher of mathematics and felt that her skills "*could be improved"* (P14) and that she *"had loads to learn"* (P14). This participant scored 100% on the DTAMS measure, the only participant to achieve this score.

Although four of the Cohort 1 participants admitted finding it "*frustrating*" (P11) and "*tedious*" (P17) and "*difficult to teach those who can't understand"* (P14) and that *"it was hard to know when to move on to another concept"* (P14), all of the participants were positively disposed to finding teaching strategies to ensure pupil success. One participant, for example, wanted her pupils to "*be able to do it"* and she wanted to "*be able to unblock the whatever, the why ever they can't access it"* (P14). Another firmly believed that *"there is a way to teach everyone to get it"* (P11). Participants spoke of their satisfaction when their pupils achieved – "*it's good if they get any little bit"* (P11) and another said that she liked it "*when a child gets something you have been plodding, plodding away at"* (P25). Four of the Cohort 1 participants pointed out that they prepared or researched topics before teaching them – *"I would go on Google because Shape might not be my greatest thing or symmetry"* (P14) and "*I'd have to go back and have a good look and make sure that I was well prepared"* (P2). One participant felt that her experience of teaching mathematics to Infants "*was a huge help"* (P11) when teaching mathematics to pupils with SEN.

All seven Cohort 2 participants loved teaching mathematics. A participant who disliked mathematics as a pupil herself had "*grown more fond of maths"* as her undergraduate training had taught her that "*maths doesn't have to be about rote learning"* (P21). Two of the participants who were particularly strong in mathematics enjoyed the challenge of teaching mathematics to 6th class pupils and one said that in fact she "*was probably the only teacher who really wanted to teach it"* (P18). The participants generally held the view that having an interest in mathematics was an advantage to your teaching of it.

The findings suggest that the participants were committed to special education and undertook further professional development in order to develop their personal skills, knowledge and understanding to enable them to undertake their special education positions responsibly and effectively.

5.4.8.2 CPD – perceptions and experiences

The participants were active participants in CPD programmes. They were of the view that CPD developed new skills and knowledge and was a means of sharing best practice between fellow colleagues. Apart from the PGDSEN programme, CPD in ICT was the most popular choice of course for the participants in the previous five years. The participants felt that CPD was motivational and they generally enjoyed it. Most of the participants had not received CPD in mathematics for SEN outside of the PGDSEN programme however.

All the eight participants in Cohort 1 were both passionate and committed to CPD. It was seen as a means of "*rejuvenating yourself"* and a way of "*keeping yourself refreshed"* (P7). Occasional summer courses, online courses, SESS and PDST courses represented the main forms of CPD for this cohort of participants. Some had undertaken courses such as *Aistear, Mata sa Rang* and *Maths Recovery* within the last five years. Local education centres were seen to provide "*very good"* CPD (P2). The Cohort 1 participants identified areas in mathematics that they felt both they and class teachers required further training in. Areas for further training included assessment, social mathematics and a step by step task analysis of "*how to actually teach mathematics"* (P7).

Three of the Cohort 2 participants referred to summer courses as their core CPD programmes. One participant loved the opportunity "*to meet with participants"* (P21) at the face to face courses. The Cohort 2 participants readily identified areas in mathematics which they required further upskilling on. They expressed a wish to receive more CPD on the teaching of number – "*how to develop a better number sense"* (P15), *"how to teach number to older pupils"* (P21). Participants also required support in planning intervention programmes. One participant wanted to *"know where to start?"* and "*how far back should you go*?" (P9) when the pupils learning in mathematics has reached a plateau. The special class participant strongly advocated for CPD and resources which would be relevant for pupils with mild to moderate levels of disability.

Participants who were passionate about the benefits of CPD tended to undertake CPD frequently themselves – "*some of us are worn out from doing courses and you've more and they are not doing them"* (P2). It is evident that there is a demand for CPD in the teaching of mathematics to pupils with SEN both for class teachers and for LS/RTs.

5.4.8.3 PGDSEN programme: Acquiring knowledge, skills and understanding in mathematics

All of the participants were aware of the need to develop their skills, knowledge and understanding in special education and anticipated that the PGDSEN programme would fulfil this need and give them the confidence and expertise to fulfil their role. Participants in both Cohorts 1 and 2 agreed that the input in mathematics on the PGDSEN programme had added to their knowledge base and increased their confidence in their ability to teach mathematics to pupils with SEN effectively.

All eight of the Cohort 1 participants agreed that they undertook the PGDSEN programme to reaffirm their existing knowledge, to upskill in special education and to learn more in order to enable them *"to teach children with SEN more effectively"* (P11) and *"to do the job right"* (P17). Teaching colleagues in two of the participants schools had previously completed the PGDSEN programme "*and came back with glowing ideas"* (P25) and "*seemed to know exactly what was involved"* (P6). This created an impetus for others in their schools to complete the PGDSEN programme. One participant also noted that the fact "*that the PGDSEN programme was funded made it possible"* for her to complete the course. Six of the eight Cohort 1 participants said that they felt more confident in their teaching following their participation in the PGDSEN programme. Participants said that they "*felt more equipped to teach mathematics now than before I had the CPD"* (P23) and that it made them "*the 'Go To' person"* in their schools (P11). Four of the participants were pleased that the PGDSEN programme had validated their current teaching practices in mathematics and they found it reassuring to know *"that what I was doing was right"* (P25) while another was glad to discover that she *"wasn't doing anything wrong"* (P23).

Despite having completed the PGDSEN programme in the previous twelve months, most of the Cohort 1 participants acknowledged that they required further training in this area. They were interested in learning more about "*the development of maths"* (P23), in gaining *"a knowledge of where the starting point is and what are the building blocks that the children need to be able to do"* (P14), and of "*how to break down all the areas"* (P17) in mathematics. The Cohort 1 participants agreed that their knowledge, skills and understanding of how to teach mathematics to pupils with SEN increased following the PGDSEN programme. They felt *"more informed"* (P7) and had changed their attitude towards their teaching approaches.

The seven Cohort 2 participants chose to undertake the PGDSEN programme for varying reasons. Four of the participants were relatively new to the SEN position and all admitted that "*they hadn't a clue about LS"* (P21). The three more experienced participants completed the PGDSEN programme in order to upskill in special education. The position of SEN coordinator was vacant in one school and the participant felt that if she was going to apply for it, that she *"had better do something about it"* (P9). Two of the participants were encouraged by friends who had recently completed the PGDSEN programme to undertake it.

Having the PGDSEN programme completed earned the Cohort 2 participants the respect of their teaching colleagues and SNAs. Participants recognised that their expertise was valued as their colleagues asked them for guidance and they became the "*Go To"* person in SEN (P9). One participant felt that the class participants considered that she was *"some sort of expert in SEN which I don't know if I am yet!*" (P21). There was a recognised sharing of expertise with the participants sharing notes and handouts from the PGDSEN programme lectures in mathematics with their teaching colleagues (P9). Resulting from their discussions with the PGDSEN programme graduates, some class teachers were making changes in their teaching approaches.

All of the Cohort 2 participants stated that their confidence levels as teachers of mathematics to pupils with SEN had increased following the PGDSEN programme. They said that they know "*a lot more this year"* (P18) and had *"picked up lots of strategies on the course"* (P21). A participant said that she "*learned an awful lot"* liked the "*applications to classroom practice"* (P22) in the lectures on mathematics. Another summed up the totality of her learning when she stated that she saw a 100% change in her teaching style. She said that her "*mainstream training taught me how to teach the typical child but the PGDSEN programme taught me how to teach the child on the margins"* (P22).

Two participants made observations suggesting that class participants and other LS/RTs in their schools did not have the necessary skills to teach mathematics to pupils with SEN.

5.4.8.4 Summary – Theme 2: Continuing professional development

The findings suggest that the participants valued CPD. This was evident by their participation in the PGDSEN programme and the wide range of other CPD courses they had undertaken. Participants who were new to SEN undertook the PGDSEN programme to acquire new knowledge and to gain confidence in their role. Those participants who were more experienced in SEN committed to the PGDSEN programme in order to upskill in special education, to reaffirm their existing knowledge and to gain a professional qualification in this area. While acknowledging that learning mathematics was difficult for pupils with SEN, the participants agreed that their knowledge, skills and understanding of the teaching of mathematics to pupils with SEN had increased following their participation in the PGDSEN programme. Participants felt that they were now more respected in their schools and in some instances there was evidence of a sharing of expertise with class teachers. The participants recognised the need for ongoing CPD in mathematics to support pupils with SEN.

5.4.9 Theme 3: Translating the learning into practice -Teaching mathematics to pupils with SEN

This section presents the perceptions and experiences of the Cohort 1 and Cohort 2 participants on the transfer of their learning from the lectures in mathematics on the PGDSEN programme to their classroom practice. The overview of the participants' case loads will provide a context for their teaching and learning experiences. Insights into their current practices in the assessment of pupils with SEN in mathematics and changes they may have made in this regard will be presented. The perceptions and experiences of the participants on the knowledge and skills they acquired to teach number and social mathematics and their understandings of the transfer of their learning into practice will be explored. The value of resources such as ICT and manipulatives in the teaching of mathematics in special education contexts will conclude this section.

5.4.9.1 Teaching mathematics to pupils with SEN- Participants' case loads

This section provides an overview of the participants' caseloads and their approaches to the teaching of mathematics twelve months following their completion of the PGDSEN programme. Thirteen participants taught pupils with identified learning needs receiving additional support for learning under the GAM or individual resource hours for identified disabilities in mainstream primary schools. Two participants taught mathematics on a whole class basis to their special class. The LS/RT participants provided support in mathematics either in small groups ranging in size from two to eleven pupils or through co-teaching approaches such as station teaching or in class support. Some pupils received daily support while others received support in mathematics less frequently.

There were eleven pupils in the reception class taught by the special school participant (Cohort 1) in a special school for pupils with MGLD. The pupils were aged between five and seven years and it was either their first or second year in school. The participant divided the pupils into groups for their pre-number lessons. She assessed their abilities before planning the mathematics programme (P25). She placed a big emphasis on social maths, time and money. Two SNAs assisted her with the teaching of the mathematics programme.

One Cohort 1 participant noted that the mathematics groups in her school tended to be larger than the literacy groups (P2). In another school, pupils were "*released and observed"* back to the classroom if they were doing well and when the support group size was too large. A participant found a group size of seven too large "*to do one to one or differentiated activities"* (P17) with and suggested that a group size of three would be ideal. However, a participant with groups of ten pupils felt that while there were advantages and disadvantages, the pupils were in a group whereby they were "*working to their ability"* (P14) and she felt that this gave them a chance to enjoy and achieve success that would not have otherwise happened.

While the Cohort 1 participants were aware of the importance of teaching foundational skills in mathematics and a social mathematics programme, participants in three of the six mainstream schools "*shadowed the work of the class teacher in learning support"* (P6) as this was *"the way the class teacher wanted to do it*" (P14). One of these participants described how she would withdraw a smaller group from a classroom and teach then "*the same topic that they are doing in the classroom at a different level"* (P6). Other participants either pre taught mathematics content or worked from the class text during a thirty minute class period (P14, P17). The pupils then returned to their classes and *"the class teacher has a half an hour to work with them and to monitor"* (P14). While one of the participants acknowledged that there was a lot of planning involved in this approach (P14), a second participant teaching in similar circumstances, said that there was "*no time for planning"* (P17) but that she would *"know the way the class teacher follows the book. We are not jumping from chapter to chapter. It's A to Z"* (P17). Two of the eight Cohort 1 participants supported their pupils in mathematics through an intervention programme based on their assessed needs – *"I would give the little assessment and then I would teach towards the specific targets. Then I would reassess and see"* (P11). This participant said that this approach was new to her and that she had acquired this knowledge from the PGDSEN programme. She based her programme on functional mathematics skills. The second participant had a similar approach of pre-testing and focused on establishing a strong foundation in number independent of the class teacher's programme in mathematics. This approach was contrary to previous approaches of some participants which would have been strictly aligned with the curriculum. Participants justified their new approaches because of the expertise they had gained on the PGDSEN programme (P23) or because of the nature of the pupil's disabilities (P2).

Mathematics was not seen as a priority for some pupils in the participants' case loads who had additional needs and the focus tended to be for example on their language and behaviour. Despite the fact that many of these pupils had considerable difficulty in mathematics, three of the Cohort 1 participants reported that mathematics was *"not a priority"* (P17). This resulted in participants "*teaching less maths because of the targets in literacy"* (P7) and other areas such as "*communication and behaviour"* (P6).

The special class participant in Cohort 2 taught a class of nine pupils aged between six and eleven with multiple disabilities in the mild to moderate range of learning disabilities with the support of two SNAs. She based her mathematics programme on the Guidelines in Mathematics for Participants of Mild and Moderate Learning Disabilities (National Council for Curricululm and Assessment, 2007; National Council for Curriculum and Assessment, 2007). This participant developed worksheets and booklets for her pupils herself and used websites such as www.mathsaids.com to support her in this. Her preference was for websites which enabled her to create worksheets based on the ability of her pupils. This participant taught the mathematics curriculum "*topic by topic"* as otherwise she felt that her pupils "*would be totally bamboozled and they wouldn't engage with it"* (P28). The class worked on the same topic and were divided into groups "*the junior group and the senior group"* (P28). One pupil required one to one support and the other groups were supported by either the class teacher or an SNA. There was differentiation within each group as *"some of the juniors can move much quicker. Some of them, you have to go back to basics"* (P28). Each mathematics class had a number of different activities and the pupils moved from individual work stations to group work to working with ICT.

The mathematics curriculum in two of the Cohort 2 participants' schools was taught by means of split classes and therefore additional support in mathematics was offered only in exceptional cases (P15, P18). Two of the seven Cohort 2 participants supported the work of the class teacher. However one of the participants noted that *"we are doing that for a long time now and maybe we just need to step back"* (P9). One participant reported that although there had been a history of working with class teachers on the text book, the school had accepted that the pupils needed to learn "*where they are at rather than where they are meant to be at"* (P10) and therefore the teachers had now *"stopped pushing that all pupils cover all strands of the curriculum"* (P10). If pupils scored a STEN of 3 or 4, the policy in one of the Cohort 2 participants' school was to work them with the class programme in mathematics "*if that is at all possible unless they find huge gaps*" (P9). The class work would be differentiated for the pupils in that "*if everyone is doing ten problems, they are doing two"* (P9). Pupils with more significant needs in this school might work on a different mathematics programme – for example, a third class pupil might work on a first class programme with the LS taking the lead on assigning homework. A Cohort 2 participant described how some of the pupils in her case load had their additional support allocations removed when their attainment levels in mathematics increased. On their return to class "*we found that they slipped again which is <u>horrible</u>"* (P21). The *Maths Recovery* programme was the main intervention provided in mathematics in one school (P10). The instruction was provided by the LS/RT participant in small groups and individual support was occasionally provided by keeping a pupil "*back for ten minutes"* to work on a "*specific thing"* but time constraints limited further interventions (P10).

There appears to be no standard model of support for teaching mathematics in the participants schools. Rather the participants moulded their teaching to support the specific needs of their schools adopting either co-teaching or withdrawal approaches. The *Maths Recovery* programme provides the only means of additional support in the junior classes in one school while two other schools support pupils with SEN in mathematics by splitting classes. There was some evidence of an assessment cycle where participants taught to identified needs. Participants who used the class text book to support pupils had either moved from this approach or were reflecting on it. It was clear that mathematics was not a priority for those pupils who had greater needs or for some EAL pupils. It can be inferred from the data that additional support is prioritised in literacy over mathematics in some schools. The two participants who taught in the special class and in the special school appeared to have more established structures in place in their classes for teaching mathematics.

5.4.9.2 Assessment

Planning to teach mathematics to pupils with SEN is a key element of the work of the special educator participants. A significant input on the assessment of pupils in mathematics was provided to the PGDSEN programme participants. The perceptions and experiences of the participants on both assessment in mathematics and their understandings of how they have changed their practice are now presented.

Seven of the eight Cohort 1 participants admitted to making changes in their assessment process in mathematics on their return to school in their classrooms and in some cases at whole school level also. The special school participant in this cohort operated within the whole school assessment framework which was well established.

Two of the Cohort 1 participants had an assessment structure in place prior to their undertaking of the PGDSEN programme. Subsequently both developed this area to include diagnostic testing. Five of the eight Cohort 1 participants identified assessment as an area where they had required upskilling. One participant noted that prior to the PGDSEN programme she "*would have jumped in. I would have said they need to know this and that. I would have made out the programme without even having met them"* (P2). Following the PGDSEN programme, she pre-tests and develops an intervention programme based on identified strengths and needs. While she said that her school had some diagnostic tests, they had now developed their repertoire of assessments to include the DTEN (ERC, 2011). This was used as a screener with all Senior Infants and First Class pupils and was followed up with the diagnostic test for some pupils. Another participant described her previous routine for working with a new group of pupils in mathematics – *"I suppose I wouldn't individually test them and I know now that I should have but I wouldn't have had. I'd start with number first and then go on to the other strands. You would do your own testing after a couple of weeks and see how it went. I didn't kind of test at the start which is something I would have done in literacy but not in numeracy*" (P23). This participant's school had purchased diagnostic tests on her recommendation. Another participant also reported how she had similarly changed her approaches to assessment and that she would now "*give the little assessment and then I would teach towards the specific targets. Then I would reassess and see"* (P11). Again, this was a new approach for her and was something that she "*had taken on board"* from the PGDSEN programme. Prior to the PGDSEN programme, this participant would have planned as the pupils worked and when they didn't understand something she "*would have gone back to it"* (P11). Her support in mathematics was not as structured as it is currently – *"I know exactly where I am working towards*" (P11).

Three of the six mainstream schools in Cohort 1 did not have diagnostic tests in mathematics - as Participant 6 said "*We are actually very poor on mathematics tests"* (P6). Seven of the eight participants (excepting the special school participant) had now developed an *"awareness of the diagnostic tests that are out there that we didn't know*| (P7). Five of the eight participants had shared information on diagnostic test materials with their colleagues and two of these schools had purchased diagnostic tests subsequently.

All of the Cohort 2 participants admitted that they had made changes to their existing assessment practices in mathematics following the PGDSEN programme and three participants had shared their expertise with their colleagues to initiate whole school approaches to assessment in mathematics for pupils with SEN. There was evidence of a general empathy to the admission of one participant that she "*hadn't a clue about assessment"* (P22) before she did the PGDSEN programme. Another acknowledged that prior to the PGDSEN programme she "*would never have thought to start with a baseline or to start with an assessment to see where I was…. I would have gone head first into the topic not even taking account first of all to figure out where we are starting out at"* (P28). The PGDSEN programme had helped another participant to "*realise the importance of assessment"* (P21).

Four of the seven Cohort 2 participants now conducted an error-analysis on the SIGMA-T results, a skill they acquired on the PGDSEN programme. Two participants described how using the findings of an error analysis on a SIGMA-T to plan an intervention programme proved successful – *"I was given a 6th class group after the* SIGMA-T *last year. I took out their papers and I just went through them and found out the areas they were bogged down in and it actually made a big difference because I targeted those areas"* (P21). Another participant noticed that fractions were a weak area when she conducted an error analysis on the SIGMA-T results of her pupils (P15). One participant realised that although she had not been familiar with the term 'error analysis', she had in fact "*been doing it and you feel better about doing it when you know what you are doing it for"* (P18). It was recognised that conducting error analyses was not a common occurrence in every school. One participant reported that in her school she *"didn't know of anybody really who goes back in and analyses, does a miscue analysis or any of that kind of thing with the results*" (P15). However, another participant had shared her expertise on error analysis of SIGMA-Ts with her teaching colleagues and now *"all the teachers have started doing this as well"* (P21).

Additional changes to assessment reported by the Cohort 2 participants included pre and post testing of intervention programmes (P9), purchasing and using the DTEN (ERC, 2011) (P18, P22) and using check lists and criterion referenced tests received on the PGDSEN programme (P21, P22, P9)

Assessment practises in mathematics had changed for the majority of the participants following the CPD they had received on the PGDSEN programme. They were more aware of the diagnostic tests available in mathematics and had learned how to implement them and how to use the results to plan intervention programmes in mathematics. Error analysis proved to be a useful skill acquired and it was particularly useful in schools who did not have access to diagnostic test materials in mathematics. Conducting an error analysis on the test materials readily available in every school, the standardised tests in mathematics, ensured that the participants now had both a recognised measure of pupil attainment and a diagnostic profile of pupils strengths and learning needs in mathematics. A comment made by one participant was typical of several others who said that the input on assessment skills had "*definitely focussed my teaching and I feel more confident teaching mathematics"* (P21).

5.4.9.3 Number

The participants' reflections on the teaching of number, a key element of the mathematics curriculum will be presented. Number forms a core element of the intervention programmes taught by the participants in both Cohorts 1 and 2.

The special school participant in Cohort 1 stated that her focus is predominantly on pre-number skills and early mathematics skills. All the participants recognised the difficulties their pupils experienced when learning number – *"I try to put myself in their shoes and see how difficult it is for them. Like it is just so difficult"* (P11). The participants experienced a certain level of frustration when teaching number to their pupils – "*You would be hoping they had learned their tables but they haven't them. It's back to the drawing board"* (P17). Another participant queried if pupils did any counting at all at home as she had pupils who at the age of seven "*still don't know one to five*" (P11). All participants assessed baseline levels in number for pupils receiving support for the first time – *"Even if a 6th class pupil comes out to you, you have to go back and make sure they have number*" (P2). Interventions implemented included programmes such as *Mata sa Rang*, evidence based strategies including doubles, counting on, counting over the decades and using concrete materials/manipulatives. Two of the participants referred to measures used to obtain baseline measurements in number. The Chinn '*Fifteen Minute Test'* (Chinn, 2012) recommended on the PGDSEN programme was the choice of one of the participants.

Both the Cohort 2 participants and the class teachers they worked with were in agreement about the importance of developing a strong capacity for number sense in their pupils. Class teachers in one school requested that the LS/RT to *"take them out and make sure they can add"* (P10) as opposed to organising maths games in a station teaching structure in the classroom. One participant felt that participants in her school *"rush from number too quickly"* (P9) and that it was necessary to go back to the basics. Older pupils in another school didn't "*seem to have a good foundation in number"* (P21). All participants acknowledged that they spent a lot of time "*doing number"* (P10) and that *"you have to help them to see it and get it"* (P15). One participant referred to the teaching approaches of a class teacher in her school and she felt from her observations of his teaching number to a pupil with SEN that this participant *"did not know what to do with special needs"* (P22).

The participants and the class participants in their schools were aware of the necessity for pupils with SEN to develop a strong foundation in basic number skills. The participants prioritised this area of the curriculum and used a variety of evidence based approaches to teach number to pupils with SEN.

5.4.9.4 Social mathematics

The PGDSEN programme provided affirmation and expertise to the participants on the importance and necessity of teaching a social mathematics programme to their pupils and was taught by all the participants.

Participants in Cohort 1 were focused on teaching the pupils *"what they need and what is functional for them"* (P11). This was accomplished by integrating the programme into real life activities including going to the local shop (P25) and by setting the teaching activities in real life contexts such as measuring the height of their friends or identifying toiletries that were permissible on flights abroad (P2). Teaching the specific skills was achieved using evidence based practices such as talk analysis and Horsteimer's (2004) teaching approach for money. There was a big emphasis on social mathematics in the special school in Cohort 1. Core elements of the programme such as number, time and money were taught every year (P25) while other strands were on a three year cycle in the school. The SNAs in this school encouraged and supported the generalisation of social mathematics in the daily routine of the class and the school by *"helping the children to set up their table at lunch time, by talking about the one to one correspondence, have we enough cups and plates?"* (P25). This school had acquired a wide range of resources to support the teaching of social mathematics. One participant felt that her expectations in the area of social mathematics did not meet with the expectations of the class teacher to complete the text book and she felt that this hindered her ability to deliver an effective social mathematics programme.

Cohort 2 participants prioritised social mathematics for their pupils. There was a strong emphasis in this cohort of participants of using real life settings and contexts to teach a social mathematics programme. Participants taught social mathematics by taking their pupils to the shop and preparing them for the social and mathematical demands of the occasion (P9, P28). One participant taught money successfully and enjoyably to a group of pupils using real money (P15). Participants stated that they taught *"a lot of time and measurement"* (P10) and felt that social mathematics should be prioritised particularly for older pupils where a level of mathematics to enable them "*to get by in life"* was the expectation of their parents (P21). One participant felt that the limited mathematical experiences in some homes hindered the acquisition of social mathematics and in her view there was "*no counting, measuring or anything going on"* (P10) in the home.

The special class participant in Cohort 2 said that she took a *"very practical approach to mathematics*" and applied "*it as much as possible to their everyday living"* (P28). She set each topic taught in the context of the pupils daily life experiences by asking *"Where do we use it in everyday life*?" She found that the participation and interest levels of her pupils was increased by setting mathematics in the specific life experiences of her pupils.

Social mathematics was a priority topic for all the participants following their undertaking of the PGDSEN programme. They recognised the value of teaching a social mathematics programme and in setting it in the everyday contexts of the daily lives of their pupils. Negative influences on the teaching of a social mathematics programme included the lack of parental support for mathematics and class teacher expectations with regard to adhering to the mathematics text book.

5.4.9.5 Resources to support the teaching of mathematics

The findings suggest a wide range of resources are central to the teaching of mathematics both in mainstream classrooms and in special education settings. It was noted that while infant classes were particularly well resourced in mathematics, the majority of schools were satisfied with the resources available to them in mathematics. Technology resources were widely available in all but one of the schools. There was some evidence to suggest that technology resources were underutilised in a small number of schools. The mathematics text book remains the core teaching resource in mainstream classes and influences to varying degrees the intervention programmes of pupils with SEN in mathematics. There is evidence to suggest that less emphasis is placed on the text book in special classes or in special school contexts. The participants generally favoured the option of teaching mathematics to pupils with SEN independently of the text book.

5.4.9.6 Summary - Theme 3: Translating the learning into practice – Teaching mathematics to pupils with SEN

The Cohort 1 and Cohort 2 participants developed intervention programmes in mathematics to meet the specific needs of their schools. Some devised interventions based on assessed needs while others either co-taught or provided in- class support or supported pupils in small groups shadowing the work of the class participant. Most of the participants made adjustments to their assessment practices in mathematics following their participation in the PGDSEN programme. They became aware of the necessity of assessment and of the monitoring of progress using diagnostic approaches such as precision teaching, error analysis and diagnostic test materials. They prioritised the teaching of number and programmes in social mathematics. Intervention programmes such as *Mata sa Rang*, *Maths Recovery* and *Mighty Maths* were implemented in a number of schools and provided an additional level of support to all pupils in mathematics. Participants used technology, hands on activities, concrete materials and evidence based practices in their teaching. Some schools had developed the practice of teaching mathematics in single streams as a means of raising attainment levels in mathematics on a whole school basis.

5.4.10 Phase 2: Summary of findings

Phase 2 (n = 15) of this research study was undertaken twelve months after the participants had completed the PGDSEN programme. It comprised of two cohorts, Cohort 1 (n = 8) and Cohort 2 (n = 7). All participants held permanent teaching posts – LS/RTs or special class teachers in their schools. While the participants were experienced classroom teachers (> 5 years), the majority of them were relatively inexperienced in special education (< 5 years). This phase examined the individual and contextual factors which influenced the participants acquisition of knowledge and skills in mathematics, identified their perceptions and experiences of the influence of the mathematics lectures on the PGDSEN programme on their acquisition of knowledge and skills in mathematics and identified their understandings of the transfer of their learning to their practice. The findings were presented thematically.

The findings indicated that the Cohort 2 participants were favourably disposed to communicating and interacting with people with disabilities, were receptive to the inclusion of pupils with SEN in mainstream schools but had concerns about aspects of inclusion relating to appropriate provision for all pupils and the impact on both their workload and their stress levels in so doing. They have high personal beliefs in their ability to teach successfully. Although the participants believed that their teaching would have a positive impact on the ability of their pupils to learn, they were less confident of this. The participants do not experience mathematics anxiety. While it is not possible to compare the beliefs and attitudes of both cohorts in relation to the above measures, the findings indicate that the Cohort 2 participants had more positive dispositions and less concerns about inclusive education than Cohort 1. Cohort 2 participants also held a slightly higher belief in the effectiveness of their teaching of mathematics. Both cohorts shared similar dispositions on the impact of their teaching on the ability of their pupils to learn mathematics. While neither cohort experienced mathematics anxiety, the Cohort 2 participants had slightly lower levels of mathematics anxiety than their Cohort 1 counterparts.

National initiatives such as the SSE process (Inspectorate, 2012) and intervention programmes in mathematics such as *Mata sa Rang* (O'Loughlin, 2012) and *Maths Recovery* (Wright et al., 2006) were perceived by the participants to positively influence the teaching of mathematics in the schools. They created a new awareness on the teaching of mathematics and afforded the participants the opportunity to implement new approaches in the school. Mandatory standardised testing in mathematics guided the allocation of resources to pupils requiring additional support in mathematics. However, there was evidence to suggest that they had a negative impact on the mathematics curriculum taught to some pupils with SEN due to the differing expectations of class teachers and LS/RTs. These factors limited the opportunities for the LS/RT participants to implement an intervention programmed based on assessed needs in some schools. Participants noted the influence of parental attitudes and expectations on their children's attainment levels in mathematics. Mathematics was not a priority area for some parents of children with SEN. Factors influencing this decision related to the negative attitude of parents to mathematics and to the fact that some pupils had considerable needs in areas such as life skills/care needs, language, literacy and behaviour. Co-teaching was identified as a new approach to supporting the teaching of mathematics. The participants recognised the need for whole school approaches to CPD in mathematics in special education contexts.

The findings suggest that the participants valued CPD. This was evident by their participation in the PGDSEN programme and the wide range of other CPD courses they had undertaken. Participants who were new to SEN undertook the PGDSEN programme to acquire new knowledge and to gain confidence in their role. Those participants who were more experienced in SEN committed to the PGDSEN programme in order to upskill in special education, to reaffirm their existing knowledge and to gain a professional qualification in this area. While acknowledging that learning mathematics was difficult for pupils with SEN, the participants agreed that their knowledge, skills and understanding of the teaching of mathematics to pupils with SEN had increased following their participation in the PGDSEN programme. Participants felt that they were now more respected in their schools and in some instances there was evidence of a sharing of expertise with class teachers. The participants recognised the need for ongoing CPD in mathematics to support pupils with SEN.

The Cohort 1 and Cohort 2 participants developed intervention programmes in mathematics to meet the specific needs of their pupils. Some devised interventions based on assessed needs while others either co-taught or provided in- class support or supported pupils in small groups shadowing the work of the class participant. Most of the participants made adjustments to their assessment practices in mathematics following their participation in the PGDSEN programme. The PGDSEN programme provided affirmation and expertise to the participants of the importance and necessity of teaching a social mathematics programme to their pupils and was taught by all the participants. The participants were applying evidence based practices relevant to social mathematics in their classrooms. They were more aware of the importance of teaching number as a foundational element of the mathematics programme and most incorporated elements of number into every mathematics lesson. Some schools had developed the practice of teaching mathematics in single streams as a means of raising attainment levels in mathematics on a whole school basis.

5.5 Findings: Phase 3

The purpose of this section is to present the findings of the final phase of the data, Phase 3 (Table 4.2). This phase explored the influence of contextual factors such as policy and provision in special education on the practice of the participants. It also explored the participants' perceptions of their acquisition of skills and knowledge in mathematics following their completion of the PGDSEN programme. The primary focus of this phase is however, on the understandings of the participants on the transfer of their new knowledge and skills to practice through the lens of a case study, a specific focus on their teaching of mathematics to a pupil or a group of pupils in their case load. Data collection for this phase began at the beginning of the second school year following the participants' completion of the PGDSEN programme and was collected over a four month timeline.

5.5.1 Overview of data set (Cohort 1 and Cohort 2, Phase 3)

Phase 3 comprised of two cohorts, Cohort 1 (n = 4) and Cohort 2 (n = 4). While both cohorts had participated in the baseline data and Phase 2 stages of data collection, Cohort 1 had also participated in Phase 1 (Table 4.2). An overview of the participants' teaching positions is presented in Table 5.16.

Table 5.16 Teaching Positions (Cohort 1 and Cohort 2, Phase 3)

Participants n = 8	LS/RTs	Special class in mainstream school	Special class in special school
Cohort 1 (n = 4)	3	-	1
Cohort 2 (n = 4)	3	1	-

5.5.2 Theme 1: Inclusive and special education: Policy and provision

This theme examines the contextual factors (external and internal to the school) influencing the participants transfer of knowledge to practice in the classroom at Phase 3 of the data gathering. These factors have been outlined in greater detail in Phases 1 and 2. The contextual factors now presented provide a brief insight into the current teaching contexts of the participants.

5.5.2.1 External influences on provision

5.5.2.1.1 National policies

The Cohort 1 participants noted the impact of national policies such as the SSE and initiatives such as *Mata sa Rang* in their schools. Three of the four Cohort 1 participants were aware of the *Mata sa Rang* initiative (O'Loughlin, 2012). Two of the schools were implementing the programme and in one school it resulted "*in an awful lot of sharing of ideas and resources"* (P7). One participant stated that the programme "*had influenced her teaching"* (P2). Two of the four schools were focusing on problem solving as part of the mathematics component of the SSE. Problem solving was described as being the "*biggest issue we have and even for ourselves as teachers"* by one participant (P7). The school had developed a whole school approach to support problem solving. Despite the SSE initiatives, one participant felt unsure that the planned whole school approaches to mathematics would be applied throughout the school as some class teachers *"close their door and work in isolation*" (P2). The influence of national policies such as the SSE or the National Literacy and Numeracy Strategy were not evident in the special school in this cohort.

One of the DEIS schools in Cohort 2 stated that the DEIS plans in numeracy influenced the teaching of mathematics in the school. The participants in the school identified that measure was an area where they "w*ere really falling down in"* (P10) and subsequently materials were purchased to support the teaching of this aspect of the curriculum. Another participant stated that the SSE focus on numeracy in her school had brought in “*something new and it would refresh and refocus you”* (P18). One participant was aware that mathematics was the focus of their SSE but she had no involvement in it (P15).

5.5.2.2 Internal influences on provision

5.5.2.2.1 Supports to the teaching of mathematics.

The Cohort 1 participants identified a number of internal influences in their schools which supported the teaching of mathematics to pupils with SEN. These factors facilitated their teaching of mathematics.

Two of four Cohort 1 participants reported that station teaching approaches in mathematics were in place in their schools. Both recognised the value of this strategy as a means of “*sharing ideas”* between colleagues (P7). It was seen as a way of *“helping a way more kids and it is giving your group a boost”* (P2). This participant stated that the classes worked well even though the teachers did not plan the co-taught mathematics lesson together (P2).

Three of the Cohort 1 participants indicated that they collaborated with class teachers when teaching intervention programmes in mathematics. There was evidence of strong collaboration between all teachers in the special school (P25). The whole school policy on mathematics directed the teaching of mathematics curriculum in the special school. The class teachers in this school were working on similar strands of the mathematics curriculum and this enabled a sharing of expertise between class teachers and a sharing of learning between the pupils also. A participant acknowledged the support of class teachers who were interested in mathematics and who shared their expertise. This sharing of expertise in addition to the PGDSEN programme had influenced her teaching of mathematics (P10).

Under the direction of the class teacher and/or the LS/RT, SNAs supported the teaching of mathematics in each of the four schools in Cohort 1. They assisted with station teaching in early intervention programmes such as *Mighty Maths*. Their role in the special school was particularly valuable. The special school participant noted that the three SNAs and the classroom assistant in her class would assist with the generalisation of the mathematics programme and would for example take a pupil on a Maths trail if they needed a break from the classroom (P25).

Two of the Cohort 2 participants collaborated with their colleagues. Two participants taught single stream mathematics and both were of the view that this approach supported their teaching of mathematics. The support of parents was recognised. Parents from Eastern Europe were said to be particularly ambitious for their children and had high expectations in mathematics as they viewed it as *"the least language heavy part of the curriculum"* (P10). *Maths Recovery* and *Aistear* were implemented in this school with the support of the SNAs and other students on work placement (P10).

In the Cohort 2 schools, SNAs supported pupils learning mathematics. The special class participant valued the role of her SNAs in implementing the mathematics programme. One of the SNAs had been in this classroom the previous year and "*is flying now at doing the maths"* (P28). However the second SNA requests the support of the participant "*to explain how to do this"* and is more anxious about mathematics.

The parents of the special class participant's focus pupil were very supportive of his mathematics programme. They could clearly identify the progress their son had made in the last two years in mathematics and were very proud that he was learning. The participant acknowledged that her "*eyes were opened doing the PGDSEN programme"* and that consequently the parents could see the "*whole new style of learning"* in the classroom which was different to from before (P28). These parents "*can't believe that he is doing as well as he actually is"* (P28). They were very proactive and worked with their child in the home.

5.5.2.2.2 Challenges to the teaching of mathematics.

The Cohort 1 participants agreed that the SENs of their pupils posed a challenge to their mathematics education. A pupil with memory difficulties was unable to place his learning experiences in real life contexts as he "*wouldn't be able to tell you what he did this morning at home"* (P7). Four of the eight pupils in the special school participant's class were non-verbal and this impacted not only on their learning but also on the assessment of their learning (P25). The negative attitude of a fifth class group resulted in a resistance on their part to learn mathematics (P2) in one school. In this instance, this may have been attributed to the particularly high standards of mathematics in the school and the challenge that existed for pupils *"that are within the average range"* to keep up with the exceptional standards of mathematics in the school resulted in these pupils feeling "*that they are struggling"* and consequently becoming discouraged (P2).

The majority of the parents of the Cohort 1 participants focus pupil/pupils did not have high academic expectations for their children in mathematics. One parent prioritised social mathematics for her child (P7) and another was supporting the special class participant in generalising the mathematics programme (P25). The parents in a school described as having a high socio-economic background had high expectations for their children in mathematics but yet were generally unable to support them at home as the participant felt that while “*they have the ability”* to do so, they did “*not have the skills”* (P2) due to their personal high ability in mathematics.

Time constraints and timetabling were noted by three of the four Cohort 1 participants as factors impacting on their teaching of mathematics. Given the extent of the needs of the pupils, one participant stated that it was difficult to fit mathematics into her learning support schedule and that “*mathematics may not get covered every day”* (P17). A participant described the timetabling of three late afternoon mathematics classes for her focus pupils as *“the real Cinderella”* and it resulted in her inability “*to do anything heavy with them”* (P2). This participant also felt that she could not justify time on assessments due to the limited time available to her for teaching mathematics.

The Cohort 2 participants all noted the challenges posed by the SENs of their pupils. Pupils in a DEIS school achieved average STEN scores of “*around threes and fours and less”* (P15). The pupils “*need everything explained to them”* and they did not have the ability to think abstractly (P15). EAL posed a particular barrier to learning mathematics in another DEIS school (P10). Participants noted the difficulties experienced by pupils with low working memory (P15) and with pupils who failed to “*link knowledge they know already”* (P18). The special class participant stated that the multiplicity of SENs of her pupils necessitated one to one teaching support (P28).

There were two DEIS schools amongst the Cohort 2 participants. Annual parent/teacher meetings in one of these schools were not well attended and the school did not rely on support from the home to teach mathematics to their pupils. The special class participant stated that the majority of the parents of her six pupils were not in a position to support their children in mathematics due to the fact that “*a lot of them have special needs themselves and so they wouldn’t have the ability”* (P28).

5.5.2.3 Priority of literacy over mathematics

The time allocation devoted to additional support in mathematics in most of the schools indicates that literacy and other subject areas receive priority. The special educational needs of the pupils dictate the time allocation. Parental expectations are initially directed towards literacy with parents of children with EAL being particularly interested in their children’s acquisition of the English language.

5.5.2.4 Summary - Theme 1: Inclusive and special education: Policy and provision

The influence of the SSE, the schools’ DEIS numeracy plan and the *Mata sa Rang* initiative were noteworthy in respect of their positive influence on the teaching of mathematics in the participants’ schools. Schools had identified areas of need in mathematics as part of their SSE process and subsequently developed whole school approaches to overcome difficulties e.g. whole school approaches to problem solving. There was some evidence to suggest that not all class teachers participated in such initiatives. The influence of national policies on the teaching of mathematics was not evident in the special school in this phase of the study.

The Cohort 1 and 2 participants acknowledged the contributions of class teachers and SNAs to the teaching of mathematics in their schools. Class teachers were involved in the design and implementation of intervention programmes in mathematics. Some LS/RTs engaged in co-teaching in mathematics either through the station teaching model or through teaching single stream mathematics classes. Collaboration and peer support from teaching colleagues was particularly evident in the special school. While SNAs supported the teaching of mathematics in most schools, their support was particularly valuable in the special school and the special class in this cohort and in initiatives such as the *Maths Recovery* and *Aistear* programmes in mainstream schools.

The individual learning profiles of the pupils was a consideration for the participants when designing and implementing intervention programmes in mathematics. Issues such as the pupils' memory difficulties, their difficulties with language (non-verbal, EAL), their negative attitude and low attainment levels generally needed to be considered. Time constraints influenced both the time available to teach mathematics and the intervention programme taught. Some participants stated that the nature of difficulties experienced by their pupils limited the time available to teach them mathematics. The supportive role of parents (in two schools) was welcomed by the participants. However, it was more generally noted that parental support was not forthcoming and may be explained by the limited mathematics standards of parents themselves. The lack of support in mathematics from parents in a school with a higher socio economic background was deemed to result from their higher personal ability in mathematics.

5.5.3 Theme 2: Continuing professional development (CPD)

This section presents the findings of the second theme in Phase 3 of the data collection, CPD. An insight into the participants views on CPD and on their understandings of the influence of the PGDSEN programme on their teaching of mathematics will be presented.

5.5.3.1 CPD – perceptions and experiences

The participants actively engaged with CPD. They expressed positive sentiments towards it as a means of further enhancing their knowledge and skills in education.

All four of the Cohort 1 participants agreed that CPD was a worthwhile endeavour – *"hugely important"* (P7). They felt that participating in CPD "*can bring so much to your teaching"* (P17) and made them feel "*more energised and more enthusiastic"* (P17). The Cohort 1 participants preferred CPD which was delivered using the face to face model. Two of the participants felt that this approach enabled the sharing of expertise and ideas amongst teachers which in turn enhanced their learning experiences – "*you can learn just as much from the person sitting beside you as you can from the facilitator"* (P2). One participant however had completed online CPD as "*it was convenient"* but acknowledged that she "*hadn't taken anything from it really"* (P28). Positive learning experiences from CPD resulted in the participants implementing new ideas "*without having to go back to the book"* (P2) and may also direct the learner to conduct further research on the topic (P17).

Having recently experienced CPD in the form of the PGDSEN programme themselves, two of the participants felt that classroom teachers should be given the opportunity to avail of CPD in mathematics for SEN. This would result in class teachers having an "*understanding of special education that would be so much broader and more comprehensive"* (P7) and also enable them to see that differentiation was every teachers' responsibility (P17). However, it was noted that some class teachers "*have no interest"* in doing CPD despite it being part of their Croke Park hours or the availability of courses in a nearby Education Centre (P2).

The Cohort 2 participants valued CPD. They found it *"really helpful"* (P18) and it made one "*think and reflect"* (P15). Three of the four participants preferred CPD delivered through the face to face model. However, owing to long distances from CPD venues, two participants found that online suited their needs better. CPD was judged to be effective if you acquired "*new knowledge"* (P18). Participants liked CPD which was "*informative and practical"* (P18) and "*helps you in the classroom"* (P15). One participant referred to discussions with her teaching colleagues as being a useful means of CPD (P18).

All of the participants value CPD and actively engage in it. Face to face is the preferred option owing to the opportunities it provides for learning with and from teaching colleagues.

5.5.3.2 PGDSEN programme – acquiring knowledge, skills and understanding in mathematics

Their participation in the mathematics lectures of the PGDSEN programme resulted in gains in the professional knowledge, skills and understanding of the participants. This section presents the views of the participants in this regard eighteen months following their completion of the PGDSEN programme.

The Cohort 1 participants had acquired new knowledge and skills. Three of the four participants referred to knowledge they had gained in the assessment of pupils with learning difficulties in mathematics. They were using checklists they had learned about on the PGDSEN programme such as the Chinn check-list (Chinn, 2012) (P2) and the checklists in STRANDS (Long, 2011) (P17, P25). One participant was using the Mathematics Assessment for Learning and Teaching (MaLT) diagnostic test (Hodder Education, 2005) which had been purchased by her school on her recommendations. Having referred to her notes from the PGDSEN programme, the participant *"went down a level in the MaLT"* as had been suggested (P2). There was evidence of sharing of new knowledge in this school as the participant said that "*everybody is using"* the Chinn test (P2). The special school participant had become aware that she was "*better to use a checklist"* (P25) and was "*definitely doing them more whereas I wouldn't have before"* (P25). She outlined how she now uses checklists to inform her *"of what the child was saying or what he was doing or how he did it*" by making a tick and a note on the checklist (P25). One of the four participants stated that she was not using diagnostic tests as there was *"no funding in the school for diagnostic mathematics tests"* (P7).

The Cohort 1 participants recognised the necessity of including a life skills programme in mathematics using real life examples to support their teaching. Three of the four participants indicated that they were more aware of this element of the mathematics programme following the PGDSEN programme and one participant stated that she had "*changed her approach"* to include the teaching of "*things which will take them through life"* (P2). She now referred to "*chocolate cakes and pizzas"* for example when teaching fractions (P2).

STRANDs (Long, 2011) was used by two of the four participants and was found to be useful for structuring intervention programmes. One participant found that it gave her the mathematical language she needed to plan her programmes and said that "*when you read my IEP, you will see it coming from there"* (P17). Two of the Cohort 1 participants noted the influence of the PGDSEN programme in their teaching of number.

In addition to acquiring new knowledge and skills which were transferable to the classroom, one participant reported that she was now *“more interested in looking at the NCCA or NCSE websites”* and said that she keeps *“more up to date with changes or what is out or what is coming down the line”* (P25).

The Cohort 2 participants recounted how they had implemented new approaches and strategies into their teaching following their participation in the PGDSEN programme. Informal testing using teacher designed tests and/or teacher observations was the most common form of assessment used by the participants. Diagnostic testing in mathematics was a feature of practice in two schools only. The special class participant used teacher designed checklists and maintained an assessment folder for each pupil to record progress.

The Cohort 2 participants taught elements of social mathematics including *“time and money”* (P10) and problem solving in the context of the pupils’ lives (P17). The special class participant taught mathematics which her pupils required in everyday life situations. Time was taught by referring to days such as St. Patrick’s Day and St. Valentine’s Day for example. One participant now sets problem solving in the context of the pupils’ lives (P15).

Evidence based approaches such as visual supports, the CRA sequence, explicit instruction, multi-sensory approaches and real life contexts were used by the Cohort 2 participants to teach number. One participant noted that the fact that her teaching approaches to number differed to those of the class teacher resulted in the pupils “*skipping down the corridor because they know they are going to be doing number but it is going to be done in so many different ways that there is no stress involved”* (P10). She now used evidence based strategies such as Think Alouds and Counting On for subtraction (P10) in her teaching.

Three of the Cohort 2 participants reflected on the theory of learning mathematics. This was an area that they had become more aware of following the PGDSEN programme. One participant said that she now questions more and that she is *“definitely thinking about their thinking and why don’t they …*?” (P18). She recounted how as a child she would *“always know the process and learn it off by heart*” before she understood the concept. She was now reflecting on the learning process of pupils with learning difficulties in mathematics and *“found it interesting that the weaker ones are not linking the knowledge they know already”* (P18). As an able mathematician herself, this participant had not been aware of the challenges experienced by some pupils when learning mathematics. Another participant expressed her wish for “*reading more”* and felt that while she did read the theory, she needed to read some more (P10).

A participant who had not taught for a number of years stated that the PGDSEN programme had made her "*think about maths and patterns"* (P15).

The findings suggest that the participants of Cohorts 1 and 2 had developed a greater awareness of the learning styles of pupils who find it difficult to learn mathematics. To overcome these challenges, the participants implemented evidence based teaching approaches and prioritised areas of the curriculum such as Social maths. They adopted a more structured approach to assessment by using checklists and diagnostic assessments. The participants were also cognisant of the research literature in this area and of its contribution to their daily teaching tasks.

5.5.3.3 Summary – Theme 2: Continuing professional development (CPD)

The Phase 3 participants actively engaged in CPD prior to their undertaking of the PGDSEN programme. They reported changes in their practice in relation to the teaching of mathematics following their participation in the mathematics lectures. The participants outlined their adoption of evidence based teaching practices in their teaching of mathematics. They described changes in their approaches to the assessment of the mathematical abilities of pupils with SEN. There was evidence also of dissemination of newly acquired skills and knowledge to teaching colleagues in the participants' schools.

5.5.4 Theme 3: Translating the learning into practice – Teaching mathematics to pupils with SEN

The perceptions and experiences of the Cohort 1 and Cohort 2 participants on the transfer of their learning from the lectures in mathematics on the PGDSEN programme to their classroom practice will be presented through individual case studies for a pupil or pupils taught by each participant during the first term of the 2013/14 school year. Qualitative data in the form of semi structured interviews, participant reflective journals and documentary analysis of participant records/planning documents provided the data base for the findings.

5.5.4.1 Individual case studies (Cohort 1, Phase 3)

An overview of the individual case studies for each of the Cohort 1 participants is presented in Table 5.17.

Table 5.17 Overview of Individual Case Studies (Cohort 1, Phase 3)

COHORT 1	Participant 2 (P2)	Participant 7 (P7)	Participant 17 (P17)	Participant 25 (P25)
Type of school	Mainstream	Mainstream	Mainstream	Special School
Name of pupil	**Dan**	**Johnny**	**Amy**	**Kevin**
Target pupil/group	One pupil (one of a group of 5 pupils)	One pupil	One pupil	One pupil (one of a special class of eight pupils)
C.A.	11 years	5 years	8½ years	5 years
Class	Fifth class	Senior infants	Second class	Reception Class
Model of support	Small group withdrawal & In-class support	Individual withdrawal	Individual withdrawal	One to one & small groups within a special class
Timetabling arrangements	2 X 30 minutes weekly (mathematics - withdrawal) 1 x 30 minutes (mathematics + literacy withdrawal) 1 X 30 minutes (in-class support mathematics)		5 X 35 minutes – Maths part of two days	30 – 60 minutes daily divided into mini lessons throughout the school day
STEN	4		Not measured	Not measured
Nature of disability	Learning difficulties	ASD	Down syndrome	MGLD/Down syndrome
EAL	No	Yes	No	No
Supported by SNA	No	Yes	Yes	Yes
Planning documentation	IPLP	IEP	IEP	IEP

Table 5.17 Overview of individual case studies (Cohort 1, Phase 3) (Contd.)

COHORT 1	Participant 2 (P2)	Participant 7 (P7)	Participant 17 (P17)	Participant 25 (P25)
Programme of work	Number – subtraction, multiplication, division	Differentiated class mathematics programme	Intervention programme based on number – Senior Infants or First Class standard	Early mathematical activities: Big/small, classifying according to colour & size - one attribute at a time. Classifying according to two attributes. Matching & comparing. Equivalent sets. Length
Evidence based approaches	Concrete materials, real life contexts, scaffolded instruction, task analysis, modelling, backward chaining, response boards	Concrete materials, visual supports, response boards, sand, shaving foam, CRA sequence	Concrete materials, visual supports, modelling, Think Alouds, task analysis, direct instruction, scaffolded instruction, CRA sequence	Concrete materials, visual supports, modelling, hand over hand assistance,
Technology	iPad, laptop	iPad,	Desktop, IWB	IWB, desktop, iPad
Assessment		Teacher observation, teacher designed tests	Teacher observation. Booklet of completed activities	Checklists. Teacher observation

5.5.4.2 Individual case study - Dan

The P2 participant chose to focus on Dan, one of five 5th class pupils receiving additional support on a withdrawal basis in mathematics under the GAM. His STEN score of 4 at the end of 4th class deemed him eligible for support in mathematics. The P2 participant was aware that the low achievers in her school would not be described as such in other schools. Pupils scoring a 4 or a 5 in their standardised testing "*would actually feel that they are struggling"* as the pace in the classroom in this school was "*fast and high average"* (P2). Dan was assessed using the MaLT assessment test in mathematics (Hodder Education, 2005) and achieved a standard score of 80 which placed him in the low average range of ability in mathematics. The participant based her intervention programme on feedback from the pupils with regards to what they wished to learn, from the results of the diagnostic tests ((Chinn, 2012; Hodder Education, 2005), she had learned about on the PGDSEN programme and in collaboration with the class teacher, included "*an element of class work*" (P2).

Dan and his group benefited from one thirty minute in-class support lesson for mathematics weekly. In addition, the group received two thirty minute lessons a week in mathematics and one thirty minute lesson shared between literacy and numeracy from the LS participant. The participant referred to the timetabling of the group support as *"atrocious"* as it was the last class period of each day (P2). The timetabling schedule impacted on the nature of the intervention programme particularly in September as "*they didn't want to be here"*. She detected a "*negativity"* towards mathematics in the pupils which was demonstrated in comments such as "*I am never going to be good at this"* (P2). The timetabling of the support sessions impacted on the motivation of the LS participant also and she said that she was "*finding it really hard in September and October"* and she was not able "*to track what the class teacher was doing"* due both to the limited time available to her and the timing of the sessions. Therefore the LS participant decided to "*do her own thing"* with the group and *"didn't do anything heavy with them"* (P2).

The P2 participant planned her intervention programme termly. Each monthly section of the termly plan focused on a strand (number) and a strand unit (operations) derived from the mathematics curriculum. Objectives and learning activities were presented. An overall section presented the approaches and methodologies to be used (talk and discussion, active learning, collaborative learning, problem solving, skills through content, using the environment, use of ICT), Resources to support the intervention programme (Figure It Out, Maths Zone, concrete materials, IWB, maths games, posters and display, number lines and activity sheets) were outlined. Approaches to differentiation (by support, by resources, by groupings, by pace) and detailed assessment measures for the term (oral assessment, teacher observation, teacher designed tasks, daily assessment of learning in maths books and maths drills and half termly tests) were listed on the plan.

Monthly plans were drawn from the long term mathematics plan for this group. Each monthly plan specified Priority Learning Needs (PLNs). An example of the PLNs are as follows - *To improve number facts recall skills, to develop good problem solving strategies.* These PLNs were restated for the subsequent months of the first school term. The curricular area, skills to be developed, strategies and resources and a progress report were outlined. The P2 participant documented her observations of progress for each pupil monthly. The monthly plan informed the fortnightly plan. On a daily basis the P2 participant would generally "*jot down"* the next steps to be taken following each lesson noting "*what worked and what didn't work"* and what she needed to change in the next lesson (P2).

As the participant was attending the CPD on *Mata sa Rang* for the duration of this school term she applied some of the approaches into her teaching. She avoided using worksheets in the classes where possible and instead focused on elements of the *Mata sa Rang* approach – "*the Friday session was given over to trying the Number Word activities covered at the course"* the previous day (P2RJ 10/10/14). She therefore focused on counting forwards and backwards in this class and noted in her Reflective Journal that Dan "*was very unsure of counting forward and backwards over the decuples and centuples"* (P2RJ 10/1014). She noted that she planned to "*incorporate more of these activities in future sessions"*. Subsequently each lesson began with a *Mata sa Rang* drill "*where they are counting forwards, counting backwards"* using response boards and sequencing cards for consolidation (P2). She used "*loop games and loads of oral drills"* in order to maintain their motivation. A later Reflective Journal entry noted that there was a "*marked improvement noted. Even Dan was more accurate"* (P2RJ 24/10/14) when counting forwards and backwards in the *Mata sa Rang* drills. The participant described an example of an activity whereby the pupils were asked to *"read, underline, highlight key words and key numbers and decide on the operation*" on a problem-solving worksheet but were not required to complete the problems. This lesson concluded with a response board activity where the pupils selected one of twelve sums to complete. The participant always uses "*a little wrap up game"* at the end of the lesson when time allowed.

An informal conversation with the class teacher led to the P2 participant providing in class support in mathematics. The time allocation was achieved by "*pooling lots of children's resource"* hours. There was no formal planning for the lesson and the participant said that she and the class teacher did *"team teaching and it worked a treat"*. She "*worked with half the class of 15 pupils"* which included her support group pupils (P2RJ 05/11/14). Both teachers taught in the classroom. It became evident to the participant that in order to achieve the agreed target of "*teaching the pupils to add and subtract fractions with and without changing to equivalent fractions"* that she needed to reteach fraction equivalents (P2RJ 05/11/14). This resulted in the most of the pupils succeeding and being "*able to make accurate calculations on their response boards"*. She then followed up the programme of work during the afternoon mathematics session with her pupils and also pre taught the next class lesson. Her pupils said to her that she was *"teaching it so more clearly than the class teacher"* (P2). On reflection the participant recognised that the class teacher was pacing the content "*at a higher level"* and "*she wasn't going step by step. Where as I was staying Step one, and they all did Step one"* (P2). The pupils recognised the benefits of their new learning in the co-taught mathematics class and said to the participant that the lesson "*was really lovely, that was really easy"*. The participant noted that Dan benefited from the follow up support with his withdrawal group and that *"finally the penny dropped with Dan and he started to make some progress"* (P2RJ 05/11/14). The participant and the class teacher subsequently decided to deliver a co-taught mathematics class on a monthly basis on the understanding that this approach would "*give the group a boost"* and it would also result in additional support to a broader number of pupils. A comment written by the participant in her Reflective Journal (25/11/14) indicated that the co-teaching approach had been successful for both pupils and teachers as the participant stated that "*it has given me affirmation to build on"* and that it was evident that "*the children in the group have visibly gained confidence"* and were more enthusiastic about their mathematics lessons.

Outcomes of the termly mathematics intervention were not formally assessed. The P2 participant stated that despite considering a formal evaluation prior to a parent teacher meeting she was of the opinion that "*you can sometimes over test"* and that given the time allocation to mathematics she queried if she wanted "*to waste a half an hour, maybe two - half hours giving them a test"* (P2). Her informal observations of the pupils' work led her to the conclusion that as she had "*been working with them, I kind of know where they are"* (P2). While the MaLT (Hodder Education, 2005) diagnostic in mathematics had been completed by Dan at the beginning of the year and the participant said that she "*found it very informative"*, there was no evidence to suggest that the results of this measure informed the intervention programme (P2).

5.5.4.2.1 Discussion – Participant 2.

Figure 5.16 presents an overview of the factors influencing special education teacher learning in relation to Participant 2 (P2). The outcomes of this learning as it translates to teaching mathematics to Dan, a pupil in the case load of P2, have been described. This discussion of special education teacher learning in relation to P2 will focus specifically on teacher learning as it relates to Dan. Positive and negative aspects of special education teacher learning will be discussed in the context of factors which inhibit or encourage teacher learning and the transfer of this new knowledge to practice.

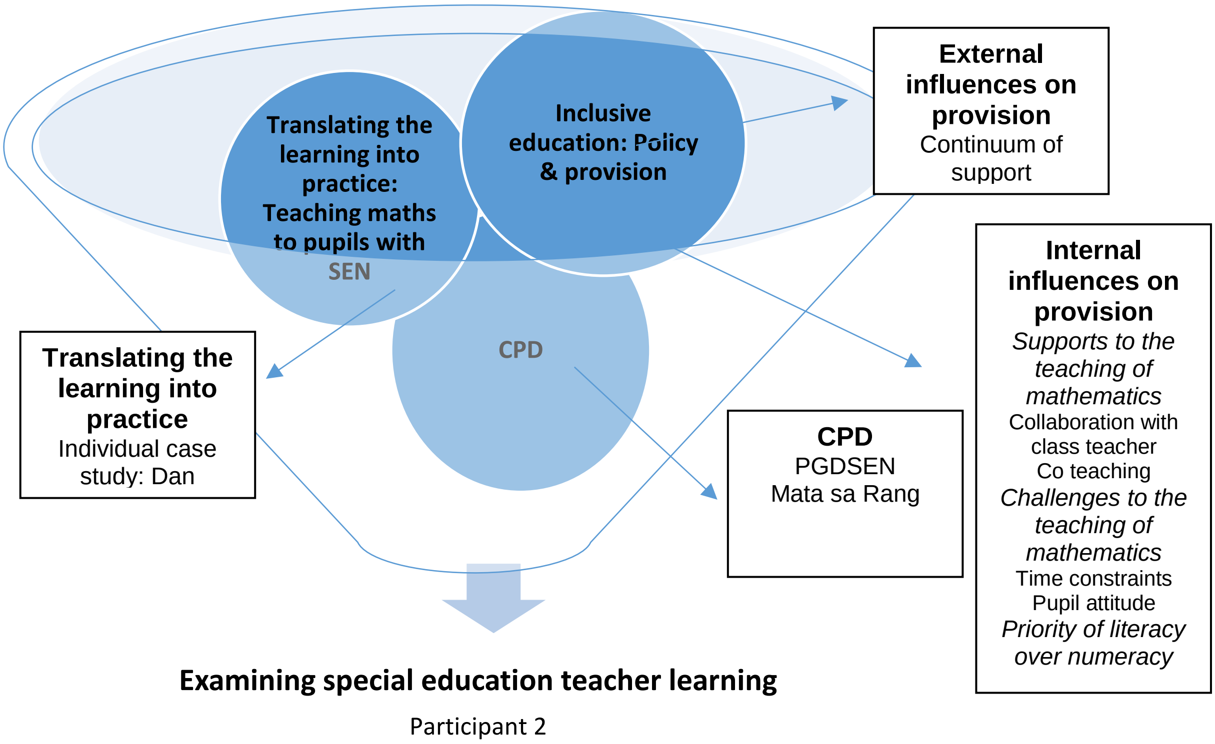

Figure 5.15 Examining special education teacher learning – Participant 2 (Cohort 1, Phase 3)

The P2 participant used diagnostic assessment measures she had learned about on the PGDSEN programme to identify the learning strengths and needs of the focus pupil. The intervention programme in mathematics was planned in great detail. Long term plans, monthly, fortnightly and daily plans were developed. Assessment measures were outlined. Progress was recorded monthly. Daily progress notes informed the planning of subsequent lessons in mathematics. The pupils were given the opportunity to suggest areas they wished to work on in mathematics. Collaboration with the class teacher involved including an element of the class mathematics programme during each support lesson. The participant used a range of active learning approaches in her teaching including co-teaching with Dan's class teacher. The participant's use of task analysis in her teaching in the co-taught class benefited the learning of all the pupils. The participant engaged with CPD in the *Mata sa Rang* programme during the course of this school term and included the *Mata sa Rang* approaches and strategies into her teaching subsequently.

Although the participant used diagnostic assessment measures at the beginning of the school year, there was no evidence to suggest that the outcomes informed the intervention programme. While the planning documents listed detailed methods of continuous assessment, the participant chose not to assess learning formally but rather relied on her own observations and professional judgments in this regard. The limited time available to her to support the pupils in mathematics was a factor in her decision to limit evaluation of learning. The participant's involvement in the *Mata sa Rang* CPD led her to deviate from her monthly plans to incorporate *Mata sa Rang* teaching approaches in to her teaching. While the outcomes of the co-teaching class were deemed to be positive, the arrangement to co-teach was made spontaneously and without planning or evaluation.

The case study of Dan illustrates the application of special education teacher learning acquired on the PGDSEN programme by the P2 participant. Evidence is provided of the use of diagnostic assessment measures in mathematics, active learning approaches including co-teaching and detailed planning of the interventions. Ongoing commitment to CPD is evident in the participant's involvement in the *Mata sa Rang* programme. Limitations to the ability of the participant to transfer her learning to practice include the time available to support pupils in mathematics and the timetabling schedule of these lessons. The negative attitude of the pupils to mathematics was also a limiting factor for the participant. While the co-teaching lesson reaped positive outcomes in the views of the participant, time to plan and evaluate the lesson would have enhanced the process and the outcomes. A more in-depth approach to collaboration with the class teacher would also benefit the intervention programme in mathematics. The failure of the participant to use the outcomes of the diagnostic measures in her planning and to evaluate pupil learning formally at the end of term was a disappointing feature of this case study.

5.5.4.3 Individual case study: Johnny

The P7 participant supported Johnny, a five year old Senior Infant pupil with a diagnosis of ASD. Johnny was receiving a resource allocation of 4.5 hours per week (Department of Education and Skills, 2005c) and received support in all areas of the curriculum – mathematics, social skills, literacy and speech and language. Johnny had the support of an SNA in his mainstream classroom. He also received support from a Speech and Language Therapist (S&LT). He received support on a one to one basis in mathematics twice a week. While English was an additional language for him, it was spoken in the home. However Johnny's limited ability with the English language impacted on his learning of mathematics – *"the whole language of maths …. needs to be covered slowly and carefully with Johnny"* (P7RJ15). His fine motor skills and his social skills were particular strengths for him. Noise caused upset to Johnny and "*he would be bawling crying"* (P7) and consequently spent "*time in the sensory room"*. He was described as being an enthusiastic learner and required one to one assistance at all times in mathematics classes. The participant communicates with Johnny's class teacher on a weekly basis at the end of the school day.

The school did not have diagnostic assessments in mathematics due to a lack of funding (P7). The Mathemagic pupil profile completed at the beginning of the school year indicated that while Johnny had a positive attitude towards mathematics but he was unable to work independently and had limited concentration. Johnny was unable to recall facts or to discuss or apply concepts. His presentation of his work was, however, described as being very good. Johnny had begun to work on the Number and Shape & Space strands of the mathematics curriculum. While he had poor understanding of counting, numeration, addition, comparing and ordering he had a basic understanding of elements of the Shape and Space strand such as spatial awareness. Informal assessment carried out by the participant at the beginning of the school year indicated that he recognised four of eight colours and recognised four of eight shapes. Johnny appeared to have an inconsistent learning style and could identify *"all of his shapes and colours"* one day and fail to do so the next but yet could recall them a few days later (P7). The participant stated this resulted in making it difficult to accurately assess his progress. However, she said "*We just keep on doing the work. We are moving him on through. We are not sticking with the same thing all the time"*. It was the participant's intention *"to keep Johnny up with the class"* (P7) work in mathematics. His intervention programme therefore was the *"Senior Infant programme"* taught on a one to one basis by the participant with the support of his SNA (P7). Johnny participated in class based activities in mathematics also.

Johnny's IEP was developed in consultation with his previous and present class teachers, his resource teacher and his parents. It identified numeracy as a PLN with a specific focus on classifying and sorting concrete objects and number recognition/matching. Examples of targets in mathematics include – *"That Johnny can match up to four pairs of identical objects in one to one correspondence; That Johnny can sort collections of objects according to certain criteria*" (P7IEP). Strategies and resources listed to support the achievement of these targets include *"Planet Maths*

Junior & Senior Infants, counters, flashcards, copy, pencil, concrete materials, Mata sa Rang resources, iPad" (P7IEP). Teacher monitoring, teacher demonstration and teacher designed tasks are also listed in the strategies and resources section of Johnny's IEP. The section on evaluation was not completed. The P7 participant planned her intervention programme for Johnny on fortnightly basis. It was devised in collaboration with the class teacher and followed the structure of the class mathematics programme. This plan was structured to include the objectives for the time period, the instructional approaches, assessment procedures, resources to be used and included sections for pupil comments and general comments where the participant documented her observations of pupil progress and her reflections on the work to be covered going forward (P7RJ1). Instructional approaches such as teacher questioning, use of the sensory playground and multi-sensory room to reinforce colour/object identification, visual supports, teacher demonstration, ICT and concrete materials were listed. Resources listed include the *Mata sa Rang* resources, the Planet Maths workbook at a differentiated level, concrete materials and IWB (P7RJ15). Planning for individual lessons was an ongoing process and occurred during *"the last five minutes of the last lesson*" (P7). This was necessary due to time constraints – *"It is like a conveyor belt. The timetable is chuck a block. There is no break"* between lessons. The participant did acknowledge the progress being made by Johnny. Progress was measured using teacher designed tests and teacher observation (P7) and was listed in the participant's reflective journal as being *"continuous"* (P7RJ11).

Johnny was working on the class mathematics programme at a differentiated level – "*the class are on the story of six. We are on the story of three"* (P7). The intervention programme he was undertaking was by its nature *"more intensive than what he would be doing in the classroom"* as there were more resources and activities used within a longer time frame. In an effort to support Johnny's memory, the participant began each lesson with a review of the previous lesson and concluded each lesson with a review of the current lesson. While the participant endeavoured to use real life contexts to support the pupil's learning she admitted that this approach had to be adapted to suit Johnny's specific needs as for example, he would be unable to recall "*what he did this morning at home"* (P7). Therefore the immediate environment was most relevant for him when using real life contexts for example – "*take two books out of your school bag"* (P7).

The Reflective Journal indicates that the participant had a close working relationship with Johnny's parents and gave them guidance with regard to supporting

Johnny in his mathematics at home. Both the class teacher and the participant met with his parents together.

5.5.4.3.1 Discussion – Participant P7

The consultative approach to planning the intervention programme in mathematics provided evidence of best practice. The P7 participant met with Johnny's parents and collaborated with his class teacher to inform her planning. His strengths and needs in mathematics were identified using the Mathemagic pupil profile assessment in addition to informal assessments undertaken by the participant. The IEP targets in mathematics were SMART-A and included evidence based instructional approaches and resources including concrete materials to support the achievement of the targets. The participant used real life contexts to support the teaching of mathematics to Johnny. His intervention programme was based on the class mathematics programme at a differentiated level.

The participant did not have access to diagnostic assessment measures in mathematics as they were not available in the school due to a lack of funding. Following her participation on the PGDSEN programme, she was aware of the DTEN diagnostic test (ERC, 2011) and of its relevance to this pupil. However, the absence of a diagnostic measure may have resulted in the participant not being aware of the particular strengths and needs of the pupil at the foundational level in mathematics. This pupil required one to one support on a withdrawal basis due to his SENs. His needs directed the teaching approaches adopted by the participant.

5.5.4.4 Individual case study: Amy

The third participant in Cohort 1, P17, supported Amy, a 2nd class pupil with DS with a ModGLD. In addition, Amy had difficulties with both expressive and receptive language. She found it difficult to stay on task but could be highly motivated if she enjoyed the activity involved. This was Amy's first year receiving support in mathematics as literacy had been prioritised in the school previously. Her IEP noted that she "*can be difficult to motivate in terms of the mathematics curriculum*" (P17IEP). Her attainment levels in mathematics were at a Senior Infant/First Class level. Amy's IEP stated that she had *"very poor number sense"* and that she had "*poor computation and problem solving skills"*. Her ability in social mathematics was also described as being "*poor*" (P17IEP). Amy had good social skills and enjoyed playing with her friends in the school playground (P17IEP). She was described as not *"having much of a grá for mathematics"* (P17) and *"finds maths challenging"*.

Amy's IEP was developed in collaboration with her SNA, her mother, her class teacher and her LS teacher, the P17 participant. Her mother was not involved in implementing the targets outlined for Amy. Numeracy featured in Amy's PLNs. The PLNs focused on aspects of number as the participant stated that Amy's "*number sense was very basic"* (P17) and included statements such as – *"to revise Amy's understanding of numbers 1 to 20, to teach Amy to count in twos and to teach Amy subtraction and addition facts up to 10"* (P17IEP). The participant formed the view that Amy had not reached the skills in number in a checklist in STRANDS and therefore used STRANDs (Long, 2011) to guide her intervention programme (P17). She also discussed Amy's ability in mathematics with her mother and with her SNA. Her class teacher was not involved in the intervention programme. This was an issue of concern for the participant – *"I know I should and I feel I should. She has a big class. They are a challenging class"* (P17). Mathematics targets on Amy's IEP included the following – "*To teach her the number sequence of 1 to 10, to read counting books with Amy and to create a counting game to use as a table top activity, to teach Amy the five counting principles as set out in STRANDS p. 189"* (P17IEP). Resources and strategies to teach the targets included – *"concrete materials, semi concrete level using dots, wooden number line and mini peg,* STRANDS *p 192, addition worksheet"* (P17IEP). The personnel involved and the monitoring arrangements were not completed on the IEP. The P17 participant completed a Cúntas Miosuil (monthly record) on a fortnightly basis. "*That she will use pegs to complete addition sums up to a total of 12",* is an example of a skill to be acquired as listed in the mathematics section of the Cúntas Miosuil (P17 CúntasMiosuil 11/14). The strategies, resources and personnel section listed the Crocodile Game, Clicker free web resources, wooden number line/pegs, ready-made clicker sets and a PowerPoint presentation of Five Little Snowmen. The work started/completed section was not filled in. During her class mathematics lesson the participant stated that Amy was "*with her SNA and she is doing worksheets"* (P17) as she did not follow the class mathematics programme.

While receiving support from the LS teacher on a daily basis, mathematics was supported on two days and *"it mightn't even be for the full session*" (P17). The P17 participant conceded that she "*didn't give it the time"* that she should give it. It was her intention to teach mathematics on Thursdays and Fridays "*but it didn't always happen".* Her intervention programme focused on ordinal number and included a lot of repetition. For example, the reflective journal indicated that the participant intended *to "keep with* *this and repeat many times"* to teach Amy "*the language and understanding of more than"* (P17RJ08/10/14). Evidence based approaches such as "*concrete materials, lots of visuals'* and '*modelling*" were used by the participant to support the pupil's learning. Concrete materials played a part in every mathematics lesson. The learning was reinforced using Clicker. The participant used STRANDs (Long, 2011) to inform her long term plan and said that she "*never"* referred to the mathematics curriculum. Her Reflective Journal on 26/09/14 noted that she *"used ideas from STRANDs book p. 193 – count on strategy".* Each lesson was planned the previous day and was informed by her termly plan and she would write a daily note for each lesson –"*use addition games or play Crocodile game"*. She did however admit that she deviated from her lesson plan as *"you could start something and it could go in another direction"* (P17). The main focus of her learning for the first term was "*to get her to recognise four and four objects and that they go in order from one to ten and that the sequence is important"* (P17). The participant assessed Amy's progress using teacher observation – "*by watching her, listening to her"* (P17).

5.5.4.4.1 Discussion – Participant P17

The P17 participant adopted a collaborative approach to the development of Amy's IEP. Numeracy was identified as a PLN. The IEP outlined targets to be achieved and listed the resources and strategies to be used to each target. The participant completed a Cúntas Miosuil to record Amy's progress. Teacher observation was the medium used to identify progress in mathematics. The participant agreed that her teaching of maths had changed since completing the PGDSEN programme. She relied on STRANDs to develop an intervention programme for a pupil with DS in mathematics. Evidence based practices such as the CRA sequence and visual supports were built into her teaching approaches. She had also learned about Clicker, a software programme, and used this in her mathematics intervention programme.

The participant relied on teacher observation rather than diagnostic assessment measures to identify Amy's learning strengths and needs in mathematics. While mathematics targets were outlined in Amy's IEP, the targets were not always SMART-A. The strategies, resources and personnel section of Amy's IEP focused mainly on resources. The monitoring arrangements for the assessment of Amy's progress was not stated on either her IEP or her Cúntas Miosuil but rather the adjective "poor" was used to describe the pupil's performance levels. The participant taught mathematics to Amy one or two days a week and sometimes due to other priority needs, mathematics was not taught at all. Given that Amy completed worksheets with her SNA during her classroom mathematics classes and that neither her class teacher nor her parents were involved in her mathematics programme, mathematics needs to be prioritised by the LS teacher. A systematic, coordinated approach to assessment, programme planning and evaluation of learning needed to be implemented.

5.5.4.5 Individual case study: Kevin

The fourth participant in Cohort 1, P25, taught the Reception class in a Special school for pupils with MGLD. The eight pupils in this class were in their first year in primary school. The focus pupil, Kevin had a diagnosis of MGLD and DS. He had previously attended a pre-school for pupils with SEN. Kevin had *"good levels of language and responded to verbal prompts and to Lámh"* (P25RJ 05/05/14). He responded using a *"three word level response"* (P25RJ05/05/14). His parents were supportive and tended *"to follow through*" on mathematics topics covered in school (P25).

Kevin's IEP was developed in collaboration with his parents. It included the teaching of money, a topic his parents prioritised for him. The participant communicated Kevin's progress to them on a daily basis. Prior to conducting assessments in September "*to figure out where he was at*" (P25), the participant had a policy of *"letting the children explore the manipulatives and the materials rather than going straight into assessment"* (P25). The participant used a combination of teacher observation, teacher designed checklists and checklists from the Action Maths text book to identify the pupil's knowledge base in mathematics. Formal tests were unsuitable as "*they are too fast and he is not at that level at all"* (P25). The early September assessments identified that the pupil *"could name his colours, had a bit of an idea of big and small"* but did not have an understanding of "*classifying or matching".* The baseline data obtained through the assessment and the mathematics curriculum informed the mathematics programme to be implemented. In addition, the participant stated that she had become more aware of the importance of social mathematics and money in the mathematics programmes for her pupils – *"having actually been in some of your lectures I am all about social maths and money"* (P25) and therefore emphasised these aspects of the curriculum. While the participant formally assessed progress (as outlined in the school policy) on a monthly basis and maintained class notes fortnightly she stated that *"every day I am always trying to figure out where they are at and make a mental note or a written note as to where he is at*" (P25). The participant referred to the PGDSEN programme for developing her skills in assessment – *"I am better to use a checklist"* and *"I am definitely doing more in-lesson assessment"* (P25).

Mathematics was allocated between thirty to sixty minutes on a daily basis. The time allocation was divided into mini lessons throughout the day. Kevin worked mostly on a one to one basis with either the class teacher, SNA or care assistant. This approach was called "*basket work*" whereby the pupil worked sometimes unaided through a mathematics programme prepared by the participant. Group work took place but was "*dependent on the level of the other children"* (P25). Each mathematics class began *"with a little finger rhyme*". Work covered the previous day was revised through the use of concrete materials or a worksheet. A new topic would be introduced *"using lots of concrete materials"* (P25) and through the use of modelling. For example, the participant "*showed Kevin"* how to sort cubes by colour as he was not doing the activity correctly (P25RJ12/09/14). Each lesson concluded with an activity. Having learned about the suitability of Maths Trails for pupils with SEN, the participant had adopted this approach for her pupils and included them in her teaching on a monthly basis. She also used STRANDS (Long, 2011) and websites to inform her teaching.

The participant recognised that teaching the mathematics programme to pupils such as the focus pupil required a considerable time input – "*to be able to present things in different ways"* (P25). Access to resources to support the teaching of mathematics was critical for the participant. As her school was well resourced, she had access to all the resources she required, including ICT resources. The participant was also challenged in sourcing text book material which was relevant to Kevin's needs. She stated that she found *"that the textbooks deal with measures in the space of one or two pages and at a level which we have not reached"* (P25RJ06/10/14) and consequently she "*spent a lot of time trying to make PowerPoints, worksheets and assessments".* Worksheets were bound topic by topic when completed.

Kevin's learning needs directed teaching of the mathematics programme. The participant acknowledged that she had *"underestimated how long it would take*" the pupil to acquire skills in mathematics and therefore had to adjust the programme of work accordingly. Although Kevin had acquired the concept of long and short using scarves and wool, for example, he was unable to transfer this knowledge to children who had "*long hair or short hair"* (P25RJ07/11/14). Learning how to classify for colour took longer than expected despite giving Kevin a "*lot of hand over hand assistance"*. A worksheet activity to consolidate the sorting of objects was difficult for Kevin and required "*more work on the transfer and generalisation of the skills"* (P25RJ12/09/14). Topics were revised to ensure maintenance of skills – "*I try and make sure that he is using it across the board".* Allowing Kevin and his peers the opportunity to play with the concrete materials gave the pupils the opportunity to transfer their learning. The participant noted Kevin's use of '*big*' when he was preparing a "*big cup of tea"* in the play area for his teacher at the end of a week's work on this concept (P25RJ 05/05/14). Further development of this concept to include sorting by size and by colour "*was tricky"* and the participant stated that she *"had to pull back and re-establish big/small and red/blue"* (P25RJ19/09/14). To ensure further consolidation of the big/small, red/blue concepts, the participant *"continued the work into PE class"* and asked Kevin to find for example, the big, yellow ball. While this was a successful activity, the participant noted in her reflective journal that she needed *"to be two steps ahead"* of herself to ensure that she had *"the right concrete materials for each lesson"* (P25RJ19/0914).

5.5.4.5.1 Discussion – Participant P25

The P25 participant adopted an in-depth approach to assessment in mathematics. She applied the new knowledge gained on the PGDSEN programme in this regard to her monthly, fortnightly and daily assessment practices. The pupil's IEP was developed in collaboration with his parents who were informed of his progress on a daily basis. The participant's instructional approaches were evidence based and included Maths Trails, knowledge of which was acquired on the PGDSEN programme. The instructional approaches were adapted to meet with the pupil's learning style. The participant applied a task analysis approach to her teaching of number and incorporated generalisation tasks and activities to consolidate learning.

This case study demonstrates the skill of the participant, P25, to link her understanding of the learning processes in mathematics with the learning needs of the pupil to develop and implement an evidence based intervention programme incorporating knowledge and skills acquired on the PGDSEN programme.

5.5.4.6 Summary of individual case studies (Cohort 1, Phase 3)

Three of the Cohort 1 participants taught mathematics to pupils with SEN in their roles as LS/RTs. The fourth participant taught in a special school. All of the participants agreed that their teaching of mathematics had changed positively following their participation in the PGDSEN programme. Core areas of learning included assessment, evidence based instructional approaches and a social mathematics programme.

The evidence presented suggests that the participants planning documentation was detailed and thorough. Long term goals and targets, instructional approaches and resources were documented. While two of the participants had detailed the evaluative measures, it was evident that this had been applied by one participant only. One of the three LS/RT participants had purchased and used a diagnostic assessment measure and had shared other assessment measures received on the PGDSEN programme with her teaching colleagues. Although the remaining two LS/RTs were familiar with diagnostic measures, they did not use them as they were not available in their schools. The special school participant had a structured, assessment process in place which she had further developed following the PGDSEN programme. Teacher observation and teacher designed check lists were the most common form of assessment used by the participants in this cohort. It was evident that while the participants had upskilled on assessment measures on the PGDSEN programme, and while they had made some changes to their assessment practices, the monitoring of pupils outcomes in mathematics remains an area for consideration for further development in most of the participants' schools.

All four participants had added to their repertoire of evidence based instructional approaches relevant to mathematics. The participants prioritised number and social mathematics for their pupils. Resources to support the teaching of mathematics were readily available in each school. However, the special school participant noted the challenges for her in accessing text book material appropriate to the needs of her pupils.

The three LS/RT participants' case studies clearly indicated that additional support in literacy, behaviour management and in life skills took precedence over additional support in mathematics. While two of the three participants collaborated with the class teacher of their case study pupil, this collaboration tended to be informal in nature and meetings were generally not planned. One of the participants did not collaborate with the class teacher.

5.5.4.7 Individual case studies (Cohort 2, Phase 3)

An overview of the individual case studies for each of the Cohort 2 participants is presented in Table 5.18.

Table 5.18 Individual Case Studies (Cohort 2, Phase 3).

COHORT 2	P10	P15	P18	P28
Type of school	Mainstream	Mainstream	Mainstream	Mainstream – special class
Target pupil/group	Two pupils	Fifteen pupils (14 x 4th class + 1 x 5th class)	Nine pupils	One pupil (in special class)
C.A.	Gina 6 years Jenny 7 years	10 years	8 years	9 years

Class	First	Fourth	Second	Special class
Timetabling arrangements	30 minutes daily	60 minutes daily	50 to 60 minutes daily	60 minutes daily
STEN		Average STEN in class is 3 or 4	Lowest STEN in class is 5	Not measured

Table 5.18 Individual case studies (Cohort 2, Phase 3) (Contd.).

COHORT 2	P10	P15	P18	P28
Model of support	Small group withdrawal	Whole class withdrawal (split class approach)	Whole class withdrawal (split class approach). One to one support within whole class.	One to one, small group, whole class within a special class of nine pupils
Nature of disability	Gina EAL Jenny GAM	Low ability	Some find maths difficulty	Pupil with Borderline Moderate General Learning Disability & ASD in a class of pupils with multiple disabilities – Rett syndrome, MGLD, ModGLD, ADHD, ASD, ODD, EBD
Supported by SNA	No	One pupil with EBD supported by SNA	No	Yes
EAL	Yes - Gina	Yes	No	No
Supported by SNA	No	One pupil with EBD supported by SNA	No	Yes
Programme of work	Maths Recovery	Fourth class programme	Second class programme	Working at Second class level
Evidence based approaches	Concrete materials, think alouds, direct instruction, CRA sequence, visual prompts, Maths Recovery	Direct instruction, visual supports, concrete materials, CRA sequence, RUDE strategy, overlearning		Task analysis, verbal prompts, scaffolded instruction, peer learning, concrete materials, generalisation, real life contexts

Technology	iPads, Laptop, IWB	Laptop	Laptop	iPad, IWB, Desktop
Assessment	Maths Recovery assessments, teacher observation			Teacher designed tests, Assessment portfolio

All four Cohort 2 participants taught in mainstream schools. One of the four participants taught a special class for pupils with multiple disabilities in a mainstream school.

5.5.4.8 Individual case study: Gina and Jenny

The first Cohort 2 participant, P10, taught in a DEIS Band 2 school which had a significant enrolment of EAL pupils. The participant chose two first class pupils for the purposes of this research study. Gina was an EAL pupil while Jenny was receiving support under the GAM. They attended the LS teacher together for a thirty minute class daily. Both pupils were assessed using the *Maths Recovery* assessments and the WRAT mathematics computation test (Robertson & Wilkinson, 2006) at the beginning of the school year. The participant stated that her participation in the PGDSEN programme had resulted in an increase in her confidence level with regards to identifying the learning needs of her pupils in mathematics.

The P10 participant used an individual short term plan to plan monthly intervention programmes for the pupils. It outlined the learning objectives from the *Maths Recovery* programme, the learning activities and the strategies, resources and personnel to implement the programme. The pupils were working on a differentiated First Class mathematics programme with their class teacher. During their learning support classes, the participant, a trained *Maths Recovery* teacher, implemented the *Maths Recovery* programme because she felt that "*there was a structure to it"* and that she could stand over what she was doing (P10). This intervention programme was *"differentiated for their needs and some activities were undertaken singly and others jointly"* (P10RJ12/09/14).

The first term was spent working on number and the participant said that she *"threw in a little bit of time and money because those two things are easily built in"* (P10). In her experience money was very "*useful for teaching tens and units".* The participant used small group work, choral and individual counting, visual and concrete props and *Maths Recovery* resources such as number lines and tracks, 100 number squares and concrete material to support her teaching (P10ISTP). The work started/completed column included comments on the progress of both pupils and comments relating to future work. Assessment records were documented and included teacher observation, pupils own assessment of ability and results of the *Maths Recovery* assessments (P10STP). Observations from the class teacher regarding the quality of the pupils' written work was shared with the LS/RT. The class teacher and the LS/RT collaborated prior to meeting with parents and *"agreed to consider the need for parental support for time and money"* (P10RJ04/11/14).

The teaching intention of each lesson was shared with the pupils at the beginning of the lesson. Reflective comments entered in the participant's Reflective Journal indicated that Gina had *"very poor concept of Number Word Before (NWB) and struggles with the language but also with the concept"* (P10RJ06/10/14). To support her in her learning, the participant was of the opinion that the pupil needed *"lots of visual cues first, then lower numbers and finally challenging numbers"* (P10RJ06/10/14). Gina's ability to name numbers had "*improved dramatically"* and the participant stated that she had needed the "*explicit teaching of numbers names with coaching and correcting"* to achieve this (P10RJ17/10/14). The concept of *"counting on"* using concrete materials was introduced to the pupils. The participant noted that the "*girls were both reliant on the concrete materials"* (P10RJ13/10/14). They enjoyed using a yellow tiled 100 square to consolidate their learning and "*considered it playing"*. The pupils used an addition app on the iPad for the same purpose. They successfully used visuals on the classroom walls to support their answering of more challenging problems. The P10 participant was pleased with this and said that "*at least they see the relevance of the supports"* (P10RJ17/10/14).

The pupils were found to have made good progress when they were tested in early December on the *Maths Recovery* programme. The pupils were observed to be using evidence based practices in mathematics. Jenny added 9 + 3 by putting *the "9 in my head"* strategy and "*tracked on her fingers"* to subtract (P10RJ04/12/14). Gina also used evidence based strategies such as the counting up strategy and the counting on from strategy to complete simple problems. By Christmas, the participant stated that "*had there been other children with needs requiring additional support"* that she would have returned the two focus pupils to their classrooms as she felt that "*they were ok to work at class level number"* (P10). The participant planned on keeping the "*number going"* in the next term but also including *"shape and space and time"* (P10).

5.5.4.8.1 Discussion – Participant P10

The P10 participant, a trained *Maths Recovery* teacher, assessed her pupils using the *Maths Recovery* assessments and the Wide Range Achievement Test (WRAT) (Robertson & Wilkinson, 2006) measure of computation at the beginning of the school year. Her monthly plans outlined her intervention programme which was firmly based on the *Maths Recovery* programme. The expertise of the participant in number was clearly evident and may be attributed to her training as a *Maths Recovery* teacher. The programme, which focused predominantly on number, was differentiated to meet their needs and incorporated evidence based practices presented on the PGDSEN programme. Significant progress was noted when the pupils were re-assessed at the end of the school term. The participant did not undertake diagnostic testing to identify strengths and learning needs in other areas of the mathematics curriculum.

5.5.4.9 Individual case study: 4th class

Participant P15 taught a mainstream school. The school had a high percentage of pupils with SEN and EAL. The policy in the school was to provide additional support in mathematics by splitting the multi-grade classes for mathematics. Additional support in mathematics was not therefore not provided. Diagnostic assessment in mathematics was not in practice in this school. The P15 participant taught the entire mathematics curriculum in her LS class room to a group of 15 pupils in 4th class (including one 5th class pupil who was working at the 4th class level).

The P15 participant had developed a termly plan for this group of pupils. It spanned a five month period from September 2014 to January 2015. The long term goals were stated as follows*: "Give the pupils activities to develop skills in the following strands of the mathematics curriculum – number, algebra, measures, shape and space and data"* (P15LTP). Seven targets were identified for the number strand while there were one or two targets for each of the other strands. Examples of targets for the number strand included: "*The pupils will identify and record place value to 9999 and read, write and order four-digit numbers"* (P15LTP). There were a number of teaching strategies listed on the termly plan and these included: "*use lots of concrete materials and child centred activities, work from concrete to pictorial to abstract"*, and "*challenge and reward pupils re automaticity in recalling table facts"* (P15LTP). Assessment measures listed included informal teacher assessment, daily testing on times tables and the assessment test in the class text book (P15LTP). Resources to support the teaching of mathematics to the 4th class grouping were: *"Mathemagic 4, Table Talk, Multiplication and Division, The Four Operations, mini clocks, 3 – d shapes, peg boards, Dienes equipment and mini-whiteboards" (*P15LTP). The P15 participant developed a fortnightly plan (handwritten) from this long term plan. The fortnightly plan included targets, strategies and a Cúntas Miosuil/Evaluation column. Targets such as "*The pupils will solve word problems by adding and subtracting big numbers"* (P15FP24/10/14) were ticked as achieved or not achieved. The evaluation column also noted a comment relating to the teaching of the target i.e. *"Interpreting the wording can be challenging when more than one calculation is involved*" or "*Will return to bar charts"* (P15FP24/10/14). The participant's fortnightly plans were informed by the class text book – *"I am looking at the book and I am thinking, I won't do that bit. I will do that bit and I write it down and I think it through".* In addition to this she used a daily note book for her own reflections and to plan her teaching approaches. Planning, she said, was essential with this class of pupils – *"there is no mercy. I would lose them if I started something and then I changed my mind. They would be lost"* (P15). She said that she had become very dependent on her daily planning and completed this each evening "*at three o'clock for five minutes".*

The participant was anxious that her pupils improved and developed their mathematical skill further – *"I am kind of determined that they will improve this year"* (P15). Collecting the homework copies was the first task of each mathematics class. This was followed by oral work on tables. Time, an element of a social mathematics programme was integrated informally into the opening activity. The P15 participant then shared the learning intention for the lesson with the class, an idea she acquired from a teaching colleague in her school. She used the white board to model the activity *she "wants mirrored on the copy"* (P15). A copy book activity formed part of each lesson. This was a strategy the participant employed to gain *"attention for the next part of the lesson"*. The pupils then undertake the activity while the participant said that she goes "*around and looks at them and sees how they are getting on"*, an approach she described as "*old fashioned"* (P15). Her observations directed her to pupils requiring additional support. The participant recognised progress made by the pupils by writing comments such as "*You are working hard at division"* in their copy books (P15). Real life contexts were used where possible and a lesson on data for example used data from a class reward system which proved to be very motivational for the pupils. She adopted a scaffolded approach to support pupil learning – "*you have to put in the supports with the pictures, with the steps you know".* She had also incorporated an active pupil learning strategy, response boards, into her lessons. This improved pupil engagement because she said that *"if you ask you will have the same four or five hands up"* (P15). The P15 participant viewed the book rental scheme in place in the school positively as she said that it gave her a *"freedom about using the book, only using what"* she felt was *"necessary as practice for the learning objective"* for each lesson (P15RJp1). The participant differentiated mathematics work for her pupils and did not see "*a need for any pupil to have competed the same number of sums and so there's no back log carried over to the next day"* (P15RJp5). Given the behavioural demands of the class, the participant implemented a reward system known as Table Points which was used by the class teacher (P15RJp13).

The participant had been away from teaching for a number of years and stated that the PGDSEN programme had resulted in her thinking about mathematics and about patterns in mathematics. Evidence of her thinking in this regard was noted in her teaching approaches in the classroom.

5.5.4.9.1 Discussion – Participant P15

This case study illustrated the ability of the participant to deliver a mathematics programme which was responsive to the needs of the pupils within a whole class context. The P15 participant planned her mathematics programme in fine detail. It was based on the mathematics curriculum, namely the class text book. Termly plans specified long term goals and targets for each strand. Evidence based instructional approaches were a feature of the strategies listed. Approaches to assessment and resources to support the class were specified. Fortnightly plans were subsequently developed from the termly plan. The evidence suggested that these were working documents used by the participant on a regular basis. Outcomes of the programme were measured using informal measures such as teacher observation and the assessment test in the class text book. The participant had developed a firm structure to her mathematics classes which acknowledged the behavioural issues of some of the pupils. The active student response strategies used in the class were evidence based. She differentiated the programme to accommodate the diverse range of learning abilities in the class.

Given that the pupils in this class did not receive additional support in mathematics, a diagnostic assessment of the mathematics abilities of the less able pupils would have identified gaps which may have existed in the mathematical knowledge of these pupils.

5.5.4.10 Individual case study: 2nd class

Participant P18 taught in a mainstream school in a rural setting. The school has a high standard in mathematics and in this context a STEN score of 5 was considered a weak score. Additional support to pupils experiencing difficulties in mathematics was provided by splitting multi-grade classes for mathematics. The participant taught a group of nine pupils comprising all of the 2nd class pupils in the school. The lowest

STEN score in the class was a 5. Some of the pupils in the class found learning mathematics difficult.

The participant used the school plan in mathematics to inform her plan as "*everything is planned out for me*". The whole school plan follows the structure of the Mathemagic text book. Pupil progress was measured using the termly assessments in the text book. This was supported by weekly tests on the mathematics text book and by teacher observation. The participant became aware of the term *"error analysis"* on the PGDSEN programme (P18). She said that this was something "*you do but you don't recognise the importance of it*".

Each lesson begins with tables, a game or skip counting (P18). New topics are explained and discussed and are supported by concrete materials where necessary. This is followed by an activity from the mathematics book. Some *"mental maths activities"* are incorporated into each lesson. Discussing their work "*with a partner"* is encouraged during the class.

Three pupils who find mathematics difficult receive individual support from the participant – "*I just go down and teach them individually"* (P18). The participant stated that following the PGDSEN programme she was now "*more aware of the theory behind the learning of maths"* (P18) and this resulted in her reflecting on how the pupils learn mathematics and that she was now more in tune with the "*why"* of learning mathematics.

5.5.4.10.1 Discussion – Participant P18

The participant's small, rural school had a high standard in mathematics. Additional support in mathematics was provided by dividing the multi-grade classes into single streams for mathematics class. The low pupil numbers in the mathematics classes (n = 9) enhanced the teaching and learning process in mathematics. The participant was aware for example of the learning strengths and needs of each pupil. While she may have undertaken an error analysis on the regular termly assessments, formal diagnostic assessments were not undertaken. Differentiation, where necessary, was provided in the form of one to one tuition in the classroom.

5.5.4.11 Individual case study: Fred

Participant P28 taught a special class of nine pupils with multiple disabilities in a mainstream school with the support of two SNAs. The pupils were aged between seven and twelve years of age. Fred, a nine year old boy was her focus pupil and had a diagnosis of ASD and a Borderline ModGLD. He had received support from an S&LT

and an OT. Fred had muscle tone difficulties which impacted on his writing and coordination abilities and he had difficulty staying on task.

Teaching mathematics to Fred involved daily planning which was informed by a group short term fortnightly plan and a yearly plan. The short term plan specified the objectives and skills to be acquired, the learning objectives, learning activities and resources. Differentiation, assessment and linkage and integration to other areas of the curriculum were also outlined. An example of a target is as follows; "*Identify and discuss the use of 2D shapes in the environment"* (P28STP30/09/14). Learning activities included "*using concrete materials, co-operative learning and modelling strategies and problem solving"*.

The participant assessed Fred's skills at the beginning of each new task to *"establish his baseline for learning"* and repeated this assessment *"at the end of the topic to see if objectives had been achieved"*. She used teacher designed tasks such as a '*worksheets and a maths trail'* to assess learning (P28STP30/09/14). Assessment record sheets were stored in a folder. The SNAs documented their perceptions of Fred's attainments and of areas requiring additional support. Comments from the pupil himself also provided evidence of his learning – "*Teacher, I know where to find this shape!"* (P28RJ21/09/14).

The mathematics programme taught was based on the NCCA Mathematics Guidelines for teachers of pupils with mild & moderate general learning disabilities (National Council for Curricululm and Assessment, 2007; National Council for Curriculum and Assessment, 2007) and followed the structure of the Primary School Mathematics Guidelines . The mathematics programme for the first school term focused on symmetry, shape – 2D & 3D, subtraction, number sequencing and time. In devising the programme, the participant stated that she wanted the pupil "*to experience as much as the mainstream would"* (P28). She felt that a focus on number only was *"not right… the others experience the full curriculum and so why not them?"* (P28). The participant developed an awareness of developing a foundation in number while undertaking the PGDSEN programme. This became her priority for Fred for the first school term.

Each mathematics lesson began with a group review of previous content using an interactive approach. Instruction was delivered initially to the whole class group using concrete materials. A lesson on time for example included an oral revision of key concepts taught which was followed by a fine motor activity and a worksheet on clocks. While Fred completed a days of the week task "*without difficulty"* he had *"difficulty with the months of the year"* and the participant noted that "*it took two days before he could* *complete a task independently*" on this topic (P28RJ11/11/14). The pupil engaged with an app on an iPad to consolidate his learning. His intervention programme involved one to one work with the class teacher or with an SNA. He also did individual work and used ICT. The class operated a work station system which was rotated to ensure that the class teacher had the opportunity to work with "*everybody at some point in the week"*. The participant stated that teaching approaches for the focus pupil needed to be interactive and also required "*clear, concise instructions"* (P28). Real life contexts were used to teach the mathematics programme as otherwise, the participant said that *"it means nothing to them"* (P28). She recognised that Fred can relate a new concept *"to something he experiences and once he can relate it to something he uses or can see its use, then he understands and retains the information better*" (P28RJ19/11/14). The participant had access to a variety of relevant concrete materials and used a number of mathematics text books and worksheets from various websites to support her teaching.

5.5.4.11.1 Discussion – Participant P28

The P28 participant stated that the PGDSEN programme had "really opened" her eyes to the teaching of mathematics to pupils with SEN. She now realised that the learning process in mathematics was more important to the pupils than the end result of a correct sum. She stated that she had "brought a whole new style of learning to the class from what was there before" (P28). She attributed the progress of the focus pupil in mathematics to her new learning on the PGDSEN programme. The pupil had developed a positive attitude to mathematics which was attributed by the participant as being related to his new found success in mathematics which was noted by his former class teacher, his parents and indeed from the pupil himself. She reported that he would say "aren't I great now at that?" or "I am fabulous. I did maths by myself last night and Dad just checked them" (P28).

The participant, P28 taught a mathematics programme based on the primary school mathematics curriculum (Government of Ireland, 1999a) and guided by the teacher guidelines in mathematics for pupils with a ModGLD (National Council for Curricululm and Assessment, 2007). Following the recommendations of the PGDSEN programme, she prioritised the development of a foundational base in number. Her teaching approaches incorporated evidence based practices such as real life contexts, task analysis and constructivism. The insights gained by the participant on the PGDSEN programme helped her to develop an awareness of the learning styles of pupils with SEN in mathematics. This was particularly significant for this participant given her previous experience as a 6th class teacher and her background in science.

5.5.4.12 Summary of individual case studies (Cohort 2, Phase 3)

Two of the Cohort 2 participants taught mathematics in single stream classes. One participant taught a special class in a mainstream school and the fourth participant was a trained *Maths Recovery* teacher.

The two participants who taught single stream classes in mathematics were responsible for teaching the mathematics curriculum to their classes. Additional support was given within these classes by the participants. The mathematics programme taught was the curriculum for that class. One of the participants differentiated the programme for some pupils. The second participant supported pupils with difficulties on a one to one basis. Neither of these participants used diagnostic assessments but rather relied on the termly tests in the class text book. Evidence based practices were used by both participants. The special class participant and the *Maths Recovery* trained participant planned the mathematics intervention programmes in fine detail. Continuous assessment was a feature of both their teaching. The special class participant assessed before and after each task using teacher-designed tests and feedback from SNAs and the pupils themselves. The *Maths Recovery* trained participant assessed using the *Maths Recovery* test materials and the WRAT. Her mathematics intervention was the *Maths Recovery* programme with the addition of money and time.

Cohort 2 featured four individual case studies, two of which were similar. The two participants who taught the single stream classes did not engage in diagnostic assessments but relied on the termly class text based tests. Assessment was a key feature of the mathematics teaching of participants P10 and P28. All participants used evidence based teaching approaches. The participants agreed that their teaching of mathematics had changed following their participation in the PGDSEN programme. Two participants became more aware of mathematics and in particular of the importance of number. One participant said that her teaching style had changed considerably and her focus was now on the process as opposed to the product. One participant collaborated with her class teacher. This was not relevant to the teaching of the other three.

5.5.5 Phase 3: Summary of findings

The primary focus of this phase of the study was to present the understandings of the participants on the transfer of their new knowledge and skills to their classroom practice through the lens of a case study, a specific focus on a pupil/s in their case load. This phase briefly examined the influence of contextual factors such as policy and provision in inclusive education on the practice of the participants. Their perceptions of their acquisition of knowledge and skills in mathematics through their participation were also presented.

The influence of national policies on the teaching of mathematics was evident in the primary schools in this phase of the study. The DEIS numeracy plans, the *Mata sa Rang* and *Maths Recovery* initiatives, the DES requirements for standardised testing and the focus on mathematics in the SSE process created a specific awareness of mathematics in the schools and of the need to develop attainment levels of all pupils in mathematics. The *Mata sa Rang* and *Maths Recovery* programmes provided CPD in mathematics for teachers and also provided a source of resources/concrete materials to support the teaching of number. Phase 3 participants who had received this CPD implemented these approaches and used the resources in their teaching of number to pupils in their case loads. Schools who were focusing on numeracy as part of their SSE process had developed whole school approaches to increasing attainment levels in mathematics. The two special classes in this phase of the study, one in a mainstream school and the other in a special class were not influenced by these external influences. There was evidence to suggest that while all schools were involved in the SSE process, a minority of class teachers were not aware of the specific school initiatives or chose not to participate in them.

Most of the class teachers in the participants' schools collaborated with them to develop and implement intervention programmes in mathematics. The extent and nature of their involvement varied however and meetings with class teachers were generally informal. SNAs supported the teaching of mathematics in the mainstream class and in the LS/RT class where necessary. Their support was critical to the teaching of the mathematics programmes in the two special classes in this phase.

The specific special educational needs of the pupils directed the content of the mathematics programme and the teaching approaches therein. In some instances, other special educational needs of the pupils took priority over mathematics. The research study found that while some parents of children with SEN supported their children in mathematics in the home, this was not the case in all instances.

The Phase 3 participants were actively engaged in CPD. They believed that they had acquired new knowledge and skills with regard to the teaching of mathematics from their participation in the PGDSEN programme. Assessment in mathematics was identified as a core learning area for them. The participants gained an understanding of the learning styles of pupils with SEN in mathematics and implemented the evidence based teaching strategies accordingly in their mathematics classes.

The eight individual case studies provided an in-depth insight into the teaching of mathematics by the participants. Each participant agreed that their teaching of mathematics had changed following their participation in the PGDSEN programme. Assessment, evidence based instructional approaches and social mathematics were identified as the core areas of learning for the participants. The participants had, for the most part, developed assessment frameworks which included diagnostic assessment and ongoing assessment practices, there was evidence to suggest that all participants were not adopting this approach. Number formed a core area of all intervention programmes. This was particularly evident in the case of a participant who was a trained *Maths Recovery* teacher. The teaching of a social mathematics programme was prioritised by the participants. Participants stated that they had gained in confidence, had received affirmation of their own teaching approaches and had acquired new knowledge and skills with respect to the teaching of mathematics following their participation on the PGDSEN programme.

Chapter 6: Discussion

6.1 Introduction

The purpose of this chapter is to interpret the key findings of the research study in the context of the relevant literature. This study is a focused examination of the perceptions and experiences of the participants (special education teachers) of the influence of the PGDSEN programme on their acquisition of knowledge and skills in mathematics and on their understandings of the subsequent transfer of this learning to their teaching of mathematics to pupils with SEN. Individual and contextual factors (within the context of Bronfenbrenner's (1979) ecological theory), which influenced their acquisition of knowledge and skills in mathematics and the transfer of learning to practice were also examined. The discussion also provides an insight into the teaching of mathematics by special education teachers in mainstream and special school settings.

The discussion, guided by the research question, will be centred on three themes which emerged from the findings: Inclusive and special education: Policy and provision; Continuing professional development and Translating the learning into practice: Teaching mathematics to pupils with SEN.

6.2 Inclusive and Special Education: Policy and Provision

Policy directives and legislation have shaped the nature of inclusive educational provision in Ireland today (Department of Education and Skills, 1993, 2003; Government of Ireland, 2004; 2010). This discussion centres on the teaching and learning of mathematics to pupils with SEN in mainstream schools, special classes and special schools in the context of current inclusive education policies.

6.2.1 School leaders (principals)

The leadership role of the principal is a key factor in the provision of an inclusive education (Ware et al., 2011). The majority of the participants in this study acknowledged the supportive role of the principal (microsystem), a finding which concurs with the sentiments of the teachers in other research studies (Travers et al., 2010; Ware et al., 2011). Some school principals allocated additional time to participants for planning purposes. Others encouraged the sharing of new practice through initiatives such as co-teaching. The participants generally felt that the expertise they gained through their participation in the PGDSEN programme was recognised and valued by their principals. This expertise was acknowledged through either the delegation of the management of SEN to the participants or by their subsequent appointment to the position of SEN co-ordinator within the school. Some participants were, however, constrained in their efforts to implement new practices. New practices such as implementing the staged approach to assessment and collaboration with class teachers require time and financial support. Whole school attitudes to inclusion (influenced by the principal) emerged as a constraint (mesosystem). The findings of this study highlight the pivotal role of the principal in enabling inclusive practices in schools (mesosystem). Recent research by Ware et al. (2009) and Banks et al. (2016) support this finding. CPD for principal teachers which addressed their leadership role for inclusion, and their role in supporting inclusive practices has been recommended in the study of Travers et al. (2010) and is endorsed by the findings of the current study.

6.2.2 Special needs assistants

Similar to other studies (Banks et al., 2016; Logan, 2006; Rose et al., 2015), the supporting role of the SNA (microsystem) was recognised and valued by all of the participants in this study but in particular by the participants in the special class and the special school. The key role of the SNA in special schools was also noted in the study by Kinsella et al. (2014). While the SNA functioned in a care role, assisting with the organisation of materials, keeping pupils on task in mathematics class and supporting the generalisation of mathematics topics outside the classroom, evidence from the current study found that SNAs were assisting with teaching in many classes. Ware et al. (2011) supports this finding and found that most differentiation for pupils with SEN in their study in mainstream schools was provided for in the form of additional support from the SNA and "that in some instances SNAs appeared to be making teaching decisions without referring to a teacher" (p.71). This was particularly evident in the special class and in the special school in the present study, where the SNA role appeared more like that of the teaching assistant in the UK (Rose & O'Neill, 2009). In the special class and special school in the current study, the SNA was found to be "pivotal to the success of educational provision" in special schools (Kinsella et al., 2014, p. 172). This teaching role was however, at variance with the primarily care role of the SNA as stipulated by the Department of Education and Skills (2014). There is clear evidence both in the literature and in this study to suggest that in practice, the role of the SNA has departed from its care role remit and now involves supporting teaching through curriculum interventions such as *Maths Recovery*, *Mata sa Rang* and one to one support in mathematics for pupils with SEN (Banks et al., 2016; Department of Education and Skills, 2011g; Rose & O'Neill, 2008; Ware et al., 2011). The perceived value of SNA support by the special school and special class teacher participants resonates with the recommendation of Kinsella et al. (2014) that “consideration should be given to creating teaching assistant posts” (p. 204) (exosystem).

The issue of training in mathematics for SNAs was identified by some participants in the current study – an issue also considered in other research studies on SNAs in Irish classrooms (Carrig, 2004; Keating & O’Connor, 2012; Ware et al., 2011). Although the Department of Education and Skills (2011g) established funded CPD programmes in SEN for SNAs in 2005 (exosystem), these have been discontinued in recent years due to budgetary constraints. The special class and special school teacher participants in this study undertook to upskill the SNAs in order to gain maximum benefit from their support. This was achieved through daily/weekly meetings informing SNAs of their role in the implementation of the mathematics programme and in the assessing of progress in mathematics. Upskilling SNAs in this way proved to be a means of enabling the special school and special class teacher to mediate their newly acquired skills (microsystem).

In the present study, some pupils with SEN were more reliant on the support of an SNA than others. For example, in one mainstream class, a pupil with Down syndrome whose attainment levels were below her peers was heavily reliant on the support of her SNA to help her “doing worksheets” during mainstream mathematics lessons in which she was not an active participant. It is of interest that in their study, Ware et al. (2011) also noted that pupils who were not working at class level were very dependent on one to one SNA support. Loreman (2007) strongly disagrees with this practice, which Shevlin et al. (2008) are of the view is not conducive to inclusive practices. Loreman (2007) states that the “downloading” (p. 27), of responsibility to the SNA by the class teacher indicates the need for the classroom teacher to assume a shared responsibility for instruction. This issue may be related to the findings of Logan (2006) that CPD for teachers working with SNAs is not available (exosystem).

It can be deduced from the present study that, pupils with greater needs in mathematics are supported in their learning by SNAs to a greater extent than pupils with lesser needs in mathematics. The evidence from a number of related studies including Ware et al. (2011) who noted the “heavy reliance on SNA support to provide curriculum access" (p.145), the conclusions of Webster and Blatchford (2013) in the UK, who noted that teacher assistant support yielded a "less appropriate and lower quality pedagogical experience" (p. 3) for pupils with SEN and the findings of the current study, highlight an urgent need for CPD in SEN for SNAs to prepare them for their supporting role in mathematics (exosystem). The current study indicates, that in most schools, SNAs are an important agent within the microsystem as they play a pivotal role in supporting the participants to implement their newly acquired knowledge and skills particularly in special class and special school contexts.

6.2.3 Standardised testing

Schools undertake annual standardised testing in mathematics, a feature of the Literacy and Numeracy Strategy (Department of Education and Skills, 2011f) and report the findings to the DES for pupils in 2nd, 4th and 6th classes (ages 8 – 12 years) (Department of Education and Skills, 2011e) (exosystem). This study found that tension existed between some LS/RTs and their class teacher counterparts with regard to the contents of the mathematics intervention programme (microsysystem). The participants reported that class teachers wanted them to focus on preparing pupils with SEN for standardised testing rather than focusing on intervention programmes which met the assessed needs of the pupil (microsysystem). Although teacher accountability is not officially assessed on pupil outcomes on standardised measures, anecdotal evidence indicates, that in some schools teacher competence is measured on results of standardised tests (mesosystem). Forlin and Sin's (2010) contention that measuring accountability by pupil outcomes represents a barrier to differentiation resonates with the finding in the current study. This difference of opinion between LS/RTs and class teachers may also have arisen due to the lack of class teachers' knowledge in special education (microsystem) (Rose et al., 2015; Shevlin et al., 2008) but more particularly, due to the class teachers' lack of specialist knowledge for teaching mathematics to pupils with SEN as outlined in the literature (Griffin et al., 2014). This issue presented a barrier to the PGDSEN participants' implementation of their new skills and knowledge in some schools.

6.2.4 DES initiatives to develop teaching and learning in schools

The positive impact of a number of national initiatives (exosystem) on the teaching and learning of mathematics was acknowledged by the participants in this research. Specific initiatives such as *Maths Recovery* (Wright et al., 2006) in DEIS schools, and *Mata sa Rang* (O'Loughlin, 2012) in non-DEIS schools were praised not only for the CPD offered to participating teachers but also for the useful resources to support their implementation. These resources were subsequently used by PGDSEN programme participants to support their intervention programmes (exosystem). These early intervention programmes in mathematics created an additional layer of support in the junior classes. While most schools participating in the SSE process (exosystem) focused initially on the development of literacy in their schools, those who were focusing on mathematics reported of whole-school approaches to developing identified areas of need such as problem-solving. Within the context of the implementation of national initiatives in schools (exosystem), participants newly acquired newly acquired expertise in mathematics in a special education tended to be acknowledged and their contributions to whole school plans and interventions in mathematics were welcomed. There were, however, a small number of schools, including a special school, where the participants were not aware of such whole school initiatives.

6.2.5 Collaboration between LS/RT and class teacher

The requirement for LS/RTs and class teachers to collaborate in the development and implementation of intervention programmes for children with SEN was highlighted in the DES Circular 24/03 (Department of Education and Skills, 2003) (exosystem). Collaboration between LS/RTs and class teachers is a pivotal influence on the transfer of learning of the participants from the PGDSEN programme (microsystem). While the findings of the Devecchi, Dettori, Doveston, Sedgwick, and Jament (2012) study indicated that collaboration between classroom and support teachers was “far from being the norm” (p. 10), in Italy and England, evidence from the current study indicates that most LS/RTs collaborated with class teachers in the design and implementation of intervention programmes in mathematics. However, the nature and extent of such collaboration varied due to time constraints for collaboration and to the variation in attitudes and expectations among LS/RTs and class teachers regarding the focus of intervention programmes in mathematics. This finding is similar to that of Shevlin et al. (2008) who noted that the collaborative relationship between LS/RTs and class teachers “varied immensely” (p. 146).

While most class teachers in the current study were willing to embrace new philosophies and interventions suggested by the PGDSEN participants, the entrenched attitudes of a minority of class teachers towards inclusive practices in mathematics (microsystem) posed a significant barrier to the transfer of new learning by the participants. A similar reluctance towards inclusion was noted in some of the teachers by Travers et al. (2010) in their study. The reluctance of class teachers in these instances may be related to their lack of expertise in SEN or to the fact that they felt under pressure to complete the class mathematics programme (exosystem), findings noted in Ware et al.'s (2011) study also. This and the other factors relating to class teacher resistance (microsystem) were recognised by some of the participants of this study as seriously limiting factors to their ability to put their newly acquired skills in mathematics to practice.

Given what might be termed the "gatekeeper" role of the class teacher in embracing changing inclusive practices in mathematics as is evident in this study, the resistance and reluctance of some class teachers to embrace such inclusive practices is worthy of further consideration. The literature notes the barrier to inclusion that results from negative teacher attitudes (Loreman, 2007). Jordan et al.'s (2009) contention that teachers, who believe that they do not have the knowledge and skills to teach pupils with SEN, have negative attitudes to inclusion, may be a factor in the current study as the literature notes the beliefs of teachers about their inadequate training in inclusion (Kearns & Shevlin, 2006; Pijl, 2010; Shevlin et al., 2013; Ware et al., 2011). This finding is supported by the findings of a European report on teacher education for inclusion (European Agency for Development in Special Needs Education, 2011). The requirement of The Teaching Council for programme providers of ITE in Ireland to include inclusive education in the programme may ensure that the lack of teacher expertise will be overcome in future generations of primary teachers (The Teaching Council, 2011a) (exosystem). The literature addressed the necessity of providing CPD in SEN to class teachers (Nimante & Tubele, 2010; Shevlin et al., 2008). While the SESS and other local providers offer CPD in SEN for all teachers, including class teachers (O'Gorman & Drudy, 2011) (exosystem), Shevlin et al. (2008) argue, that courses of short duration are inadequate in meeting the needs of teachers in SEN. It seems reasonable to suggest, therefore, that extended courses should be made available to class teachers, who are primarily responsible for the educational provision of pupils with SEN in their classes (Department of Education and Skills, 2000) (exosystem).

The LS/RT participants in the current study identified lack of time as a barrier to their collaborative relationships with class teachers, a factor also noted in the research (Kinsella et al., 2014; O'Gorman & Drudy, 2011; Shevlin et al., 2009; Travers, 2011; Travers et al., 2010). This study found that in some instances, issues relating to the availability of time led to a situation where collaboration did not exist. In most cases, the participants overcame the difficulty by meeting informally with class teachers during break time or on the corridor, as did teachers in the study of Ware et al. (2011), a practice which the participants of the current study clearly acknowledged as being unsuitable. Formal collaborative meetings tended to exist when Croke Park hours, (a public sector agreement providing for additional hours for planning or CPD within the school year) (Department of Education and Skills, 2011d) (exosystem), were used to facilitate meetings or when the principal teacher facilitated same (mesosystem). Similar issues relating to availability of time were reported in the Travers et al. (2010) study which recommended the "need for dedicated time outside of existing teaching hours for shared planning and collaboration" (p. xx), a recommendation which has received considerable support in the literature (O'Gorman & Drudy, 2011; Ring & Travers, 2005; Travers, 2011; Ware et al., 2011). Such organised structures (exosystem) may support closer collaboration between class teachers and LS/RTs and facilitate the transfer of new learning on the part of the LS/RT participants (mesosystem).

Despite policy directives relating to the provision of additional support to pupils with SEN in the classroom (Department of Education and Skills, 2003), the research suggests that the withdrawal model (small group) remains the most popular model for providing additional support to pupils with SEN in Ireland (Kinsella et al., 2014; Travers, 2011). Just 2% of the learning support teachers in the disadvantaged schools in the Eivers, Shiel, and Shortt (2005) study indicated that they were providing additional support in the pupil's classroom. The co-teaching model is, however, increasing in popularity in special education contexts and evidence of its implementation has been found in schools in Ireland and elsewhere (Cook et al., 2011; Rose et al., 2015; Travers et al., 2010). The study of Travers (2011) found that although LS teachers were uncertain of the benefits of in-class support in mathematics, 41% of the cohort, all of whom had engaged in CPD in SEN, were using this model in their teaching. The findings of the current study suggest that the co-teaching model is increasing in popularity and most schools were engaging in some form of co-teaching in mathematics (microsystem). The participants tended to support the teaching of interventions such as *Mata sa Rang* (O'Loughlin, 2012) and *Maths Recovery* (Wright et al., 2006) with class teachers in their schools using the station teaching model or engaging in team teaching with their class teacher counterparts. The model of co-teaching described by the participants as "split classes" whereby the mathematics classes in a multi-class situation were separated and the entire mathematics programme was taught by the class teacher and the LS/RT to each cohort individually was evident in this study (microsystem). In these instances, additional support in mathematics was not offered but was perceived to be provided for in the smaller whole-class context. This model of additional support may address the suggestion made by Eivers et al., (2005) that the withdrawal model of additional support needed to be reconsidered in schools where a greater number of pupils required support. The evidence presented in the present study indicates that much of the co-teaching occurred without prior planning or evaluation of its effectiveness. While the participants in this study had received CPD on co-teaching, the need for similar training for their class teacher counterparts was highlighted (exosystem). The positive attitude of the participants of this study to the co-teaching model may be due to their CPD opportunities in co-teaching as noted in the literature (Pancsofar & Petroff, 2016). The unwillingness of some class teachers to engage in co-teaching may be explained by the fact that they had not participated in CPD on co-teaching.

The findings on co-teaching, as it relates to the teaching of mathematics, in this study give rise for concern. While there was evidence of good practice in co-teaching in one school, practices in place in others limited the ability of the participants to transfer their newly acquired skills and knowledg. It is evident, therefore, that there is an urgent need for CPD for all teachers to ensure that the implementation of co-teaching approaches, including planning and evaluation, are in line with best practices as outlined in the literature (Gately & Gately Jr, 2001; Scruggs, Mastropieri, & McDuffie, 2007; Villa et al., 2008) (exosystem). The increase in co-teaching evident in this study may reflect the policy initiatives to provide additional support for pupils with SEN in the classroom (Department of Education and Skills, 2003) and the flexibility afforded to schools to provide such provision (Department of Education and Skills, 2005c) (exosystem). However, the lack of empirical research to support co-teaching suggests that a degree of caution is required (Cook et al., 2011). Nonetheless, this model is recognised as an effective means of building capacity by facilitating the shared expertise of special education and class teachers (Zigmond et al., 2013) and is therefore, worthy of further consideration. In cognisance of the research literature, Cook et al.'s (2011) recommendation to "retain the core tenets of special education" (p. 158) such as evidence based instructional approaches, progress monitoring etc. when co-teaching in special education contexts seems plausible .

6.2.6 Priority of literacy over numeracy

A number of factors in this study combined to lend support to the notion that schools tend to favour literacy over numeracy in their allocation of support in special education (microsystem/exosystem). Historically, the time allocation to mathematics in learning support and special education has been less favourable than that allocated to literacy. This led McCarthy and Burns (2005) to suggest that mathematics was the "Cinderella of learning support". Recent research indicates that while 96% of primary schools provide additional support in literacy, just 83% of schools provide additional support in mathematics (Kinsella et al., 2014). International evidence indicates similar weighting of support towards literacy (Clarke, Lembke, Hampton, & Hendricker, 2011).

While all schools in the current study provided additional support in literacy and numeracy, it was evident that support in literacy was prioritised over mathematics (microsystem). In some schools additional support in literacy was prioritised due to the high standards of mathematics in the school. In other instances, a pupil's needs in literacy, language or social skills were prioritised over mathematics. This practice was more noticeable in the case of pupils with more significant special educational needs. Some schools in this study tended to support more pupils in mathematics in the junior classes than the senior classes, a pattern noted in the Travers (2011) study also. The implementation of early intervention programmes in mathematics may account for this emphasis in the junior classes. The current study also found that the implementation of the staged approach to assessment, identification and programme planning in mathematics (Department of Education and Skills, 2003) (exosystem) was not actively in place in all schools. However, this approach tended to be routinely applied in literacy in most schools. The emphasis on literacy over numeracy resulted in less time being available to the participants of the programme to implement their newly acquired skills and knowledge in mathematics (microsystem).

6.2.7 Summary

The development of inclusive educational provision in Ireland has been guided by legislation and policy directives (exosystem). Management of inclusive provision rests with the principal teacher (microsystem). This study found that principal teachers were generally positive towards inclusive practices in their schools. The role of the SNA was valued and recognised by LS/RTs in the teaching and learning of mathematics. The findings of this study indicate that SNAs tended to provide greater support to those pupils with greater learning needs in mathematics (microsystem). The importance of collaborating with class teachers was acknowledged by all participants in this study. While most LS/RTs collaborated with class teachers (microsystem) in the design and implementation of intervention programmes in mathematics, time constraints for meetings and class teacher attitudes towards inclusion posed particular challenges in some instances. In many schools, LS/RTs co-taught with mathematics with class teachers (microsystem). However, little evidence of planning or evaluation of lessons was found in this study. The accessibility of CPD in SEN for class teachers (exosystem) and the scheduling of meeting times for collaboration (mesosystem) would enhance the collaborative practices between class teachers and LS/RTs. Evidence from this study indicates that CPD in SEN on a whole-school basis is necessary for the development of effective inclusive practices (exosystem).

6.3 Continuing Professional Development

The importance of CPD in the continuum of teacher education (exosysystem) is well documented in the literature. Inclusive educational provision requires teachers skilled in inclusive pedagogies. There has been a noticeable increase in the availability of CPD in SEN in recent years. This discussion centres on teacher knowledge in SEN, the availability of CPD in SEN and its influence on participants and pupils alike.

6.3.1 Teacher knowledge in SEN

The lack of teacher knowledge in special education has been clearly borne out in the literature internationally (Agbenyega, 2007; Black-Hawkins, 2014; European Agency for Development in Special Needs Education, 2011; McCann, 2001) and more recently in Ireland by Banks et al. (2016). They found that teachers in special schools expressed similar sentiments about their lack of expertise in SEN. Participants in the current study stated that they did not have the necessary skills and knowledge to teach mathematics to pupils with SEN prior to undertaking the PGDSEN programme (microsystem). This finding was evidenced by their comments indicating that they were undertaking the PGDSEN programme to "learn how to teach children with SEN more effectively" (P11) and to learn how "to do the job right" (P17). Similar to the teachers in the study of Ware et al. (2011), the participants felt that CPD was the medium for upskilling in SEN (exosystem). They had actively participated in CPD and had undertaken a range of short CPD courses in SEN prior to participating in the PGDSEN programme as had the majority of LS/RTs in O'Gorman and Drudy's (2011) study. Most teachers in Rose et al.'s (2015) study also reported that they had participated in short CPD courses in SEN. This finding is in contrast to that of Ware et al.'s (2009) small scale study of eleven teachers, however, which found that the majority of teachers had not participated in CPD in SEN, a finding which was also borne out in the Ware et al. (2011) study.

6.3.2 CPD in SEN

The nature of the CPD undertaken by the participants in the current study prior to their participation in the PGDSEN, was described by Conway et al. (2009) as the "one shot workshop model", which both they and Shevlin et al. (2008) agree was an inadequate form of CPD in SEN. The commitment of the participants of the current study to an accredited post graduate programme with theoretical and practical components of one academic years duration (Department of Education and Skills, 2011c) (exosystem) indicates both their awareness that their ITE (exosystem) did not provide them with the skills required throughout their teaching career, a point also noted by Conway et al. (2009) and Ware et al. (2011) and their preference for professional learning which was in direct contrast to the “one shot workshop model”. The majority of teachers in O’Gorman’s study (2010) also favoured CPD in SEN which was accredited and of longer duration. Some participants of the current study undertook the PGDSEN programme to enhance their career prospects in SEN and there was clear evidence of appointments to SEN co-ordinator positions on completion of the PGDSEN programme. O’Gorman and Drudy’s (2011) study of CPD for special education teachers supports this finding that teachers in SEN management positions hold qualifications at post graduate level. They found that 70% of post holders in senior management positions had post graduate qualifications in SEN (O'Gorman & Drudy, 2011). This findings also supports Rose et al.’s (2015) suggestion that senior management post holders in SEN were more likely to hold accredited qualifications in SEN .

6.3.3 What do special education teachers want to learn?

In their national study on the CPD needs of special education teachers in primary and post primary schools in Ireland, O’Gorman and Drudy (2010) found that 16% of teachers participated in CPD to upskill in special education. The current study identified specific aspects relating to the teaching of mathematics requested by teachers for additional support. Assessment, ICT, social mathematics and evidence based instructional approaches in mathematics were all key areas prioritised by the participants for upskilling (exosystem). Participants in this study requested CPD on “effective strategies to teach number well” and on assessment measures in order “to know where to begin”. Similarly, requests for upskills in assessment were noted by Shevlin et al. (2008) and by O'Gorman and Drudy (2010). The participant requests in the current study for evidence based instructional approaches is in accord with the findings of Chval, Abell, Pareja, Musikul, and Ritzka (2008) who found that most of the teachers in their study anticipated that the CPD would focus on “instructional strategies and activities” (p. 38).

Findings from both the current research study and the literature indicate the “reactive” CPD needs of the participants for skills required in their daily teaching practices (O'Gorman & Drudy, 2010; O'Gorman, Drudy, Winter, Smith, & Barry, 2009). Although the study of O’Gorman and Drudy (2010) noted a <1% request for input on research skills and philosophy, it is evident that the participant demands in both their study and the current study focused exclusively on skills related to every day teaching routines. The research of Ware et al. (2011) also supported this finding and provided evidence that some teachers requested CPD that was “directly relevant to their current teaching situation” (p. 148). It is possible that the recent moves towards inclusive education (macrosystem) account for the prioritising of a basic skill set in SEN for pupils with SEN by the participants. However, the study of Chval et al. (2008) on science and mathematics teachers experiences and expectations of CPD found that teachers also wanted to learn about instructional strategies relevant to classroom instruction. Given the evidence from the present study and from the literature, it seems reasonable to suggest that teachers believe that CPD will add to their knowledge and skills of instructional practices relevant to their teaching role in classrooms.

6.3.4 Influence of CPD

Participants of the PGDSEN programme (exosystem) agree that their classroom practices, including assessment measures and instructional approaches, changed following the CPD. LS/RTs in the study of Rose et al. (2015) who had undertaken similar post-graduate training in SEN felt that the training they had received was immediately applicable in their classrooms, a finding which was validated by the researchers during field visits to schools. While the current study did not seek to quantify the increased attainment levels of pupils, the majority of the participants agreed that the attainment levels of pupils in mathematics (microsystem) in their schools would be influenced by the CPD in SEN they had received (exosystem). Their perceptions of the impact of the CPD in SEN concur with the depth of research in the literature on the relationship between CPD for teachers and increased attainment levels for their pupils (Horrocks & Morgan, 2011; National Council for Special Education, 2013; Villegas-Reimers, 2003). Benefits to pupils with ASD, for example, were evident following training specific to ASD received by their teachers (NCSE, 2015).

The participants of the PGDSEN programme believed that the programme had been a positive influence on their personal attitudes (microsystem) to the teaching of mathematics and resulted in an increase in their confidence and motivation to teach mathematics in special education contexts. A measure of personal mathematics teacher efficacy (PMTE) for the Cohort 2 participants upon completion of the PGDSEN programme indicated a slight increase over the results of the Cohort 1 participants taken before the PGDSEN programme and thus suggests that teacher perception of personal mathematics teacher efficacy increases following CPD (exosystem). This supports findings in other studies where teachers expressed similar teacher efficacy sentiments following CPD in SEN (Banks et al., 2016; O'Gorman et al., 2009). At an individual level (microsystem), the participants referred to the fact that they had increased their knowledge and skills and had “picked up lots of strategies on the course” (P21) and, therefore “felt more equipped to teach mathematics now than before” (P23) undertaking the PGDSEN programme. At a school level (microsystem), completion of the PGDSEN programme had raised the professional profile of most of the participants and they were recognised as having expertise in the area and became the “***Go To”*** person in mathematics for SEN in the school (P11). There was evidence to suggest a sharing of expertise acquired with class teachers by some participants (microsystem). A participant stated, for example, “Everybody is using the Steve Chinn Test” (P2) where she referred to her sharing of assessment measures in mathematics with her colleagues. Some participants had initiated co-teaching in mathematics following the PGDSEN programme (microsystem) with a view to implementing alternative teaching approaches. The findings suggest that this met with varied responses by class teachers (microsystem). Sharing of expertise was particularly evident in the special school in this study. This may be explained by the challenges experienced by special school teachers in obtaining resources and assessments relevant to the needs of their pupils and the ensuing necessity of collaboration. It was notable in this school, however, that a number of the teachers had recently completed the PGDSEN programme (exosystem), and it was clearly apparent that such CPD was highly favoured and supported by the principal teacher (microsystem). There were a small number of participants for whom opportunities for sharing expertise in the school was not evident. It is possible that personal factors (microsystem) and /or school culture/policies (micrsystem) accounted for this. The findings of the current study indicated that changes in practice at multiple levels (microsystem, mesosystem) occurred within some of the participants’ schools. These concur with Pugach and Blanton’s (2014) view that CPD for inclusion results in change in practice at school level, individual teacher level and across disciplines i.e. in special and mainstream classes resulting in an increase in “system capacity” (O'Gorman & Drudy, 2010, p. 157).

While most participants of the current study developed an awareness of the need to change or adapt their current instructional approaches (microsystem), the mathematics input reaffirmed existing practices for a few participants. In their study on special schools and classes, Ware et al. (2009) report the Church of Ireland College of Education (2005) findings of the high satisfaction levels of participants on a post graduate programme similar to the PGDSEN programme. They also note the positive response of the participants in the Prunty et al. (2007) evaluation of a certificate course in ASD where participants stated that that changes in their teaching were related to their participation in CPD in ASD. Similarly, participants in the present study concur with the previous findings (microsystem, mesosystem). They agreed that the PGDSEN programme was relevant to their needs and that it would impact positively on teaching and learning in their classrooms. All the participants indicated that they were confident of their abilities to teach mathematics to pupils with SEN following their participation on the PGDSEN programme.

6.3.5 Summary

Most of the participants in this study were active participants of CPD. They were aware of the need to upskill in SEN. Areas for upskilling included assessment, ICT and social mathematics. Participants' preferences were for knowledge and skills in SEN in mathematics which was directly applicable to their everyday class room practices (microsystem). They believed that their participation in the mathematics input on the PGDSEN programme (exosystem) had increased their skills and knowledge in the teaching and learning of mathematics thus initiating changes in their teaching practices (microsystem). The CPD in SEN had also benefitted them personally as they were more motivated and more positive in their attitudes towards teaching mathematics to pupils with SEN (microsystem).

6.4 Teaching Mathematics to Pupils with SEN: Translating Learning into practice

This section of the discussion reflects on the key focus of this study. It seeks to examine the perceptions of the participants of the CPD in mathematics for pupils with SEN on their acquisition of knowledge and skills (microsystem). It also examines their understandings of the transfer to practice of content acquired on the PGDSEN programme (exosystem) to their instructional programmes (microsystem). The discussion will centre on specific areas of learning for the participants namely, Assessment, Number and Social maths.

6.4.1 Assessment

Special education teachers including LS/TRs are responsible for the diagnostic assessment of pupils with SEN and have a role in the ongoing evaluation of learning in the staged approach to special educational provision process (Department of Education and Skills, 2003, 2007a) (exosystem). The participants of the current study, similar to other studies of special education teachers (O'Gorman & Drudy, 2010; Shevlin et al., 2008), clearly identified assessment in mathematics as an area in which they lacked expertise (microsystem). Of interest, however, is the fact that the assessment process in literacy was clearly defined in schools in the current study. It is possible that Travers (2010) argument that the introduction of the GAM is a factor in increasing teachers' demands for professional development in assessment in mathematics (exosystem). It seems reasonable also to suggest that the participants' prior training at both ITE and at in-service level had not provided them with the skills they required to perform this task (exosystem). This suggestion is consistent with the research literature as previously indicated in this study (Conway et al., 2009; Shevlin et al., 2008; Ware et al., 2011).

Having identified the input on assessment as the topic of most relevance to their needs, the vast majority of the PGDSEN participants anticipated that this input would influence their future practices (microsystem). Their practices on their return to school indicated that most participants had indeed implemented new assessment approaches in their classrooms and almost half had shared assessment information with their colleagues (microsystem). This finding is similar to that of Wynne (2004), as cited by Ware et al. (2009), who found that special school teachers in her study had made positive changes to their assessment measures following CPD and to that of Rose et al. (2015), who noted that teachers who had received in CPD in SEN were "more adept at providing well differentiated modes of teaching and assessment" (p. 174). A significant change in practice was reported by one participant who acknowledged that prior to the PGDSEN programme, she would have developed the intervention programme in mathematics before meeting her pupils (microsystem). Following the PGDSEN programme, she has changed her practice and pre-tests her pupils to inform her instructional decisions.

The input on assessment provided the participants the opportunity to reflect on their current practice. This was evident in the comments of a participant who stated that she "would never have thought to start with an assessment" but would have started teaching a topic without considering the learning strengths and needs of the pupils in mathematics (microsystem). Most participants were not familiar with error-analysis in mathematics, an approach used to identify error patterns in a pupil's work (Forbringer & Fuchs, 2014) and this was not commonly used in mathematics assessment in their schools. Following the PGDSEN programme (exosystem), a number of participants described how they used error-analysis on standardised test measures or on mathematics text books to inform their intervention programmes, an approach recommended in the literature (Forbringer & Fuchs, 2014; Riccomini & Witzel, 2010). Some participants had shared this expertise with class teachers, resulting in changes in practice throughout their schools (microsystem). This supports the view of Travers et al. (2010) that schools need to develop systems to enable the sharing of expertise between teachers who had received CPD and those who had not (microsystem). On completion of the PGDSEN programme, all participants were using informal assessment measures in the form of checklists and/or teacher designed tests informed by input they had received. Teacher observation was used by all participants as a means of assessment, an approach recommended for Irish primary schools (NCCA, 2005; Ware et al., 2011) (exosystem).

The current study found that participants in the special school and special class had clearly established routines in terms of their assessment practices. They used the problem solving process, from assessment through to teaching interventions in their planning. A trained *Maths Recovery* participant in a DEIS school also had clearly established assessment practices in place. The input on assessment on the PGDSEN programme, in addition to their prior knowledge, had enabled these participants to further refine their assessment practices and had broadened their awareness of diagnostic measure relevant to the needs of their pupils.

The findings of this study indicates that prior to their participation on the PGDSEN programme, many of the participants did not use diagnostic assessment to inform their teaching programme but rather used the class text book to provide additional support in mathematics. This approach is at variance with best practice in the literature which empathises the necessity of obtaining "evidence of students' current mathematical understandings" as a base for developing intervention programmes in mathematics (NCTM, 2014, p. 53). The participants failure to undertake diagnostic assessments prior to their participation on the PGDSEN programme may be related to their lack of knowledge of the assessment process as outlined in the Continuum of Support (Department of Education and Skills, 2007a) (exosystem). It may also be due to the fact that class teachers feel under pressure to complete the mathematics programme with all their pupils – a finding borne out in the study of Ware et al. (2011) and in the Primary Curriculum Review (NCCA, 2005) (exosystem). Evidence in the current study suggests that many LS/RTs feel compelled to support class teachers in achieving this aim.

Assessment formed a core area of the PGDSEN programme in mathematics for the participants. However, the evidence from this study clearly indicates that some participants were not "using data to inform instructional decisions" in their teaching of mathematics to pupils with SEN after completing the PGDSEN programme (Forbringer & Fuchs, 2014, p. 8) . This not uncommon finding, has been found elsewhere in the literature (Cohen & Hill, 2000; Desimone, Porter, Garet, Yoon, & Birman, 2002; Eivers et al., 2005). A closer analysis of the findings of the current study reveals a number of important issues for consideration in this regard.

Firstly, diagnostic assessment in mathematics was not common practice in all of the participants' schools (microsystem). A recent study of Rose et al. (2015) supports this finding. Their research study details the extent of diagnostic testing in literacy but failed to find evidence of similar testing in numeracy (Rose et al., 2015).

Secondly, some participants in the current study did not have access to diagnostic test materials in mathematics in their school (microsystem/exosystem). This factor clearly presented a barrier in implementing new practices. The impact of the absence of resources to support the implementation of new practices has been recognised in the literature (Klingner, 2004). The lack of designated funding for the purchase of diagnostic test materials may account for the dearth of such tests in schools (exosystem). While grants are available to schools to purchase diagnostic test materials, the purchase of standardised test materials is given priority and "any funds remaining after the standardised testing costs have been met may be spent on diagnostic tests in accordance with a school's needs" (Department of Education and Skills, 2011e, p. 6) (exosystem). The findings of this study therefore, strongly indicate the necessity of providing designated funding to schools for the purchase of diagnostic test materials in mathematics.

Thirdly, the availability of suitable tests materials is, however, a more serious issue. The findings of this study, similar to those of Rose et al. (2015) highlight the challenge for schools in sourcing tests that are suitable for "recording academic progress for those with SEN" (p. 173). Teachers in the Ware et al., (2011) study also reported their difficulties in sourcing relevant diagnostic measures for their pupils (exosystem). The participants of the current study, particularly those who were teaching in special classes or in special schools had similar problems when trying to source suitable assessment tools (exosystem). Two participants with a high enrolment of EAL pupils reported similar difficulties. The findings of the NCCA (2005) Curriculum Review in Mathematics acknowledged the difficulties that existed in regard to the availability of appropriate assessment measures for pupils with SEN. The issue of Circular 34/2015 by the Skills (2015) provided guidance on relevant assessment measures for post primary teachers. However, similar guidance is not available for primary schools. Although the Drumcondra Test of Early Numeracy (DTEN) was published in 2011, most of the participants of the current study were not aware of it. The participants of this study acknowledged that the PGDSEN programme had (exosystem) increased their awareness of relevant diagnostic test materials and the findings indicated that many of them had either purchased the DTEN measure or intended to purchase same for their schools. The recommendation made by Rose et al. (2015) for the development of assessments which “recognise the particular complexities associated with documenting the progress” (p.9) of pupils with SEN is strongly endorsed by the current study. Although it is recognised that standardised testing does not meet the needs of all pupils, the argument for the “inclusion of some diagnostic or descriptive information” in standardised testing in literacy (Eivers et al., 2005, p. 29) could equally apply in mathematics and would support many teachers in making better use of test materials that are accessible to them.

Fourthly, even though some participants conducted diagnostic assessments for the first time following the PGDSEN programme, the findings of this study suggest that the ensuing data were not always used to inform instructional approaches (microsystem). This finding concurs with that of Rose et al. (2015) who found that little evidence to suggest that data obtained from such measures was “used in a systematic formative manner to inform planning and evaluation of the efficacy of teaching approaches” (p. 171). Similar findings were found by Eivers et al. (2005) relating to the use of assessment data to inform the teaching of literacy.

Fifthly, following their participation on the PGDSEN, it was found that although some participants were using diagnostic measures to inform their initial instructional decisions, ongoing assessment or progress monitoring to evaluate the effectiveness of intervention programmes was not always evident, a practice also noted by Travers et al., (2010). The practice of formative assessment is highly recommended in the literature as an effective means of monitoring instruction and adapting instructional approaches to meet the specific needs of pupils with SEN (Clarke, Lembke, et al., 2011; Gersten, Beckmann, et al., 2009; Pedrotty Bryant, Bryant, Shin, & Hughes Pfannenstiel, 2015). It is possible that the participants in this study require further CPD to overcome the historical emphasis of summative assessment as the only means of assessment (NCTM, 2014)(exosystem). They may also require further CPD in order to reflect on the merits of prioritising time for formative assessment and the subsequent use of the data to inform their instructional decisions (National Mathematics Advisory Panel, 2008) (exosystem).

Finallly, the findings of the current research study lend support to the conclusions of Travers et al. (2010) which suggest that further opportunities to develop expertise in assessment practices be given to teachers and schools in order to meet the mathematical needs of pupils with SEN more effectively (exosystem). Clarke et al.’s. (2011) proposal for the use of technology in formative assessment measures is supported by the National Mathematics Advisory Panel (2008) and is worthy of consideration (exosystem) and may indeed overcome difficulties associated with time limitations currently experienced by special education teachers (microsystem).

6.4.2 Number

Number, forms an essential element of each strand of the mathematics curriculum (Government of Ireland, 1999b) (exosystem). Early mastery of number and number sense is, therefore, an essential skill (Riccomini & Witzel, 2010; Sharma, 2015). Pupils with SEN, however, find it difficult to learn number (Forbringer & Fuchs, 2014; National Council for Curriculum and Assessment, 2007). The National Mathematics Advisory Panel (2008) published an influential report on future developments in mathematics education in the US. It recommends that teacher education programmes for elementary teachers including special education teachers "should fully address the topics on whole numbers… as well as the concepts and skills leading to them" (National Mathematics Advisory Panel, 2008, p. xviii). In line with this suggestion, number, a critical foundation skills is regarded as an integral component of the mathematics input on the PGDSEN programme (exosystem). The input on number on the PGDSEN programme is intended to build on the prior knowledge of the participants (microsystem) . Participants of the programme requested input on the content and pedagogical aspects of number, with a particular emphasis on evidence-based instructional approaches (microsystem). Following their completion of the PGDSEN programme, the participants admitted to spending a significant proportion of their mathematics classes "doing number". This emphasis on number and their use of assessment measures in mathematics represented a change in practice for most participants (microsystem).

The DTAMS measure of teachers' content and pedagogical knowledge in whole number/computation (CRiMSTeD, 2016a) undertaken by Cohort 1 participants (Phase 1, n = 12) (microsystem) yielded a group result of 49% in the pedagogical content knowledge section and, therefore, indicated that this area required further development. Although this research study did not measure increases in pupil attainment levels over time, research indicates that there is a positive link between pupil attainment and teachers' mathematical knowledge (National Mathematics Advisory Panel, 2008). In light of the recommendations of the (National Mathematics Advisory Panel, 2008), that "teachers must know in detail the mathematical content they are responsible for teaching and its connections to other important mathematics, both prior to and beyond the level they are assigned to teach" (p. 37), the results of the

DTAMS measure clearly indicate the need for further research in this aspect of special education teacher preparation (exosystem).

Influences on the teaching of number, other than those acquired on the PGDSEN programme, were evident in the teaching of three participants. They had incorporated newly acquired expertise into their previous early mathematics intervention programmes. There was some indication of a return to familiar teaching routines, however, observed in the teaching approaches of one participant who based her teaching programme on an established intervention programme in mathematics (microsystem). Similar to the findings of Dingle et al. (2011), it was evident that, this participant who had routinely taught the same mathematics intervention programme effectively over the years, did not overly change her teaching routine in number following her participation in the PGDSEN programme. It is of interest that in their study, Cohen and Hill (2000) found that changes in teacher practices following CPD typically occurred "slowly and partially" (p. 331). Similar to the findings of the current study, the teachers in their study tended to "blend new elements into their practice while reducing their reliance on some older practices" (p. 331). Several participants of the current study indicated that they had adapted their teaching routines and incorporated evidence-based instructional approaches such as explicit instruction, visual supports and the CRA sequence into their teaching of number (microsystem). These practices are strongly advocated in the literature to support the teaching of number and other concepts to pupils with SEN (Gersten, Beckmann, et al., 2009; Pedrotty Bryant, Bryant, Williams, Kim, & Shin, 2013; Westwood, 2013).

6.4.3 Social mathematics

Social mathematics is a priority area in mathematics for pupils with SEN (National Council for Curriculum and Assessment, 2007) (exosystem). All participants recognised the influence of the input on social mathematics in the PGDSEN programme on their teaching (microsystem). For some, it had reaffirmed their personal understandings of the importance of skills such as number, money, time and measurement, while others developed a new awareness of life skills in a mathematics context. One participant noted that she had learned "to teach what matters". Most of the participants were not aware of the recommendations of the National Council for Curriculum and Assessment (2007) that intervention programmes for pupils with Mild General Learning Disabilities (MGLD) should emphasise and prioritise the social aspect of mathematics, with a particular focus on "managing money, understanding timetables and using measures in everyday life situations" (p.3) (exosystem). The findings of the current study indicated that most participants had begun to place social mathematics at the centre of their intervention programmes (microsystem). For some, their newly acquired expertise in teaching social mathematics led to a change in their teaching practices and it became a key component in their intervention programmes (microsystem). However, there were instances where the expectations of class teachers about the completion of the mathematics curriculum or the skills necessary to complete standardised tests in mathematics limited their opportunities to teach social mathematics (microsystem). The lack of support for change from class teachers for change is documented in the literature. Teacher attitudes or beliefs may result in their refusal to adopt new approaches in mathematics “even when their students are not demonstrating success” (Campsen, Granzin, & Carnine, 2011, p. 205). Such teacher attitudes and beliefs underline the need for CPD in SEN for class teachers and whole-school approaches to inclusive practices (Campsen et al., 2011; Nimante & Tubele, 2010; Shevlin et al., 2008) (exosystem).

The results of this study show that the participants were applying core elements of a social mathematics programme such as number, time and money (Westwood, 2000). They were adopting specific evidence based instructional approaches for teaching social mathematics, knowledge and skills acquired on the PGDSEN programme, in their teaching of mathematics. The participants readily acknowledged that they “had never heard of’ the Dollar First Strategy” (Gurganus, 2007; Snell & Brown, 2000) or of an evidence based approach for teaching identification of notes and coins (Horstmeier, 2004). There was evidence of participants’ implementation of both strategies and reports of the positive response of their pupils to this alternative teaching approach (microsystem). Participants also spoke of incorporating visual approaches, task analysis and real life contexts into their social mathematics programme. As a result of their learning on the PGDSEN programme, there was evidence of participants linking social mathematics to social skills programmes and of using Maths Trails on a more regular basis to enhance the teaching and learning of social mathematics (microsystem).

The National Mathematics Advisory Panel (2008) states that mathematics text books do not meet the “curricular expectations of each pupil” (p. 56). The participants practice in this regard was noted particularly in their teaching of social mathematics (microsystem). This marked a departure from their traditional teaching style and reflected their new learning in practice. This practice may however, also be explained by the unsuitability of the mathematics text books for some pupils with SEN, in particular for pupils with greater learning needs in mathematics. Participants also referred to their use of real-world contexts when teaching social mathematics. This approach is strongly advocated in the literature for meeting the educational needs of pupils with SEN in mathematics (National Council for Curriculum and Assessment, 2007; National Mathematics Advisory Panel, 2008) (exosystem). The participants reported that their pupils enjoyed learning mathematics and it is possible that social mathematics may prove a medium for overcoming mathematics anxiety in some pupils. However, the time constraints of sourcing relevant materials for teaching social mathematics was acknowledged by most of the participants (microsystem).

The participants were very satisfied with the input on Social Mathematics on the PGDSEN programme (exosystem) . It promoted a more positive attitude to the teaching and learning of mathematics. For some, the teaching of social mathematics proved to be a new avenue in mathematics which was both necessary, meaningful and attainable for their pupils. Some participants used social mathematics as a means of supporting pupils in mathematics independently of the class mathematics programme. In addition, it was acknowledged as being an accessible medium for involving parents in supporting their children's learning in mathematics.

6.4.4 Summary

The findings of this study indicate that, for the most part, instructional approaches in number, social mathematics and assessment practices, skills acquired on the PGDSEN programme (exosystem) were evidenced in the participants' practices following their participation on the PGDSEN programme (microsystem). However, there were some constraints to full implementation of newly acquired expertise. It seems reasonable to suggest that the overturning of mitigating factors such as the lack of resources, insufficient time for collaboration, negative attitudes of class teachers would lead to further changes in practices in the future (microsystem, exosystem).

6.5 An Ecological Perspective on Special Education Teacher Learning in Mathematics

Bronfenbrenner's (1979) ecological model (Figure 3.1) provided a suitable framework for contextualising, analysing and interpreting special education teacher learning in mathematics for the purposes of this research study. The participants, special education teachers, are placed at the centre of the model. Each participant is surrounded by a series of nested, interconnecting systems, in environments unique to each learner (Bronfenbrenner, 1979; Lewthwaite, 2011). Their learning is influenced by the interactions between people and events in their immediate and wider environment (Odom et al., 2004). Bronfenbrenner's (1979) model led to the understanding of the individual and contextual factors influencing special education teacher learning in mathematics and the subsequent transfer of new learning to practice. Factors within the participants' immediate environments (microsystems) proved to be most influential on their learning. However, factors in their wider environment (exosystems/macrosystems), while not as influential on their learning and adapted classroom practices, were also significant.

6.5.1 The special education teacher

The participants in this study were a heterogeneous group of special education teachers with varying levels of experience in general and special education (microsystem). They were united in their positive attitudes to inclusion. They also shared common beliefs on the value of CPD as a mechanism for developing their personal skills and knowledge in SEN. Although their personal attainment levels in mathematics varied, the participants did not experience mathematics anxiety and they held high personal beliefs in their abilities to teach mathematics successfully. The participants were committed to providing a quality education for their pupils, pupils with special educational needs. Their voluntary participation in the PGDSEN programme (exosystem) indicated their willingness to upskill in inclusive pedagogies (microsystem). A majority of the participants identified assessment as an area requiring upskilling. They also wanted to upskill on social mathematics, number and planning and implementing intervention programmes in mathematics. The participants were satisfied that the PGDSEN programme in mathematics met their professional needs. The input on assessment was identified as the lecture of most relevance to their work.

6.5.2 The microsystem

The participants hold special education teaching positions in either a primary or a special school in Ireland. Each school operates under the remit of the Department of Education (DES) and follows the prescribed curriculum. Legislative and policy influences in Ireland have led to the development of an inclusive education system which facilitates all learners in all schools (Department of Education and Skills, 1993; Government of Ireland, 2004). Learning support, special class and resource teachers have specific roles and responsibilities (Department of Education and Skills, 1999a, 2000). Schools vary in terms of their size, gender of their population, location, socio-economic status and in the diversity of their pupils. Schools also vary in terms of whole-school approaches to inclusion (Winter & O'Raw, 2010), leadership styles, teacher expertise in SEN, teacher attitudes to inclusion (Travers et al., 2010) and attainment levels in mathematics (Shiel, Kavanagh, & Millar, 2014). The participants in this study, teach children with a range of learning needs. Some participants support pupils in their mainstream classes, while others teach them individually or in small groups in a setting external to their mainstream class (Department of Education and Skills, 2005c). Some participants were supported in their teaching of mathematics by SNAs. While most schools had access to the resources they required to teach mathematics, participants in some schools did not have access to assessment measures or relevant text books in mathematics. The knowledge and skills acquired by the participants in the PGDSEN programme are implemented in their classrooms in the microsystem level.

6.5.3 The mesosystem

This layer of the Bronfenbrenner (1979) model consists of the relationships or links between the variables in the microsystem. The ability of the participants to implement adapted practices is dependent on the relationships between the variables in their individual mesosystems. These relationships may support or limit new approaches to the teaching of mathematics for pupils with SEN. Bronfenbrenner's (1979) model suggests that having more connections in their mesosystems, strengthens the position of the participants to be influential in terms of their transfer of personal knowledge and skills to practice.

The participants, all recent graduates of the PGDSEN programme, were satisfied that they had acquired the skills and knowledge necessary to teach mathematics to pupils with SEN in inclusive educational settings (microsystem). In particular, they had increased their knowledge of assessment measures, evidence based practices and planning in mathematics. Evidence in the literature refers to the pivotal role of the principal in promoting inclusive practices (Banks et al., 2016) (mesosystem). While all the principals in this study supported inclusive education, it was evident that under their leadership, some schools had developed more inclusive practices than others. Collaborative relationships between class teachers and special education teachers, a core factor in inclusive practice (Shevlin et al., 2008), was variable in the participants' schools in the current study (microsystem). The nature of this relationship proved to be significant in terms of the transfer of adapted practices in the current study. Collaborative relationships with class teachers proved complex. On one hand, there was the matter of finding time to collaborate and secondly, the attitudes and perspectives of the class teacher were found to direct the opportunities for the participants to implement adapted practices (microsystem). Collaboration was facilitated in a few schools, under the leadership of the principal, through the allocation of dedicated meeting time (mesosystem). This time was used to plan intervention programmes in mathematics and to monitor progress. However, in most schools, meetings tended to be informal conversations which took place on the corridor or in the staff room. Consequently, some participants were denied opportunities to collaborate with class teachers. There were examples of LS/RTs planning and implementing intervention programmes in mathematics independently of the class teacher in the current study (microsystem). This represented a missed opportunity to share the expertise of the LS/RT with class teachers.

The attitudes of class teachers to inclusion proved to be a key factor in terms of the implementation of adapted practices in the current study (microsystem). Positive teacher attitudes to inclusion are a factor in developing inclusive schools (Westwood, 2013; Ring & Travers, 2005) directly influencing “teaching behaviours” (O’Toole & Burke, 2013, p. 239). The literature indicates that factors including length of teaching experience, experience teaching pupils with SEN, CPD and gender, influence teacher attitudes to inclusion (Avramidis & Norwich, 2002). The study of O’Toole & Burke (2013) reported that positive attitudes towards inclusion were held by pre-service teachers in Ireland. While most participants in the current study reported the positive attitudes of class teachers to inclusive education practices in mathematics, there was evidence of a few class teachers who were not willing to embrace new approaches. This unwillingness towards inclusion was previously noted in the study of Travers et al (2010). Some class teachers had firmly entrenched attitudes relating to the teaching of mathematics to pupils with SEN in their classes which may not have been similar to those of the recent graduates of the PGDSEN programme. The evidence in this study indicates that the participants tended to accommodate to varying extents, the views of the class teachers when planning intervention programmes. Class teacher attitudes in this instances proved to be a barrier to implementing new approaches (microsystem). Some participants engaged positively with class teachers however, and shared expertise through co-teaching in mathematics. This approach is advocated in policy directives issued by the DES (2005c). However, the organisational structures did not always facilitate time for planning or for evaluation in each school (mesosystem). This represented a key constraint to the effectiveness of this teaching approach. CPD in SEN has been associated with positive teacher attitudes to inclusion (Avramidis & Norwich, 2002). The provision of funded CPD programmes in SEN for class teachers is worthy of consideration (exosystem). sceot

6.5.4 The exosystem

A number of variables external to the immediate school setting indirectly contributed to the transfer of new practices on the part of the participants in this study. National policy directives such as the SSE (Department of Education and Skills, 2012b) and the implementation of the National and Literacy Strategy (Department of Education and Skills, 2011f) (exosystem) in schools created new teaching and learning opportunities in literacy and mathematics. However, most of the participants schools in this study chose to focus initially on literacy for their SSE process. Participants reported of renewed whole school awareness of mathematics in schools concentrating on mathematics.

All participants spoke of the lack of support from professionals such as Educational Psychologists (EP) and Speech and Language Therapists (SLT) in mathematics (exosystem). While difficulties in mathematics may be reported on professional reports, this was not followed through with recommendations for teaching and learning. On the other hand, the participants noted the support they received in literacy.

The participants in this study reported of the influence of parents on their teaching of mathematics. Parents' contributions are considered in the development of intervention programmes. It was apparent that parents of children with greater educational needs prioritised the development of language, literacy, social skills over mathematics. On the other hand, some parents held key supporting roles in the mathematics intervention programmes. Some schools involved parents in programmes such as Maths for Fun. Other parents aided the generalisation of mathematics topics in the home environment.

6.5.5 The macrosystem

Represented as the outer ring in Bronfenbrenner's (1979) model, societal attitudes and beliefs to inclusion have shaped educational provision. Legislative demands nationally and internationally demanded education systems which were responsive to the learning needs of all children (Ainscow, 2014; Ferguson, 2008; Government of Ireland, 2004; UNESCO, 1994). The attitudes of the society at large to a diverse culture is influential in developing inclusive practices in schools. For example, employment opportunities for all young people in the 21st century requires school leavers who are skilled in literacy and numeracy. Cultural ideologies such as this influence inclusive approaches to education in schools and classrooms.

6.5.6 Summary

Bronfenbrenner's ecological theory (1979) supports a broader understanding of special education teacher learning in mathematics. Their learning is nestled within a series of inter-related systems. The interactions between and within the systems (ideologies, beliefs and structures) influence special education teacher learning. Skilled special education teachers cannot achieve their vision of equipping pupils with SEN with the mathematical competencies society demands of them, in isolation. The current research study has identified factors which support and hinder the work of the special education teacher in mathematics. Successful outcomes for pupils with SEN in mathematics are dependent on the interplay of each of the four layers in Bronfenbrenner's (1979) model. CPD in mathematics for special education teachers is but one variable within this process.

6.6 Conclusion

This chapter presented an interpretation of the findings of the current research study within an ecological perspective. Inclusive practices in schools continue to develop under the management of the principal teacher with the support of LS/RTs, class room teachers, SNAs, parents and other professionals. While it appears that additional support in mathematics has not achieved a similar status to literacy, all schools are providing additional support in mathematics to pupils with learning difficulties. The participants of this study undertook CPD at post graduate level in SEN (exosystem) to fill the gaps they had identified in their knowledge of inclusive pedagogy. Their newly acquired expertise in the teaching of mathematics to pupils with SEN was evident in their practices, in particular, in the areas of assessment, number and social mathematics (microsystem).

It is evident however, that the interplay of variables both within and external to their schools influenced special education teacher learning in mathematics and the subsequent transfer to practice of newly acquired skills and knowledge (microsystem, mesosystem, exosystem). Effective CPD in mathematics for special education teachers needs to consider the broader influences on their learning within their classrooms, schools and school communities (microsystem, mesosystem, exosystem, macrosystem).

Chapter 7: Conclusion

7.1 Introduction

The purpose of this final chapter is to situate the findings within the parameter of the research question in order to elicit implications and recommendations for policy and provision. The strengths and limitations of the study are outlined. The contribution of this study to the research field and suggestions for further research will also be presented.

7.2 The Research Question

The mathematics input on a Post Graduate Diploma in Special Educational Needs (PGDSEN) programme (Department of Education and Skills, 2011c) for special education teachers provided the stimulus for this research study. The purpose of the study was to understand the factors, individual and contextual, influencing special education teachers' acquisition of knowledge and skills for teaching mathematics to pupils with Special Educational Needs (SEN). Individual teacher factors such as teacher motivation, attitude and commitment to Continuing Professional Development (CPD) were considered as were teacher sentiments, attitudes and concerns about inclusive education. In addition, mathematics teaching efficacy beliefs, personal mathematics anxiety levels and measures of teacher content and pedagogical knowledge in whole number and computation served to provide an insight into individual teacher factors influencing the acquisition of new knowledge and skills by the participants, Learning Support/Resource teachers (LS/RTs), special class and special school teachers in Irish primary schools. Contextual factors considered in this study included the role of school leaders, national policies, inclusive school policies and practices and collegial expectations in relation to the teaching of mathematics to pupils with SEN. The study also sought to understand the perceptions and experiences of the participants, of the influence of the mathematics input on the PGDSEN programme on their acquisition of new knowledge and skills. Finally, the understandings of the participants of the transfer of their learning to classroom practice was examined. Barriers and facilitating factors to the implementation of their adapted practices were elicited.

It was anticipated that the outcomes of the study, the understandings of the network of relationships influencing special educators teaching of mathematics, would inform the future design of the CPD programmes for teachers and schools. The resulting CPD would therefore be more closely aligned to meeting the specific needs of special education teachers in mathematics and would make a contribution towards improving attainment levels for their pupils.

The research question and embedded questions which served to elicit the data for this study are as follows:

What factors influence special educators' teaching of mathematics to pupils with SEN?

1. What are the individual teacher factors influencing special educators' acquisition of knowledge and skills in mathematics?
2. What are the contextual factors influencing special educators' acquisition of knowledge and skills in mathematics?
3. What are the special educators' perceptions and experiences of the influence of the mathematics input on the PGDSEN programme on their acquisition of knowledge and skills in mathematics?
4. What are the special educators' understandings of the transfer of their learning to classroom practice?

An overview of the four phases of the research study is presented in Table 4.2. The findings chapter, Chapter 5, addressed the research question and embedded questions in detail. The first embedded question, individual teacher factors was addressed in the sections on measures in Phase 1 and Phase 2. Contextual factors were reported in Theme 1, Inclusive and special education: Policy and provision in Phases 2 and 3. Findings relating to the third and fourth research question were presented in Themes 2 and 3 respectively in the baseline, Phase 2 and Phase 3 sections of Chapter 5. Finally, Chapter 6, presented a discussion of all four research questions under the three themes of the study: Inclusive and special education: Policy and practice; CPD and Teaching mathematics to pupils with SEN: Translating the learning into practice.

7.3 Findings

The research question and embedded questions provide the framework for a summary of the findings of this study.

7.3.1 What are the individual teacher factors influencing special education teachers' acquisition of knowledge and skills in mathematics?

International evidence indicates that individual teacher responses to CPD varies (Brownell, Adams, Sindelar, Waldron, & Vanhover, 2006). Individual teacher factors influence teacher learning and subsequent learner outcomes (Dingle et al., 2011). Individual teacher factors relevant to the current study include; teacher motivation and commitment to CPD, attitudes towards implementing new approaches, personal attitude to mathematics, mathematical knowledge for teaching, mathematics teacher efficacy beliefs and attitudes to inclusive practice.

Participants in the current study supported inclusive approaches to education. However, over half of the cohort expressed some concern about their personal skills and knowledge for teaching pupils with SEN. The lack of teacher knowledge in SEN is not unexpected and is supported by international research (Black-Hawkins, 2014; European Agency for Development in Special Needs Education, 2011). The positive attitudes of the participants in the current study to inclusive education and their equally positive attitudes to CPD led to their participation on the PGDSEN programme, a year long academic programme in SEN. Similar to teachers in the study of Ware et al. (2011), the participants believed CPD would provide a medium of upskilling in SEN. The participants believed they were effective teachers of mathematics, had high personal levels of competencies in mathematics and did not experience mathematics anxiety. However, measures of their mathematical knowledge for teaching highlighted a lacunae in their problem solving abilities and in their pedagogical content knowledge. Results of the measure indicated that there was considerable variation in the participants' mathematical knowledge for teaching.

The findings of this study suggest that the individual teacher factors of the participants will positively influence on their acquisition of new knowledge and skills. Motivated teachers transfer new skills to practice (Bryant, Linan-Thompson, Ugel, Allison, & Hougen, 2001). Participation in the PGDSEN by this cohort of teachers is more likely, therefore, to result in changes in teacher practice. Pupils benefit from the CPD received by their teachers (Horrocks & Morgan, 2011; NCSE, 2015). Precisely how they benefit appears to be a matter for discussion. Participants of this study perceive that their pupils' attainment level in maathematics will increase. Burchell, Dyson, and Rees (2002) approve of teacher self-reports of the impact of CPD and state that "a teacher's explanation of the ways in which this pattern of learning and development relates to changes within her classroom or school is an important indicator of impact” (p. 220). However, without evidence of increased pupil attainment levels, Brownell et al. (2006) argue that CPD leads to changing practices in teaching rather than “improvement” (p. 184). This is a matter of consideration for future research.

The levels of mathematical knowledge for teaching of participants in this study is of concern. Brownell et al.’s (2006) research on teacher qualities supports that of others who agreed that “teachers who had a strong knowledge base to build on” (p. 182) tended to apply newly acquired expertise in their classrooms by contrast to teachers who “lacked prerequisite knowledge” (p. 182). Professional learning communities may be a means of providing additional learning opportunities in inclusive settings (Shepherd & Brody Hasazi, 2007).

7.3.2 What are the contextual factors influencing special educators’ acquisition of knowledge and skills in mathematics?

The findings of this study indicate the influence of contextual factors in the acquisition of teacher knowledge and skills in mathematics for SEN. Inclusive policies in education (Government of Ireland, 2004; UNESCO, 1994) demand teachers trained in inclusive pedagogies (Kershner, 2007). National policies such as the National Literacy and Numeracy Strategy (Department of Education and Skills, 2011f) and the SSE process (Department of Education and Skills, 2012b) are promoting higher attainments in mathematics for all pupils including those with SEN. Principal teachers, co-ordinators of inclusive educational provision (Department of Education and Skills, 2000) were found to be supportive of CPD in SEN for the special education teachers in this study. Their appreciation of the expertise of the participants was acknowledged. The participants, special education teachers, held teaching positions which they felt their ITE had not prepared them for. Having experienced short CPD courses in SEN, the participants acknowledged the need for more in-depth CPD in SEN. Although special education teachers in the Republic of Ireland are not required to hold specialist qualifications to hold a position in special education (Travers et al., 2010), the DES provides funding for an accredited post graduate programme in SEN. Similar opportunities for professional development for class teachers are recommended by Rose et al. (2015).

7.3.3 What are the special educators' perceptions and experiences of the influence of the mathematics input on the PGDSEN programme on their acquisition of knowledge and skills in mathematics?

The vast majority of participants agreed that the input on mathematics on the PGDSEN programme was relevant to their professional needs. Influences were seen at a number of levels – personal, class and whole-school level. On a personal level, acquiring new skills and knowledge increased the participants' confidence in their teaching. For some, existing practices were reaffirmed. Participants reflected on their practice. Practices were adjusted and areas identified for future CPD. Participants perceived that pupil attainment levels would increase. However, the influence on pupils was broader than attainment alone. The participants reported that the pupils liked the new instructional approaches. The influence of the PGDSEN was also evident at whole school level. Some participants were appointed to leadership positions in SEN in their schools. Others shared their expertise at whole school level through their involvement in the SSE process or through engaging in co-teaching.

7.3.4 What are the special educators' understandings of the transfer of their learning to classroom practice?

All of the PGDSEN programme participants agreed that they had implemented new practices in their teaching of mathematics to pupils with SEN. They were generally enthusiastic and willing to embrace new instructional approaches and many were supported by their principal teacher and class teacher colleagues to apply their newly acquired skills. The findings suggest that the transfer of new learning to classroom practice was achieved more easily when there was a whole school culture towards inclusion. There was evidence of changed approaches to diagnostic and formative assessment practices, at individual class level and in one instance at school level. Most participants now prioritised a social mathematics intervention programme for their pupils which they taught using evidence based approaches. Many participants collaborated with class teachers to teach mathematics using the co-teaching model of instruction. There was no evidence of formal planning or evaluation of co-teaching instructional approaches in most instances. SNAs supported the participants in the teaching and learning of mathematics to pupils with SEN. It was apparent that some SNAs were given more responsibility than others in this regard. All participants recognised the importance of developing a strong, foundational base in number and most participants now included some element of number in their daily teaching of mathematics.

Inevitably, there was some variation in the extent of participants' abilities to implement new practices. A minority of the participants were challenged in so doing by class teacher attitudes and expectations of pupil outcomes which differed from their own. It became evident that the class teacher held a pivotal position in many schools with regard to the implementation of new practices. The findings suggest that some class teachers did not implement inclusive practices thus mitigating the influence of the new practices acquired by the special educator. Despite the good will of their colleagues, many participants were hampered by the lack of suitable resources required to implement new approaches. This was a particular problem with regard to the availability of suitable diagnostic test materials in mathematics. Structural issues in schools such as finding time to collaborate with class teachers also arose as a challenge to implementing new practices.

The research study noted the slight resistance of one participant to change her existing instructional approaches in mathematics. She had considerable expertise in mathematics for SEN prior to participating on the PGDSEN programme and had an established teaching routine in mathematics. She did however, incorporate aspects of her new learning into her existing practice. The special school and special class participants in this study had well established teaching and learning routines in mathematics prior to their participation on the PGDSEN programme. However, both appreciated the new opportunities for learning presented to them and integrated new practices into their instructional approaches.

The findings presented indicate the transfer of learning to classroom practice. The special education teacher was central to the resulting change in practices. Within an ecological perspective, it is evident that further opportunities for change exist. Input on the teaching of mathematics to pupils with SEN is essential in Initial Teacher Education (ITE) programmes to facilitate the transfer of collaborative practices. Similarly, class teachers, who hold responsibility for the teaching of mathematics to all pupils in their classes, require opportunities to upskill in this area.

7.4 Implications and Recommendations

The findings of this study draw together a number of issues related to the teaching of mathematics to pupils with SEN which have implications for policy, provision and research. The conclusions of the study, similar to other current inclusive research studies, aim to inform future policy, provision and research initiatives to further support and enhance the teaching of mathematics in inclusive and special education settings. This will enable the sustained implementation of new practices, provide better quality learning experiences for pupils with SEN in mathematics and result in increased pupil outcomes in mathematics. Implications and recommendations for policy and provision are presented separately.

7.4.1 Policy

Inclusive education policies provide for the educational provision of pupils with SEN in mainstream educational settings (Government of Ireland, 2004). Participants in this study supported children with a wide range of disabilities attending mainstream schools, a special class and a special school. The provision by the DES, of a funded PGDSEN programme for teachers involved in learning support and special education to support their professional development in fulfilling their role is a valuable initiative and recognises the commitment of the DES to inclusion (Department of Education and Skills, 2011c). It provides participants with the theory and practical skills required to teach pupils with SEN. This study found that there was a lacunae in the provision of similar CPD in SEN for class teachers, principal teachers and SNAs to develop the skills required for their role in the inclusion process. Given the commitment of schools to provide inclusive education and the ecological perspective on special education teacher learning previously outlined, whole school approaches to CPD in SEN are essential (Rose et al., 2015).

DES initiatives at national level to improve outcomes for pupils were in place in each school in this study. School plans developed in response to the SSE process (Department of Education and Skills, 2012b) and the Literacy and Numeracy Strategy (Department of Education and Skills, 2011f) created a focused awareness on attainment levels in mathematics and resulted in enhanced learning opportunities in mathematics for pupils with SEN. This study supports the further development of national initiatives to improve learning outcomes in mathematics for all pupils including those with SEN.

Policy directive guide the provision of additional teaching support to pupils with learning difficulties in mathematics (Department of Education and Skills, 2007a). A three step process to assessment and intervention identifies and supports special educational needs. The findings of this study indicate, that this cycle of intervention is not as well developed in mathematics as it is in literacy in schools. Schools are challenged in so doing for a number of reasons. Firstly, it is clearly evident that relevant assessment measures in mathematics are not available in schools. Policy makers in assessment need to develop assessment measures which are appropriate for the particular needs of pupils with SEN in mathematics. A range of measures, screening and diagnostic, are required to meet the learning needs of pupils with a range of learning needs in mathematics. Secondly, the purchase of relevant assessment measures has financial implications for schools. Schools require support from the DES to acquire assessment measures in mathematics. Thirdly, the provision of CPD to class teachers, principals and SNAs to support the teaching and learning of mathematics to pupils with SEN would enhance the implementation of the Continuum of Support (Department of Education and Skills, 2007a). A specific focus on the use and interpretation of assessment measures should form an integral element of such professional development.

7.4.2 Provision

Similar to other research on inclusive education in Ireland, this research study found evidence to suggest that inclusive education provision as evidenced in mathematics is evolving in primary schools. While all schools in this study supported pupils with SEN in mathematics, the nature and extent of this provision varied from school to school. Policy directives such as the Continuum of Support (Department of Education and Skills, 2007a) did not always reflect practice in schools in mathematics. Some participants were challenged in their implementation of new practices due to the lack of relevant texts and assessment measures in mathematics. The lack of structured time for collaborative planning in mathematics between LS/RTs and class teachers presents a serious challenge to inclusive practices in mathematics. In addition, the lack of support from some class teachers towards new approaches hindered the implementation of same and indicated, therefore, the importance of providing CPD in SEN for all teachers. Some schools were providing additional support in mathematics using the co-teaching instructional model. It was evident however, that all schools were not planning or evaluating co-teaching classes.

An ecological perspective on the teaching of mathematics by special education teachers permits a broader perspective on the challenges and facilitating factors of implementing changed practices. The influence of national initiatives to increase attainment levels in mathematics is evidenced through whole school approaches to mathematics. The development of the *Maths Recovery* programme to non-DEIS schools in the form of the *Mata sa Rang* programme is a welcome initiative. To overcome the varying approaches to the teaching of mathematics both between and within schools, it is suggested that school policies on SEN address the teaching of mathematics to pupils with SEN directly. While the practice of co-teaching represents an inclusive approach to the teaching of mathematics, participating teachers require CPD to support them with its effective implementation into the Continuum of Support framework of additional support. CPD on co-teaching at whole school level needs to be considered by school management. The class teacher has emerged as a pivotal figure in the transfer of learning to practice. Class teachers would benefit from participating in CPD on the teaching of mathematics to pupils with SEN. This, in addition to time to collaborate, would enable a stronger partnership between the class teacher and LS/RT which, it was hoped, would lead to achievement gains for their pupils. Participants teaching mathematics to pupils with greater educational needs had difficulty accessing relevant texts and resources to support their teaching. There is an urgent need for educational publishing companies to develop text materials to support the teaching of mathematics to pupils with a range of special educational needs.

7.5 Strengths and Limitations of Study

The methodological approach of this study, multiple case studies, permitted an examination of the phenomenon, special education teacher learning and subsequent transfer to practice of newly acquired skills and knowledge, in a range of schools. A second visit to each of eight sites, permitted the researcher to gain insights into the work of the special education teacher, initially with her case load of pupils on a broad scale and secondly, with a specific focus on one pupil or a small group of pupils. It was therefore possible, to obtain a rich, description of issues relating to the teaching of mathematics to pupils with SEN and special education teacher learning in mathematics.

The position of the researcher in this study, as special education teacher educator on the PGDSEN programme, facilitated easy access to the participants. In addition, the researcher had sole responsibility for data collection and analysis. A robust approach to triangulation including member checking, multiple sources of data collection, the use of a Reflective diary by the researcher and the application of Bronfenbrenner's (1979) ecological theory were applied to the study in order to overcome the possibility of researcher bias.

The size of the sample population proved to be a limitation in this research. The findings of this study are based on the responses of the primary/special school participants of a PGDSEN programme for one academic year only (n=32). Further research may need to consider extending the data set to include the graduates of PGDSEN programmes in other host Higher Education Institutions (HEIs). This would enable a national data set from which generalisations could be formed.

It may also be useful to gain additional perspectives of the phenomenon. This study was limited to special education teachers. The perspectives and experiences of principal teachers, class teachers and SNAs on the teaching and learning of mathematics to pupils with SEN would provide a broader context for the future development of CPD for all stakeholders.

Rose and Shevlin (2014) verified their study on inclusive education in the Republic of Ireland by considering their findings in terms of school variables such as school type, status e.g. DEIS or non-DEIS and size. This led the researchers "to provide a well-informed generalisation" of inclusive provision generally (p. 6). Given that there were similar variabilities in the data set of the current study, a consideration of the school variables would have enhanced the generalisation of the findings.

7.6 Contribution to the Research

The aim of the current study was to better understand factors (individual and contextual) influencing the acquisition of knowledge and skills acquired on the PGDSEN programme in mathematics. The study also sought to examine the perceptions and experiences of the special education teachers of the influence of the CPD on their acquisition of new knowledge and skills and their understandings of the transfer of their learning to practice. An understanding of these factors is required to develop CPD which meets the needs of teachers and their schools (Chval et al., 2008).

This study makes a unique contribution to the limited research that exists in the field of CPD for special educators in mathematics in Ireland. The study provides an insight into the perceptions and understandings of participants of a PGDSEN programme on their acquisition of new knowledge and skills in mathematics and their understandings of the transfer of this expertise to practice. In addition, the study documented the participants' current practices in the provision of additional support in mathematics. Bronfenbrenner's ecological framework enabled an understanding of the interconnecting factors which supported and impeded the acquisition and implementation of expertise in mathematics through a PGDSEN programme. The findings suggest that while CPD for special education teachers plays a central role in improving mathematical outcomes for pupils with SEN, the interaction of additional systems level factors requires consideration in future CPD initiatives. An understanding of the complexities of the factors presented will enhance the future planning of CPD in mathematics. It will ensure that such CPD is responsive to the needs of special education teachers.

7.7 Suggestions for Further Research

This small scale study has examined one aspect of the many factors influencing the teaching of mathematics to pupils with SEN - special education teacher learning. Implications for further research are evident in the findings.

Given the small scale nature and short time frame of the current study, longitudinal research to examine the sustained implementation of new practices acquired on the PGDSEN programme in mathematics is recommended.

The DES have invested considerable resources to support CPD in SEN for special education teachers. An evaluation of pupil outcomes in terms of increased attainment, attitude and motivation to mathematics is therefore justified.

Research on the mathematical knowledge of teachers in special education is necessary to design CPD to meet the specific needs of both the special education teacher and of their pupils

This study focused on the perceptions and experiences of special education teachers of their CPD endeavours and subsequent transfer to practice. Research is needed to ascertain the perceptions, experiences and needs of class room teachers regarding the teaching of mathematics to pupils with SEN in order to design CPD programmes which are responsive to their specific needs.

An examination of the "student voice" was outside the remit of the current study. Research which examined pupil attitudes and motivation to mathematics, experiences of learning mathematics and future expectations in mathematics would further inform the development of CPD in mathematics for special education teachers.

7.8 Conclusion

This study has traced the journey of the participants of a PGDSEN programme through their academic year of studies. The journey continued in their classrooms, twelve months and eighteen months later. The PGDSEN input on mathematics was the specific focus of this study. The participants, experienced mainstream teachers with less experience in special education, held special education posts in mainstream schools, special classes and special schools. Although they participated actively in CPD, they had identified SEN as an area requiring upskilling. The participants agreed that the input on mathematics had met with their professional needs and anticipated that the programme would influence their teaching of mathematics. While all participants changed their practices to varying extents on their return to their classrooms, some participants were challenged in so doing by existing school cultures which proved reluctant or resistant to implementing change.

The implications of the findings suggest that increasing attainment levels in mathematics for pupils with SEN requires inclusive whole school approaches to the teaching and learning of mathematics. CPD undertaken by special education teachers is but one aspect of a positive school culture in mathematics. Bronfenbrenner's ecological perspective frames the factors influencing special education teacher learning. Given that the ultimate goal of CPD is increased pupil attainment levels, it is evident that all personnel in the school, principal, class teachers and SNAs require CPD in SEN to support their role in inclusive mathematics approaches. A whole school approach to CPD in SEN in mathematics supported by supports at systems level will ensure that each pupil, including those with SEN, achieve their learning potential in mathematics.

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Appendices

Appendix A: Semi-Structured Interview Schedule (Phase 3)

1. School profile: Number of pupils/teachers/SNAs/setting/type of school
2. Pupil profile: a) Template b) Do you think the focus pupil/s likes maths? c) Does he experience maths anxiety? d) How would the pupil rate his own ability in maths? e) Do you think the pupil is achieving to his potential in maths?
3. Maths programme: a) Tell me about the programme you taught to this pupil/s since September. b) How did you decide what to teach? c) What assessment did you use? d) What did you teach? e) What texts/resources did you use? Did you have access to all the resources you required? f) Did you use ICT? g) How did the pupil respond? h) What were the outcomes of the maths programme? i) How did you evaluate the maths programme? j) How much time do you allocate to the teaching of maths? What time of day do you teach maths? k) What model of teaching do you use to teach maths? l) Tell me about the instructional approaches you use to teach maths? CRA, concrete materials, real life experiences, modelling etc m) What is your core maths text book? What are your views on it? If you were designing a maths text book for pupils with SEN what would it look like? n) Describe a typical maths lesson for me. o) Tell me about your planning in maths.
4. LS/RT/Special class teacher a) What informs how you teach maths to pupils with SEN? b) Can you describe to me one of the moments when you successfully taught a maths concept?... one of those aah moments! c) Do you collaborate with your colleagues with regard to the teaching of maths? d) How do you prepare for teaching a maths class? e) Are their constraints to your teaching of maths to pupils with SEN? f) Has how you teach maths to pupils with SEN changed since completing the PGDSEN? g) Are there factors other than the PGDSEN that influenced how you teach maths to pupils with SEN? h) Describe to me your ideal course in maths for pupils with SEN i) How would you rate your own level of technology use on a scale of 1 to 5 with 5 being the top of the scale?

Appendix A: Semi-Structured Interview Schedule (Phase 3) (contd.)

5. Class teacher a) How is the class teacher involved in the maths intervention programme? b) How does the class teacher view the support given by you as LS/RT to the pupil? c) How confident are you that class teachers have the necessary skills and knowledge to teach maths to pupils with SEN? d) What is the best way of supporting class teachers to develop the skills and knowledge they need?
6. Parents: a) What are the attitudes of the parents to their child's maths achievements? b) What are the expectations of the parents with regard to their child's achievements in maths? c) How do you involve the parents in the maths programme? d) How responsive are the parents to providing support in maths? e) What areas in maths are priorities for the parents?
7. SNAs: a) Can you tell me about the role of the SNAs in the maths programme?
8. Other professionals: a) Do other professionals such as Eps, S&LTs have a role in the maths programmes you teach?
9. Whole school approaches to maths: a) Are their school wide programmes/interventions in maths? Mata sa Rang, early intervention programmes, co-teaching b) Have national policies influenced your teaching of maths? SSE, National Literacy & Numeracy Strategy c) Other teachers in the school who have completed the PGDSE – does the impact the teaching of maths?
10. CPD: a) What are your views on CPD? b) How does the CPD you have received in special education/maths translate into classroom practice? c) Are there areas in maths that you would like to upskill on? d) What type of CPD would best meet your needs? Online, face to face e) What other CPD courses have influenced your teaching of maths? f) How do you judge effective CPD?
11. Other: a) Is there anything else that you think would be helpful for me to know with regard to improving outcomes in maths for pupils with SEN?
12. Supporting documentation: Planning documents IEP/IPLP/Group plans/ Short term plans/Assessment/ Samples of pupils' work

Appendix B: Sample of Participant's Reflective Journal (Phase 3)

Week 6: Oct 6th - 10th.

- Teacher absent 1 day.

- As part of SESE - we have been focussing on the theme: Transport across the junior School. We integrated this into our maths by making long trains + train tracks. We used the vocab - getting longer when we added another carriage / piece of track and I overheard TC saying this during play time.

- He is struggling a bit with this concept and will need more reinforcement. He is definitely at the hands-on, lots of concrete materials stage.

- I tried to use a powerpoint on Thursday asking TC + OC

Appendix B: Sample of Participant's Reflective Journal (Phase 3) (contd.)

to click on the long/short items. there was no consistency and a lot of guesswork.

- I found that integrating the topic into other subjects was more beneficial. As we were talking about trains and their long carriages + ~~threa~~ threading long snakes it was more practical and more of a life skill which is ultimately what I was trying to achieve.

- I find that the textbooks deal with measures in the space of 1 or 2 pages + at ~~which~~ a level which we have not yet reached. As a result I spend a lot of time trying to make powerpoints/ worksheets/assessments.

Appendix C: Questionnaire (Phase 1)

Special Education Mathematics Teachers: The influence of a continuing professional development programme and other factors.

Code: ____ ____ ____ ____

This code will be used to track pre and post test data and will not be used to identify individual teachers. All information provided will be treated in the strictest confidence.

Background Information

Please complete the following by either filling in the answer or circling the response.

1. Teaching position

   i. Learning support teacher
   ii. Resource teacher
   iii. Learning support/resource teacher
   iv. Special class teacher
   v. Other (please specify) ____________________

2. Length of teaching experience _________

3. Length of teaching experience in special education __________

4. To which age group do you belong?
   i. 20-29 years ii. 30-39 years iii. 40-49 years iv. 50-59 years v. 60 years and above

5. Gender
   i. Male
   ii. Female

6. Which of the following qualifications do you hold? **(Please circle all that apply)**

   i. A primary school teaching diploma or certificate or other primary school qualification
   ii. A primary degree in education (B.Ed)
   iii. A primary degree in another subject (BA)
   iv. A post graduate diploma in education

v. A higher degree in education (Masters, PhD) (please specify)

____

vi. A higher degree in another subject (Masters, PhD) (please specify)

____

vii. A qualification in special education (please specify)

____

viii. Leaving Certificate Honours Mathematics (or equivalent)
Grade obtained __________

ix. Leaving Certificate Pass Mathematics (or equivalent)
Grade obtained _____________

x. Other (please specify) ________________________

7. List any **CPD courses** you have undertaken in **special education** in the last three years
   i. ____
   ii. ____
   iii. ____
   iv. ____
   v. ____

8. List any **CPD courses** you have undertaken in **mathematics** in the last three years.
   i. ____
   ____
   ii. ____
   iii. ____
   iv. ____

9. List any **CPD courses** you have undertaken which focused specifically on **mathematics for children with learning difficulties/special needs** in the last three years.
   i. ____
   ii. ____
   iii. ____

Appendix D: Codebook (Phase 2)

CODE	ACRONMYN	CODE DEFINITION
1. Assessment	ASMNT	Reference to any form of assessment or diagnosis of a child
2. *Case Load*	*CL*	*Reference to the case load of the LS/RT/Special Class Teacher*
3. Challenges to teaching maths	CM	Reference to the challenges of teaching mathematics
4. Class Teacher	CT	Reference to the class teacher
5. *Class Teacher Expectations in Mathematics/SEN*	*CTEXMTH*	*Reference to the expectations of the class teacher in maths for pupils with SEN/Learning difficulties*
6. Collaboration	COLL	Reference to collaboration between the LS/RT and class teachers
7. *Concrete materials*	*CM*	*Reference to concrete materials*
8. Continuing professional development	CPD	Reference to Continuing Professional Development - not maths specific
9. Continuing professional development in mathematics for SEN	CPDM	Reference to CPD in mathematics for pupils with SEN/learning difficulties
10. Co-teaching	CoT	Reference to co-teaching models including station teaching and team teaching
11. Delivering Equality of Opportunity in Schools	DEIS	Reference to the official model
12. Differentiation	DIF	Reference to differentiation of the curriculum or learning for children with SEN
13. Early Intervention	EI	Reference to early intervention initiatives
14. Education Centres	EC	Reference to the availability of CPD in education centres
15. English as an Additional Language	EAL	Reference to children for whom english is an additional language
16. Entry Requirement	ER	Reference to the entry requirement in maths for entry to the B. Ed. Programme
17. Group size	GS	Reference to either the number of children within a class or the six of a group within which a pupil with SEN is educated
18. Impact of PGDSEN	IPGDSEN	Reference to factors which resulted following the undertaking of the PGDSEN by the teacher
19. Impact of Standardised Testing	IMPSTDS	Reference to the impact of standardised testing in mathematics on the teaching of mathematics in the school
20. Inclusion	IN	Reference to definition or opinion about inclusion

Appendix D: Codebook (Phase 2) (contd.)

21. Individual education plan	IEP	Reference to formulation or implementation of an IEP
22. Information and Communications Technology	ICT	Reference to information and communications technology to support teaching and learning
23. Intervention	INT	Reference to specific teaching interventions for pupils with SEN
24. Mathematical Knowledge for teaching pupils	MKT	Reference to the mathematical knowledge of teachers for teaching pupils
25. Mathematical Knowledge for teaching pupils with SEN	MKTSEN	Reference to the mathematical knowledge of teachers for teaching pupils with SEN
26. Mathematics Curriculum	MC	Reference to the mathematics curriculum
27. Maths and Gender	MG	Reference to maths and gender
28. Maths Programme	MP	Reference to the mathematics programme
29. Maths in SEN Evolving	ME	Reference to the evolving or positive changes to the teaching and learning of maths to pupils with SEN
30. Maths Teaching	MT	Reference to the teaching of mathematics
31. Maths Text Book	MTB	Reference to the mathematics class text book
32. Multi-agency	MATHS	Reference to work across education, social services or health services (HSE) or between any of these
33. My Reflections	*ME*	*Reference to reflections made by the researcher during the coding process*
34. National Policies	NP	Reference to national policies which impact on the teaching of maths – SSE, Literacy and Numeracy Strategy
35. Number/Numeracy	N	Reference to number or numeracy specifically
36. Parents	PA	Reference to parents in relation to the mathematics education of their children
37. Perception of Class Teacher to expertise gained by the LS/RT following completion of the PGDSEN	*PCTPGDSEN*	*Reference to the perceptions of the class teacher to expertise gained by the LS/RT on the PGDSEN*
38. Positive Attitude to Mathematics	PAM	Reference to the positive attitudes of LS/RTs/Class teachers to mathematics
39. Positive Attitude to the teaching of Mathematics	PATM	Reference to the positive attitudes of the teachers to teach mathematics
40. Post-Graduate Diploma in SEN	PGDSEN	Reference to the Post-Graduate Diploma in SEN

Appendix D: Codebook (Phase 2) (contd.)

41. Priority of Literacy over Mathematics (Cinderella Maths)	CM	Reference to the prioritising of literacy over mathematics in the curriculum for pupils with SEN
42. Problem-solving	PS	Reference to the teaching and learning of problem-solving
43. Pupil Labelling	PL	Reference to pupils ability in mathematics
44. Raising Attainment in Mathematics	*RAM*	*Reference to initiatives aimed at raising attainment in mathematics in the school*
45. Reasons for undertaking PGDSEN	RPGDSEN	Reference to reasons for undertaking the PGDSEN
46. Resources for teaching maths	RES	Reference to specific equipment, materials or facilities designed to enable access to learning for pupils in mathematics
47. Resources for teaching maths in the infant classes	RESIN	Reference to specific equipment, materials or facilities designed to enable access to learning for pupils in mathematics in the infant classes
48. Role of Principal	PRINCIPAL	Reference to the role of the principal in the co-ordination and management of teaching provision in special education including mathematics in the school
49. School Policy/Plan	SPLN	Reference to school policy/plan in relation to the teaching of mathematics
50. School Profile	SP	Reference to the type of school, and to the number of pupils, teaching staff, SNAs in a school
51. Social Maths programme	SM	Reference to a social maths or functional maths programme
52. SEN Co-ordination	*SENCRD*	*Reference to the co-ordination of SEN in the school*
53. Special Needs Assistant	SNA	Reference to special needs assistants
54. Staff Meetings	SM	Reference to the discussion of SEN and mathematics related activities at Staff Meetings
55. Staged Approach	*SA*	*Reference to the staged approach*
56. Standard of Maths	STDMTHS	Reference to the standard of maths in the school
57. STEN	STEN	Reference to STENS - a standardised measure of attainment in literacy or numeracy
58. Supports to the teaching of maths	STM	Reference to supports for the teaching of maths to pupils with SEN
59. Target	TG	Reference to learning targets (or goals) set for individual pupils with SEN
60. Teacher Reflections	*TR*	*Reference to the reflections of the LS/RT/Special Class Teacher during the interview process*

Appendix E: First Cycle Codes (Phase 2)

Assessment	Co-teaching	ICT	Maths standards	Perceptions of class teacher to PGDSEN expertise
Challenges to teaching maths	Differentiation	Instructional approaches	Maths text book	Positive attitude to maths
Class teacher	Early intervention	Intervention	Multi-agency	Positive attitude to teaching maths
Collaboration	Education centre	MKT	National policies	Priority of literacy over maths
Case load	EAL	MKT for SEN	Number	Play
Concrete materials	Group size	Maths curriculum	Parents	Problem-solving
CPD	Impact of PGDSEN	Maths in SEN evolving	Planning to teach maths	Pupil labelling
CPD in maths for SEN	IEP	Maths teaching	Parents	Pupil attitudes to maths

Appendix F: Second Cycle Codes: Emerging Themes (Version 1) (Phase 2)

Planning to teach maths

Assessment

IEP

STEN

Supports for the teaching of maths

Class teacher

Perceptions of class teacher to PGDSEN expertise

Collaboration

Co-teaching

SNA

EAL

Parents

Maths in SEN evolving

External factors

Multi-agency

National policies

School self-evaluation

Whole school evaluation

Challenges to teaching maths

SEN maths teacher

Positive attitude to maths

Positive attitude to teaching maths

Teacher competence

MKT

MKT for SEN

School policy/plan

Standards of maths

Maths standards

Priority of literacy over maths

Maths curriculum

Number

Problem-solving

Social maths programme

Maths text book

Teaching approaches to maths

Maths teaching

Play

Differentiation

Instructional approaches

Early intervention

Intervention

Pupil/s with learning difficulties in mathematics

Group size

Target child

Target group

Case load

Pupil labelling

Pupil attitudes to maths

CPD

CPD in maths for SEN

Education centre

Impact of PGDSEN programme

Resources for teaching maths

Concrete materials

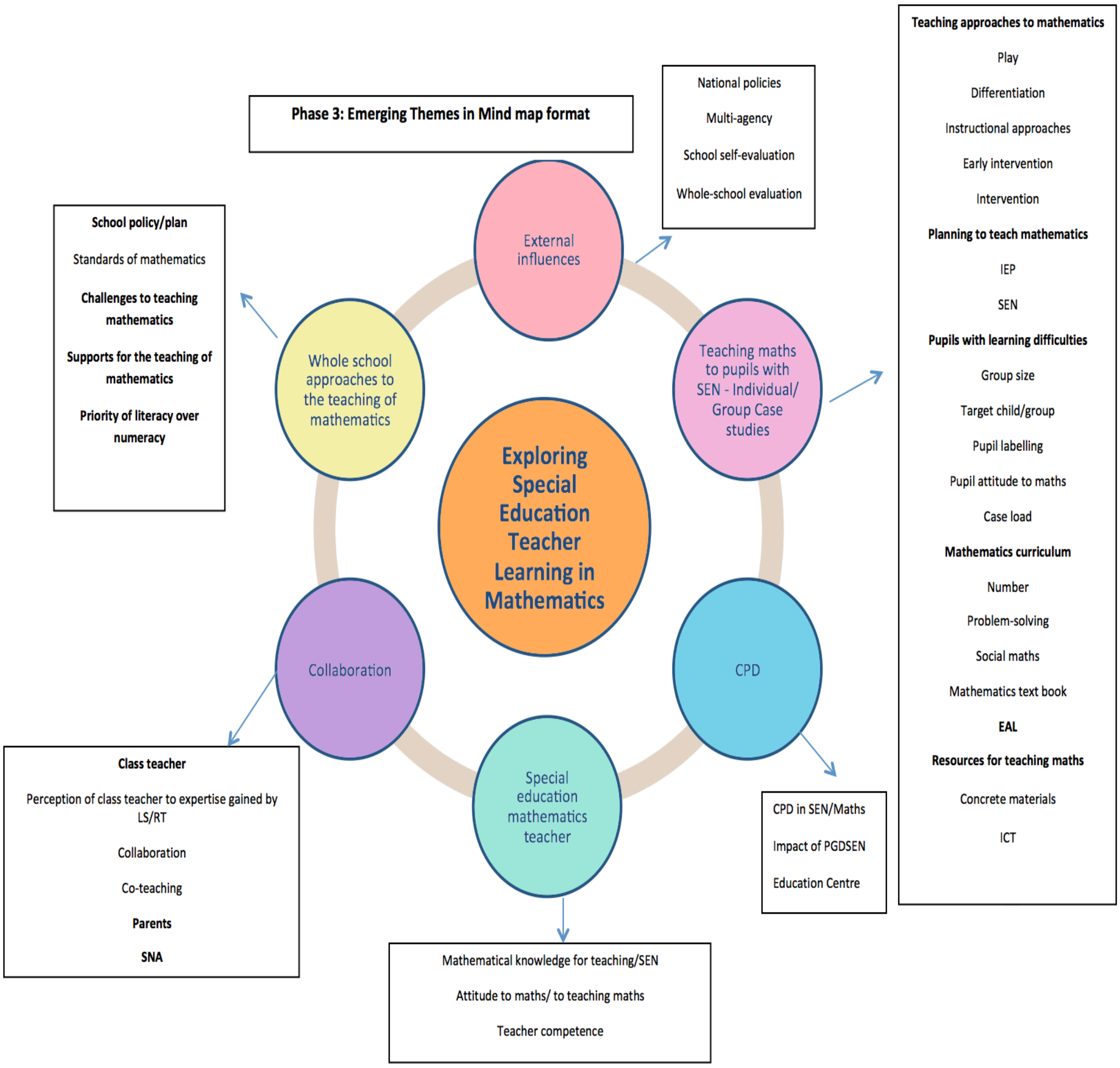
ICT

Note. Emerging themes in bold print

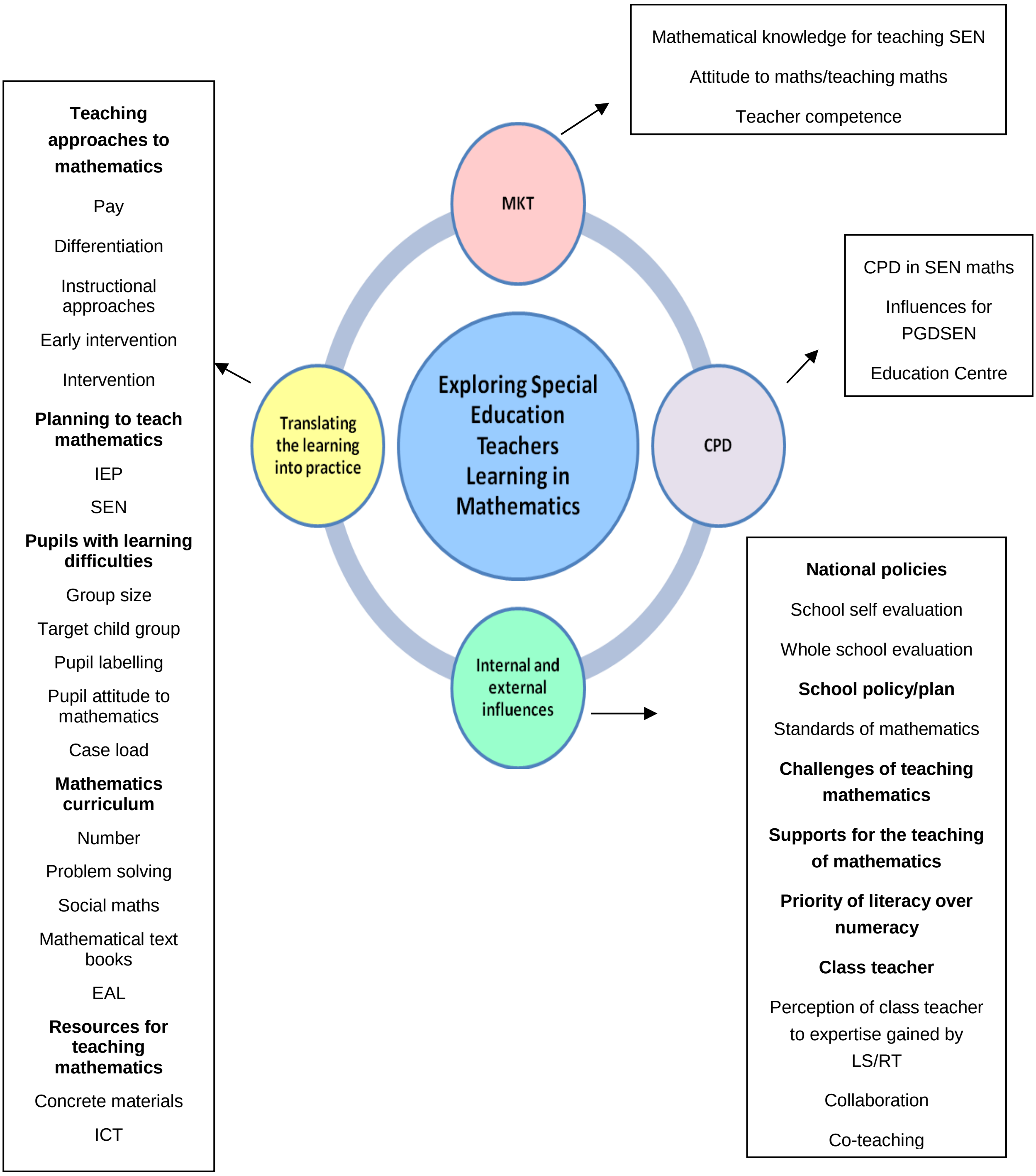
Appendix G: Emerging Themes - Phase 2 (Version 2)

CPD	Collaboration	External factors	Special education maths teacher	Teaching maths to pupils with SEN – Individual/group case studies	Whole school approaches to the teaching of maths
CPD CPD in maths for SEN Education Centre Impact of PGDSEN	**Class teacher** Perceptions of class teacher to PGDSEN expertise Collaboration Co-teaching	Multi-agency National policies School self-evaluation Whole school evaluation	Attitude to maths Attitude to teaching maths Teacher competence MKT MKT for SEN	**Mathematics curriculum** Number Social maths Maths text book Problem-solving	**School policy/plan** Standards of maths
	Parents			**Pupils with learning difficulties** Group size Target child Target group Case load Pupil labelling Pupil attitude to maths	**Challenges to teaching maths**
	SNA			**Resources for teaching maths** Concrete materials ICT	**Supports for the teaching of maths**
				Teaching approaches to maths Maths teaching Play Differentiation Instructional approaches Early intervention Intervention IEP STEN Assessment	**Priority of literacy over numeracy**
				EAL	

Appendix H: Themes Phase 2 (Version 1)



Appendix I: Themes - Phase 2 (Version 1)



Appendix J: Themes - Phase 2 (Version 2)

Pupils with SEN (Caseload)

Group size

Target child/group

Case load

Planning to teach mathematics

Assessment

Targets

Mathematics curriculum

Number

Social mathematics

Teaching approaches to mathematics

Differentiation

Interventions

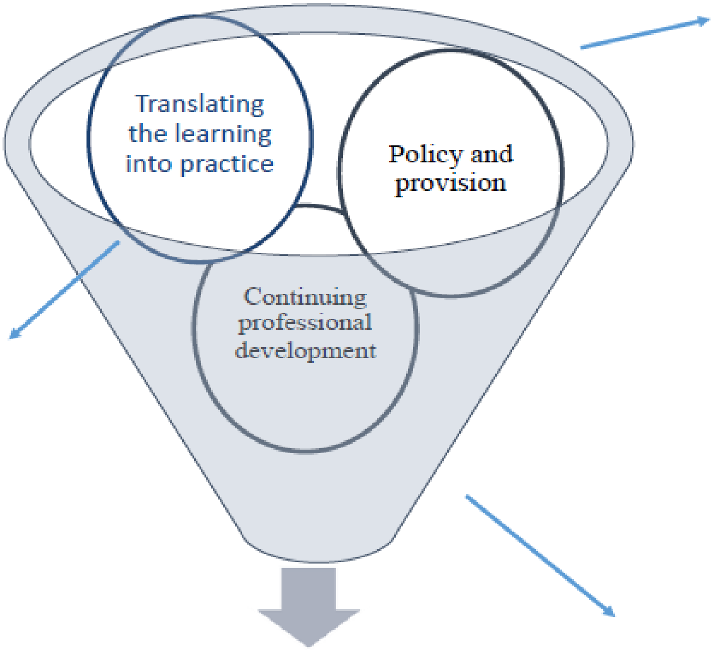
Raising attainment in mathematics

Resources to support the teaching of mathematics

Text book

Concrete materials/manipulatives

ICT



Exploring special education teacher learning in mathematics

Internal influences

School profiles

SEN coordination

Staff meetings

School plan

Class teacher

Role of principal

SNAs

Challenges/supports to the teaching of mathematics

Collaboration

Co teaching

External influences

Multi-agency

National policies

Impact of standardised testing

Continuum of support

Parents

CPD

PGDSEN

MKTSEN

Attitude to teaching mathematics

Appendix J: Themes -Phase 2 (Version 2)

Appendix K: Ethics

Code of Ethics

This *Code of Ethics* is informed by the principles established in the Ethical Guidelines for Educational Research (2011) issued by the British Educational Research Association.

1. The researcher will conduct the research within an ethic of respect for all persons involved in the research being undertaken. Individuals will be treated fairly, sensitively, with dignity and within an ethic of respect and freedom from prejudice regardless of age gender, sexuality, race, ethnicity, class, nationality, cultural identity, partnership status, faith, disability, political belief or any other significant difference.
2. Voluntary informed consent will be sought without any duress from the participants prior to the commencement of the research.
3. Participants in the research will be informed of the research process and why their participation is necessary.
4. Participants in the research have a right to withdraw from the process at any time and will be informed of this right.
5. The researcher will comply with Articles 3 and 12 of the United Nations Conventions on the Rights of the Child and will ensure that the best interest of children is served at all times. Children will be facilitated to give informed consent and this will be in addition to the consent given by parents or carers.
6. In the case of participants whose age, intellectual capability or other vulnerable circumstance may limit the extent to which they can be expected to understand or agree voluntarily to undertake their role, the researcher will seek the collaboration and approval of their parents/guardians.
7. The researcher will ensure that she complies with legal requirements in relation to working with school children or vulnerable adults.
8. The researcher will recognise that participants may experience distress or discomfort in the research process and will take all necessary steps to reduce the sense of intrusion and to put them at their ease. Any action ensuing from the research process that causes emotional or other harm will be desisted.
9. The researcher recognises the rights of all professional colleagues, teachers, principal teachers, parents/carers and students who participate in the research to have their confidentiality protected at all times.
10. In circumstances where participants use non-traditional orthography or alternative modes of communication, the researcher will take full account of this in seeking informed consent and will endeavour to provide support and full access to information
11. Data collected as part of the research process will be securely maintained and will be accessible only to the researcher involved in this project.
12. The researcher will protect the sources of information gathered from interviews, focus groups, document scrutiny, observations and other collection methods.

Appendix K: Ethics (contd.)

13. In The researcher is under an obligation to describe accurately, truthfully and fairly any information obtained during the course of the research.
14. The researcher is obliged to communicate the findings of her research to other members of the educational research community through research seminars, conference presentation and proceedings and publication taking account of all issues of confidentiality and protection of research participants.
15. The researcher will report the procedures, results and analysis of the research accurately and in sufficient detail to allow all interested parties to understand and interpret them.
16. This ethical code will be continually reviewed in order to take full account of any changes in procedure or legislation which may impact upon the conduct of the study.

British Educational Research Association (2011). *Ethical Guidelines for Educational Research*. London: British Educational Research Association.

Appendix L: Participant Information Form

Participant Information Form

Title of Research Project: Special Education Mathematics Teachers: The influence of a continuing professional development programme and other factors

Researcher: Stella Long, School of Education, Trinity College Dublin

Research Supervisor: Dr. Michael Shevlin, Associate Professor, School of Education, Trinity College Dublin.

This study is designed to investigate the influence of continuing professional development in mathematics by participants undertaking the Graduate Diploma in Special Educational Needs in .... in the academic year 2012/13. Other factors such as teacher efficacy towards teaching mathematics, mathematics anxiety, perceptions to inclusion and mathematical knowledge for teaching will also be considered.

You are invited to participate in the study (Phase 1) which is being carried out by Stella Long. Your participation is voluntary. Even if you agree to participate now, you can withdraw at any time. It is not necessary for you to give a reason and your withdrawal will not have any adverse personal consequences as participation is entirely anonymous.

As a participant in the Graduate Diploma in SEN 2012/13, your participation is welcomed, valued and appreciated. Data generated by your participation will form an integral part of the research for the doctoral dissertation of Stella Long.

If you agree to participate, this will involve you completing the following scales/questionnaires:

- Mathematics Anxiety Scale- UK ((Hunt, Clark-Carter & Sheffield 2011)
- Sentiments, Attitudes, and Concerns about Inclusive Education Revised (SACIE-R) Scale (Forlin, Earle, Loreman & Sharma 2011)
- Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) (Enochs, Smith & Huinker 2000)
- Diagnostic Teacher Assessment in Mathematics (DTAMS) - Whole Number & Computation Assessment (CRMSTD, University of Lousiville)

Appendix L: Participant information form (contd.)

You will also be asked to take part in a focus group discussion (relating to the teaching of maths to pupils with SEN) and to complete a reflection log. These documents and questionnaires will be completed at various points during the course of the Academic Year 2012/13.

This research will benefit the special education maths community. Special education teacher educators, policy makers, researchers and special education teachers will be interested in the findings and it is anticipated that the research will inform the future development of CPD in this field. The ultimate goal of the research is to provide effective instruction in maths to pupils with special educational needs.

The Code of Ethics governing this research has been informed by the Ethical Guidelines for Educational Research (BERA 2011) and has received approval from the School of Education, Trinity College Dublin. For your information a copy of the Code of Ethics will be provided to you.

A Consent Form will also be given to you.

Any information or data which we obtain from you during this research which can be identified with you will be treated confidentially. We will do this by using numbered questionnaires and test materials. The data will be stored securely in a locked filing cabinet in the office of Stella Long in ....

If you would like to know more about the research or if you have any questions please contact Stella Long, ... You are also welcome to contact Dr. Michael Shevlin, Associate Professor, Trinity College Dublin .... who is supervising the research to seek further clarification and information.

Appendix M: Consent Form (Phase 1)

Consent Form

Title of Research Project: Special Education Mathematics Teachers: The influence of a continuing professional development programme and other factors.

Researcher: Stella Long, School of Education, Trinity College Dublin.

Research Supervisor: Dr. Michael Shevlin, Associate Professor, School of Education, Trinity College Dublin.

This study is designed to investigate the influence of continuing professional development in mathematics by participants undertaking the Graduate Diploma in Special Educational Needs in .... in the academic year 2012/13. Other factors such as teacher efficacy towards teaching mathematics, mathematics anxiety, perceptions to inclusion and mathematical knowledge for teaching will also be considered.

I am invited to participate in the study (Phase 1) which is being carried out by Stella Long. My participation is voluntary. Even if I agree to participate now, I can withdraw at any time. It is not necessary for me to give a reason and my withdrawal will not have any adverse personal consequences as participation is entirely anonymous.

As a participant in the Graduate Diploma in SEN 2012/13, my participation is welcomed, valued and appreciated. Data generated by my participation will form an integral part of the research for the doctoral dissertation of Stella Long.

If I agree to participate, this will involve me completing the following scales/questionnaires:

- Mathematics Anxiety Scale- UK ((Hunt, Clark-Carter & Sheffield 2011)
- Sentiments, Attitudes, and Concerns about Inclusive Education Revised (SACIE-R) Scale (Forlin, Earle, Loreman & Sharma 2011)
- Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) (Enochs, Smith & Huinker 2000)
- Diagnostic Teacher Assessment in Mathematics (DTAMS) - Whole Number & Computation Assessment (CRMSTD, University of Lousiville)

I will also be asked to take part in a focus group discussion (relating to the teaching of maths to pupils with SEN) and to complete a reflection log. These documents and questionnaires will be completed at various points during the course of the Academic Year 2012/13.

Appendix M: Consent Form (Phase 1) (contd.)

This research will benefit the special education maths community. Special education teacher educators, policy makers, researchers and special education teachers will be interested in the findings and it is anticipated that the research will inform the future development of CPD in this field. The ultimate goal of the research is to provide effective instruction in maths to pupils with special educational needs.

The Code of Ethics governing this research has been informed by the Ethical Guidelines for Educational Research (BERA 2011) and has received approval from the School of Education, Trinity College Dublin. A copy of the Code of Ethics has been provided to me.

I have received the Participant Information leaflet.

Any information or data which is obtained from me during this research which can be identified with me will be treated confidentially. This will be achieved by using numbered questionnaires and test materials. The data will be stored securely in a locked filing cabinet in the office of Stella Long in ……………

I can contact Stella Long, …………… or Dr. Michael Shevlin, Associate Professor, Trinity College Dublin …………. to seek further clarification and information.

I understand what is involved in this research and I agree to participate in the study. *[I have been given a copy of the Participant Information Leaflet and a copy of this consent form to keep.]*

--- ------------------------

Signature of participant Date

Signature of researcher

I believe the participant is giving informed consent to participate in this study.

--- --------------------------

Signature of researcher Date

Appendix N: Mathematics Anxiety Scale – UK (MAS-UK) (Hunt et al., 2011)

Code: __ __ __ __

Please fill in your personal code.

How anxious would you feel in the following situations? Please circle the appropriate numbers below.

1	2	3	4	5
Not at all	Slightly	A fair amount	Much	Very much

1.	Having someone watch you multiply 12 X 23 on paper.	1	2	3	4	5
2.	Adding up a pile of change.	1	2	3	4	5
3.	Being asked to write an answer on the board at the front of a mathematics class.	1	2	3	4	5
4.	Being asked to add up the number of people in a room.	1	2	3	4	5
5.	Calculating how many days until a person's birthday.	1	2	3	4	5
6.	Taking a mathematics exam.	1	2	3	4	5
7.	Being asked to calculate €9.36 divided by 4 in front of several people.	1	2	3	4	5
8.	Being given a telephone number and having to remember it.	1	2	3	4	5
9.	Reading the word 'algebra'.	1	2	3	4	5
10.	Calculating a series of multiplication problems on paper.	1	2	3	4	5
11.	Working out how much time you have left before you set off to work or place of study.	1	2	3	4	5
12.	Listening to someone talk about maths.	1	2	3	4	5
13.	Working out how much change a cashier should have given you in a shop after buying several items.	1	2	3	4	5
14.	Deciding how much each person should give you after you buy an object that you are all sharing the cost of.	1	2	3	4	5
15.	Reading a mathematics text book.	1	2	3	4	5
16.	Watching someone work out an algebra problem.	1	2	3	4	5

Appendix N: Mathematics Anxiety Scale – UK (MAS-UK) (Hunt et al., 2011) (contd.)

17.	Sitting in a mathematics class.	1	2	3	4	5
18.	Being given a surprise mathematics test in class.	1	2	3	4	5
19.	Being asked to memorise a multiplication table.	1	2	3	4	5
20.	Watching a teacher/ lecturer write equations on the board.	1	2	3	4	5
21.	Being asked to calculate three fifths as a percentage.	1	2	3	4	5
22.	Working out how much your shopping bill comes to.	1	2	3	4	5
23.	Being asked a mathematics question by a teacher in front of a class.	1	2	3	4	5

Appendix O: Mathematics Teaching Efficacy Beliefs Instrument – MTEBI (Enochs, Smith & Huinker 2000)

Code: __ __ __ __

Please fill in your personal code.

Please indicate the degree to which you **agree or disagree** with each statement below by **circling the appropriate letters** to the right of each statement.

SA	A	UN	D	SD
Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree

1.	When a student does better than usual in mathematics, it is often because the teacher exerted a little extra effort.	SA	A	UN	D	SD
2.	I will continually find better ways to teach mathematics.	SA	A	UN	D	SD
3.	Even if I try very hard, I do not teach mathematics as well as I will most subjects.	SA	A	UN	D	SD
4.	When the mathematics grades of students improve, it is often due to their teacher having found a more effective teaching approach.	SA	A	UN	D	SD
5.	I know how to teach mathematics concepts effectively.	SA	A	UN	D	SD
6.	I am not very effective in monitoring mathematics activities.	SA	A	UN	D	SD
7.	If students are underachieving in mathematics, it is most likely due to ineffective mathematics teaching.	SA	A	UN	D	SD
8.	I generally teach mathematics ineffectively.	SA	A	UN	D	SD
9.	The inadequacy of a student's mathematics background can be overcome by good teaching.	SA	A	UN	D	SD
10.	The low mathematics achievement of some students cannot generally be blamed on their teachers.	SA	A	UN	D	SD
11.	When a low-achieving student progresses in mathematics, it is usually due to extra attention given by the teacher.	SA	A	UN	D	SD
12.	I understand mathematics concepts well enough to be effective in teaching primary level mathematics.	SA	A	UN	D	SD
13.	Increased effort in mathematics teaching produces little change in some students' mathematics achievement.	SA	A	UN	D	SD
14.	The teacher is generally responsible for the achievement of students in mathematics.	SA	A	UN	D	SD

Appendix O: Mathematics Teaching Efficacy Beliefs Instrument – MTEBI (Enochs, Smith & Huinker 2000) (contd.)

15.	Students' achievement in mathematics is directly related to their teacher's effectiveness in mathematics teaching.	SA	A	UN	D	SD
16.	If parents comment that their child is showing more interest in mathematics at school, it is probably due to the performance of the child's teacher.	SA	A	UN	D	SD
17.	I find it difficult to use manipulates to explain to students why mathematics works.	SA	A	UN	D	SD
18.	I am typically able to answer students' mathematics questions.	SA	A	UN	D	SD
19.	I wonder if I have the necessary skills to teach mathematics.	SA	A	UN	D	SD
20.	Given a choice, I would not invite the principal to evaluate my mathematics teaching.	SA	A	UN	D	SD
21.	When a student has difficulty understanding a mathematic concept, I am usually at a loss as to how to help the student to understand it better.	SA	A	UN	D	SD
22.	When teaching mathematics, I usually welcome student questions.	SA	A	UN	D	SD
23.	I do not know what to do to turn students on to mathematics.	SA	A	UN	D	SD

Appendix P: The Sentiments, Attitudes, and Concerns about Inclusive Education Scale Revised (SACIE-R) (Forlin, Earle, Loreman & Sharma 2011)

Code: __ __ __ __ Please fill in your personal code.

The following statements pertain to inclusive education which involves students from a wide range of diverse backgrounds and abilities learning with their peers in regular schools that adapt and change the way they work in order to meet the needs of all. *Please circle the response which best applies to you.*

SD	D	A	SA
Strongly Disagree	Disagree	Agree	Strongly Agree

1.	I am concerned that students with disabilities will not be accepted by the rest of the class.	SD	D	A	SA
2.	I dread the thought that I could eventually end up with a disability.	SD	D	A	SA
3.	Students who have difficulty expressing their thoughts verbally should be in regular classes.	SD	D	A	SA
4.	I am concerned that it will be difficult to give appropriate attention to all students in an inclusive classroom.	SD	D	A	SA
5.	I tend to make contacts with people with disabilities brief and I finish them as quickly as possible.	SD	D	A	SA
6.	Students who are inattentive should be in regular classes.	SD	D	A	SA
7.	I am concerned that my workload will increase if I have students with disabilities in my class.	SD	D	A	SA
8.	Students who require communicative technologies (e.g. Braille/sign language) should be in regular classes.	SD	D	A	SA
9.	I would feel terrible if I had a disability.	SD	D	A	SA
10.	I am concerned that I will be more stressed if I have students with disabilities in my class.	SD	D	A	SA
11.	I am afraid to look directly at a person with a disability.	SD	D	A	SA
12.	Students who frequently fail exams should be in regular classes.	SD	D	A	SA
13.	I find it difficult to overcome my initial shock when meeting people with severe physical disabilities.	SD	D	A	SA
14.	I am concerned that I do not have the knowledge and skills required to teach students with disabilities.	SD	D	A	SA
15.	Students who need an individualised academic programme should be in regular classes.	SD	D	A	SA

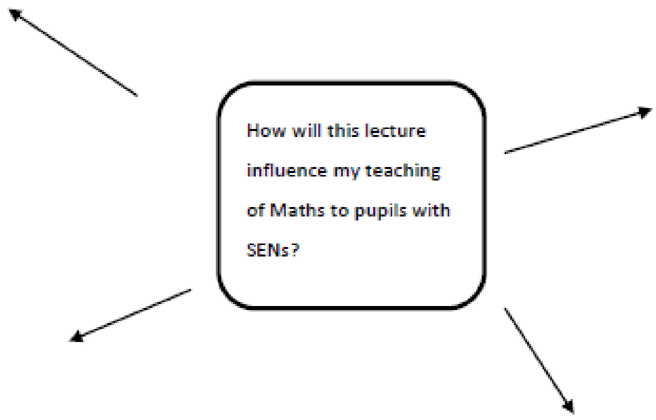
Appendix Q: Example of Diagnostic Teacher Assessments in Mathematics and Science (CRiMSTeD, 2016a)- Whole Number & Computation subset

Directions for completing items:
Please record date and starting and finishing times in the spaces in the upper right-hand corner of this page. It is *very important* to fill out the demographic information above, ***especially*** the last 4 digits of your SSN, as test results will be reported using that as your ID.

Please answer all questions as completely as possible. Show all work in responding to items and briefly explain your thinking on all items. Let the test facilitator know when you are finished. Thank you very much for your time.

#	Item	Answer
1	Which of the following is expanded notation for the number 207,035? a. $207{,}000 + 35$ b. $207 \times 1{,}000 + 35 \times 1$ c. $20 \times 10{,}000 + 70 \times 100 + 35 \times 1$ d. $2 \times 100{,}000 + 0 \times 10{,}000 + 7 \times 1{,}000 + 0 \times 100 + 3 \times 10 + 5 \times 1$	
2	Which of the following numbers, when rounded to the nearest thousand, becomes 21,000? a. 21,523 b. 21,379 c. 20,089 d. 20,492	
3	The distributive property holds for a. addition over multiplication b. multiplication over addition c. addition over subtraction d. multiplication over subtraction	
4	Solve: $^{-}36 \div (^{-}9 + 3) = [\ ]$ a. 3 b. -3 c. -6 d. 6	

Appendix R: Social Maths - Reflective Sheet



Overall Comment

Appendix S: Reflective KWL - Number

What I Know	What I Want to know	What I have Learned

Appendix T: Evaluation: Teaching Mathematics to Pupils with SEN Lectures

1. The 'Teaching Mathematics to Pupils with SEN' lectures were relevant to my needs *(please circle correct response)*

Strongly agree   Agree   Neither agree nor disagree   Disagree   Strongly disagree

Comment:____

____

____

2. The lecture of most relevance to my particular needs was.....*(see course overview sheet)*

____

____

Comment:____

____

____

3. The lecture of least relevance to my particular needs was....

____

____

Comment:____

____

____

4. Other topics I feel should have been included in these lectures were.....

____

____

____

____

____

5. Following my participation in the 'Teaching Mathematics to Pupils with SEN' lectures, I feel prepared to teach mathematics to pupils with SEN in the following areas *(please tick)*

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Assessment					
Number					
Social Maths					
Maths Trails					
Overall					

Appendix T: Evaluation: Teaching Mathematics to Pupils with SEN Lectures (contd.)

6. **What influence will the 'Teaching Mathematics to Pupils with SEN' lectures have on your teaching of mathematics to pupils with SEN?**

____
____
____
____
____
____
____
____

7. **The CPD I have received on teaching mathematics to pupils with SEN will influence pupil achievement levels in mathematics in my school** *(please circle correct response)*

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Comment________________________________
____
____
____

8. **If there was one thing I would change about this part of the course it would be....**

____
____
____
____
____

9. **What did you enjoy most about the 'Teaching Mathematics to Pupils with SEN' lectures?**

____
____
____
____
____

10. **Overall Comments:**

____
____
____
____
____

THANK YOU FOR COMPLETING THIS QUESTIONNAIR

Appendix U: Participant Information Letter and Consent Form (Phase 2)

Title of Research Project: Exploring special education teacher learning in mathematics

Researcher: Stella Long, School of Education, Trinity College Dublin.

Course of Study: PhD

Research Supervisor: Dr. Michael Shevlin, Associate Professor, School of Education, Trinity College Dublin.

This study is designed to investigate the factors relating to the teaching of mathematics by participants of the Post Graduate Diploma in Special Educational Needs (PGDSEN) in ……… in the academic year 2012/13. The research will examine specifically the impact of the Continuing Professional Development (CPD) in mathematics on the PGDSEN. Other factors such as teacher efficacy towards teaching mathematics, mathematics anxiety, teacher perceptions to inclusion, whole school approaches to teaching mathematics to pupils with Special Educational Needs (SEN) will also be considered.

I am invited to participate in the study (Phase 2) which is being carried out by Stella Long. My participation is voluntary. Even if I agree to participate now, I can withdraw at any time. It is not necessary for me to give a reason and my withdrawal will not have any adverse personal consequences as participation is entirely anonymous.

As a participant in the PGDSEN 2012/13, my participation is welcomed, valued and appreciated. Data generated by my participation will form an integral part of the research for the doctoral dissertation of Stella Long.

If I agree to participate I can choose which levels to participate in.

If I agree to participate in **Level 1**, this will involve me completing the following scales:

- Mathematics Anxiety Scale- UK ((Hunt, Clark-Carter & Sheffield 2011)
- Sentiments, Attitudes, and Concerns about Inclusive Education Revised (SACIE-R) Scale (Forlin, Earle, Loreman & Sharma 2011)
- Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) (Enochs, Smith & Huinker 2000)

If I agree to participate in **Level 2**, this will involve me completing a questionnaire.

- Sections include a teacher profile, CPD courses attended and your perceptions and experiences of the lectures in mathematics on the PGDSEN 2012/13

If I agree to participate in **Level 3**, this will involve me participating in an interview which will take the form of a discussion relating to the following topics:

- Mathematics-personal experiences and perspectives
- Whole-school approaches to the teaching of mathematics

- PGDSEN
- Teaching mathematics to pupils with SEN
- Professional collaboration

I understand that the interview will take place in my school or at a location that is convenient for me. The time and date will be pre-arranged to suit me. Interviews are scheduled to take place from May 19th to June 30th 2014.

This research will benefit the special education mathematics community. Special education teacher educators, policy makers, researchers and special education teachers will be interested in the findings and it is anticipated that the research will inform the future development of CPD in this field. The ultimate goal of the research is to improve the attainment levels in mathematics of pupils with special educational needs (SEN).

The Code of Ethics governing this research has been informed by the Ethical Guidelines for Educational Research (BERA 2011) and has received approval from the School of Education, Trinity College Dublin. A copy of the *Code of Ethics* has been provided to me.

Any information or data which is obtained from me during this research which can be identified with me will be treated confidentially. This will be achieved by the use of a coded system. The data will be stored securely in a locked filing cabinet in the office of Stella Long in ………… for a period of 13 months following the submission of the final report (in accordance with the requirements of TCD). Data generated by the research will be utilised in this research project only and directly reporting publications.

I can contact Stella Long, ... or Dr. Michael Shevlin, Associate Professor, Trinity College Dublin .... to seek further clarification and information.

Teacher Consent Form

I understand what is involved in this research and I agree to participate in the study. I have been given a copy of the Participant Information Leaflet to keep.

I am willing to participate in:

Level 1 ◯ **Level 2** ◯ **Level 3** ◯

Signature of participant________________________________ **Date** _______________

I believe the participant is giving informed consent to participate in this study.

Signature of researcher ________________________________ Date ______________

Appendix V: Letter and Consent Form to Principal Teachers (Phase 2).

Research Study

Principal
Information Letter and Consent Form

Name of Principal,
Address of Principal.

23/05/2014

Dear ………..

I am a Lecturer in Special Education in…………….. . I am currently undertaking research for my PhD studies in Trinity College Dublin. My research focuses on the factors relating to teaching mathematics to pupils with special educational needs (SEN) by the participants of the Post Graduate Diploma in Special Educational Needs 2012/13 (PGDSEN) in …………. The research will examine specifically the impact of the Continuing Professional Development (CPD) in mathematics on the PGDSEN. Other factors such as teacher efficacy towards teaching mathematics, mathematics anxiety, teacher perceptions to inclusion, and whole school approaches to teaching mathematics to pupils with SEN will also be considered.

…………... has kindly agreed to participate in the study. Her participation is voluntary and she may choose to withdraw at any time. Data generated by her participation will form an integral part of the research for my doctoral dissertation.

By agreeing to participate in the research, …………. will complete the following test instruments:

- Mathematics Anxiety Scale- UK (Hunt, Clark-Carter & Sheffield 2011)
- Sentiments, Attitudes, and Concerns about Inclusive Education Revised (SACIE-R) Scale (Forlin, Earle, Loreman & Sharma 2011)
- Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) (Enochs, Smith & Huinker 2000)

……….. will complete sections on the following in a questionnaire:

- Teacher profile
- Continuing Professional Development
- Perceptions and experiences of the lectures in mathematics on the PGDSEN 2012/13

……….. will participate in an interview which will take the form of a discussion relating to the following topics:

- Personal experiences and perspectives on mathematics
- Whole-school approaches to the teaching of mathematics
- PGDSEN
- Teaching mathematics to pupils with SEN
- Professional collaboration

The interview will take place in your school or at a location that is convenient at a time and a date which will be pre-arranged to suit ……………

This research will benefit the special education mathematics community. Special education teacher educators, policy makers, researchers and special education teachers will be interested in the findings and it is anticipated that the research will inform the future development of CPD in this field. The ultimate goal of the research is to improve the attainment levels in mathematics of pupils with special educational needs (SEN).

The Code of Ethics governing this research has been informed by the Ethical Guidelines for Educational Research (BERA 2011) and has received approval from the School of Education, Trinity College Dublin. A copy of the *Code of Ethics* has been provided to ………...

Any information or data which is obtained from me during this research will be treated confidentially. It will not be identifiable in any way either to ……….. or to your school. The data will be stored securely on a password protected computer and in a locked filing cabinet for a period of 13 months following the submission of the final report (in accordance with the requirements of TCD). Data generated by the research will be utilised in this research project only and directly reporting publications.

If you wish, you may contact either myself, Stella Long, ... or Dr. Michael Shevlin, Associate Professor, Trinity College Dublin …………to seek further clarification and information.

Yours sincerely,

____

Stella Long

Appendix W: Questionnaire (Phase 2)

Code: _________ This code will be used to track pre and post test data and will not be used to identify individual teachers. All information provided will be treated in the strictest confidence.

Section 1: Teacher Profile

Please complete the following by either filling in the answer or circling the response.

10. Teaching position

Learning support teacher	Resource teacher	LS/RT
Special class teacher	Class teacher	Other (please specify)

11. Current employment status

Permanent	Contract of Indefinite Duration (CID)
Fixed term contract	Other (please specify)

12. Length of teaching experience ___________

13. Length of teaching experience in special education _____________

14. To which age group do you belong?

20-29	30-39	40-49	50-59	60+

15. Are you a member of a professional organisation?

Yes (please specify)	No

Appendix W: Questionnaire (Phase 2) (contd.)

16. Which of the following qualifications do you hold? *(Please indicate all that apply)*

xi. A primary school teaching diploma or certificate or other primary school qualification
xii. A primary degree in education (B.Ed.)
xiii. A primary degree in another subject (BA)
xiv. A post graduate diploma in education
xv. A higher degree in education (Masters, PhD) (please specify) ____
xvi. A higher degree in another subject (Masters, PhD) (please specify) ____
xvii. A qualification in special education (please specify) ____
xviii. Leaving Certificate Honours Mathematics (or equivalent) Grade obtained ____________
xix. Leaving Certificate Pass Mathematics (or equivalent) Grade obtained ________________
xx. Other (please specify) ______________________________

17. Current case load

Number of pupils		Class	Category of SEN
Models of support	**Time allocation (%)**	**Focus of teaching interventions**	
Individual Withdrawal Group Withdrawal Co-teaching Whole-class teaching Other (please specify)			

Appendix W: Questionnaire (Phase 2) (contd.)

Section 2: Continuing Professional Development (CPD)

1. List any **CPD courses** you have undertaken in **special education** in the last five years

Name of course	**Duration** (time span and contact hours)	**Model of CPD** (face to face/online)

2. List any **CPD courses** you have undertaken in **mathematics** in the last five years.

Name of course	**Duration** (time span and contact hours)	**Model of CPD** (face to face/online)

3. List any **CPD courses** you have undertaken which focused specifically on **mathematics for children with learning difficulties/special needs** in the last five years.

Name of course	**Duration** (time span and contact hours)	**Model of CPD** (face to face/online)

4. List any other CPD courses you have undertaken in the last five years.

Name of course	**Duration** (time span and contact hours)	**Model of CPD** (face to face/online)

Appendix W: Questionnaire (Phase 2) (contd.)

5. Can you identify your future needs in CPD? *(course content/duration/model)*

____

____

____

____

____

____

____

____

____

____

____

____

____

____

6. In your opinion what is the function of CPD? *(Please rate each statement by ticking one box on each line).*

Statement	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
To develop teachers' skills					
To share best practice					
To motivate teachers					
Career move					
Up-skilling					
Professional development					
Personal development					

Appendix W: Questionnaire (Phase 2) (contd.)

Section 3: Post Graduate Diploma in Special Educational Needs 2012/13 (PGDSEN)

1. Following your participation in the mathematics for SEN lectures on the PGDSEN 2012/13, **please rate changes in your teaching practices** in the following areas *(tick one box in each line):*

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Approaches to assessment					
Comment					
Planning to teach mathematics					
Comment					
Collaboration with class teachers					
Comment					
Teaching number					
Comment					
Social Maths					
Comment					
Instructional approaches					
Comment					
Overall changes in teaching practices					
Comment					

Appendix W: Questionnaire (Phase 2) (contd.)

2. Following your participation in the PGDSEN 2012/13, please rate how **whole-school teaching practices in relation to the teaching of mathematics to pupils with SEN have changed** *(tick one box in each line)*:

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Approaches to assessment					
Comment					
Planning to teach mathematics					
Comment					
Collaboration with class teachers					
Comment					
Teaching number					
Comment					
Social Maths					
Comment					
Instructional approaches					
Comment					
Overall changes in teaching practices					
Comment					

Appendix W: Questionnaire (Phase 2) (contd.)

3. Rate the impact of the mathematics for SEN lectures on the PGDSEN on your professional practice *(tick one box only)*

No impact	Small impact	Moderate impact	Large impact

Comment____
____
____
____
____
____
____

5. How did your experience of the mathematics for SEN lectures on the PGDSEN impact on your *ability and enthusiasm* to teach mathematics to pupils with SEN?

Ability:____
____
____
____

Enthusiasm:____
____
____

6. Please complete this sentence: *Effective CPD in mathematics for SEN should involve*

____
____
____
____
____

7. Optional comments regarding the teaching of mathematics to pupils with SEN:

____
____
____
____
____

Thank You for completing this questionnaire.

Appendix X: Participant Information Form

Title of Research Project: Exploring special education teacher learning in mathematics

Researcher: Stella Long, School of Education, Trinity College Dublin

Research Supervisor: Dr. Michael Shevlin, Associate Professor, School of Education, Trinity College Dublin.

This study is designed to investigate the factors relating to the teaching of mathematics by participants of the Post Graduate Diploma in Special Educational Needs (PGDSEN) in ………. in the academic year 2012/13. The research will examine specifically the impact of the Continuing Professional Development (CPD) in mathematics on the PGDSEN. Other factors such as teacher efficacy towards teaching mathematics, mathematics anxiety, teacher perceptions to inclusion, whole school approaches to teaching mathematics to pupils with Special Educational Needs (SEN) will also be considered.

You are invited to participate in the study (Phase 3) which is being carried out by Stella Long. Your participation is voluntary. Even if you agree to participate now, you can withdraw at any time. It is not necessary for you to give a reason and your withdrawal will not have any adverse personal consequences as participation is entirely anonymous.

As a participant in the PGDSEN 2012/13, your participation is welcomed, valued and appreciated. Data generated by your participation will form an integral part of the research for the doctoral dissertation of Stella Long.

This phase of the study involves **tracking** either a **cohort of pupils** or a **single pupil** receiving **support in mathematics** from you between **September and December 2014.** By agreeing to participate in the research, you will:

- Complete the Pupil Profile
- Complete a Reflective Log (weekly or fortnightly)
- Provide a copy of your planning documents in respect of mathematics (short term plan, IEP/IPLP) to the researcher
- Provide supporting documentation such as pupil work samples, assessments (if applicable)
- Participate in a short interview in December 2014. The interview will focus on your experiences of the teaching of mathematics to the focus pupil/s.

All documentation provided must be anonymised. Pseudonyms must be used when referring to pupils. A Note Book is provided to you for the purposes of the Reflective Log. Should you prefer to keep a digital Reflective Log, please contact me. All documentation (Reflective Log, Planning, Assessment, and Work Samples) will be collected from you by the researcher in December 2014.

Appendix X: Participant Information Form (contd.)

This research will benefit the special education mathematics community. Special education teacher educators, policy makers, researchers and special education teachers will be interested in the findings and it is anticipated that the research will inform the future development of CPD in this field. The ultimate goal of the research is to improve the attainment levels in mathematics of pupils with special educational needs (SEN).

The *Code of Ethics* governing this research has been informed by the Ethical Guidelines for Educational Research (BERA 2011) and has received approval from the School of Education, Trinity College Dublin. For your information a copy of the *Code of Ethics* will be provided to you.

A *Consent Form* will also be given to you. If you agree to participate in the research you are asked to sign this form.

Any information or data which we obtain from you during this research which can be identified with you will be treated confidentially. This will be achieved by the use of a coded system. The data will be stored securely in a locked filing cabinet in the office of Stella Long in ……. for a period of 13 months following the submission of the final report (in accordance with the requirements of TCD). Data generated by the research will be utilised in this research project only and directly reporting publications.

If you would like to know more about the research or if you have any questions please contact Stella Long, ... You are also welcome to contact Dr. Michael Shevlin, Associate Professor, Trinity College Dublin......................., who is supervising the research to seek further clarification and information.

Consent Forms (teacher and principal) should be placed in the Stamped Addressed Envelope provided and posted before Friday, September 19th, 2014.

Thank you.

Your support with this research is greatly appreciated.

Appendix Y: Reflective Journal (Phase 3)

Please note the following in your Reflective journal:

- Collaboration with class teacher, parents, SNA
- Your reflections on instructional approaches, content, resources, ICT, assessment, pupil progress – challenges, positive experiences, actions going forward
- Comments made by pupils
- General comments (any comment related to the teaching of mathematics to the focus pupil/s)

Date each entry. Thank you!

Appendix Z: Pupil/Group Profile Template (Phase 3)

Name of Pupil/s	
Class	
Class Teacher	
Nature of Learning Difficulty/Disability	
Assessment (Sigma-T/Drumcondra) **Psychological Assessment (Maths results)**	
Support Timetable	
Model of Support	
Brief Overview of Learning Programme in Mathematics ***(September to December 2014)***	
Additional Information ***(if applicable)***	

Appendix AA: Interview Schedule (Phase 2)

I would like to talk to you today about factors relating to the teaching of mathematics to pupils with SEN in your school.

School profile
Number of pupils/teachers/LS/RTs/SNAs Urban/rural/DEIS How is SEN provision co-ordinated in the school? Timetable, IEPs, assessments Is SEN timetabled on staff meetings?
Maths-personal experiences & perspectives
Did you like maths as a pupil yourself? As a teacher do you like teaching maths? What experiences have you of teaching maths? What are your views on how we teach maths? What do you think of the standards of maths in primary schools? How do you feel about teaching maths? (i.e. do you have the necessary skills?) Do you think that your personal attitudes towards maths impacts on your teaching of maths?
Whole-school approaches towards the teaching of maths
Tell me about whole-school approaches to the teaching of maths: Is there a policy on the teaching of maths? to pupils with SEN? Text books Approaches to assessment Resources to support the teaching of maths Role of technology Early intervention programmes Models of teaching – co-teaching/in-class support Extra-curricular activities in maths Attainment levels – Results of standardised testing What do you think are the attitudes of the teachers in the school towards the teaching of maths?
Teaching maths to pupils with SEN
Tell me what happens when a pupil is first observed to be having difficulty in maths in this school….the continuum of support Do you teach maths to pupils with SEN? Tell me about your case load (or about the case load of other teachers supporting pupils with SEN in maths): • Nature of difficulties/amount of support given – timetabling • Models of support- withdrawal (individual/group), co-teaching, in-class support, early intervention, whole class teaching • Focus of teaching interventions in maths. How is this decided on? What is the role of the class teacher? The SNA? The parent? The role of the LS/RT? • Assessment – what measures are used? How do the results inform teaching and learning? Tell me about the use of technology in your maths lessons Do you have access to maths resources to support teaching and learning? What are the *expectations* of class teachers with regard to teaching maths to pupils with SEN? What are *attitudes* of the class teachers towards the support received by their pupils from the LS/RT? What level of involvement do class teachers have in the teaching of maths to pupils with SEN? What are *your attitudes* towards teaching maths to pupils with SEN? What is different in your maths for SEN classes by comparison to a mainstream maths class? (instructional approaches/assessment/content) Do you feel you have the necessary skills and knowledge to teach maths to pupils with SEN? What school practices help to improve the participation and learning of pupils with SEN in maths? How do SNAs in your school assist with the teaching of maths to pupils with SEN? What is your view of the role of the SNA in assisting with the teaching of maths to pupils with SEN? What *expectations* do parents/guardians of pupils with SEN have for their children in maths? Are the parents/guardians of pupils with SEN involved in their children's maths education? What are your views on involving parents/guardians in maths education of pupils with SEN?

Appendix AA: Interview Schedule (Phase 2) (contd.)

Do you receive support from professionals such as S &LTs, Educational Psychologists specifically in the area of maths? **What factors (barriers) limit your capacity to teach maths to pupils with SEN effectively?** **What factors (barriers) support your capacity to teach maths to pupils with SEN effectively?** What is the impact of national policies on the teaching of maths to pupils with SEN in your school?
CPD-PGDSEN
Why did you undertake the PGDSEN? Personal/school factors? What expectations did you have of the PGDSEN? Are you planning on progressing to Master's level? Have you undertaken CPD since completing the PGDSEN? What support did you receive from the principal and teachers in your school when you were undertaking the PGDSEN? How does the teaching staff in your school perceive the CPD you received on the PGDSEN? Is your expertise recognised and valued? Are the class teachers willing to support new approaches? *Focusing on the lectures in maths for SEN:* What difference did your participation on the PGDSEN make to: – You as a teacher of maths to pupils with SEN? Do you think that you acquired the skills and knowledge that you needed to teach maths to pupils with SEN? – Your school – Your pupils (achievement levels/instructional approaches/assessment/content) **Did what you learned about teaching maths to pupils with SEN on the PGDSEN transfer to your classroom practice? In what way? If not, why not?** **Are there factors which impacted on the transfer of your learning from the PGDSEN to classroom practice? Positive factors? Negative factors?** Have you disseminated the knowledge and skills you acquired with class teachers? Other LS/RTs? SNAs? If so, in what format? Did it result in a change in practices? Do you have any evidence to suggest that the learning of your pupils in maths improved as a result of your participation on the PGDSEN? What additional content would you like to have seen covered in the maths for SEN lectures? What type of CPD would you like to undertake as a follow up to the maths input on the PGDSEN?
Conclusion
What influences your teaching of maths to pupils with SEN? • Personal level • School level • Society/national level What is the best way to raise the attainment levels of pupils with SEN in maths? Is there anything else you would like to tell me about: • The teaching of maths to pupils with SEN in your school? In your case-load? • **How to develop teacher skills for teaching maths to pupils with SEN** • **How to improve the teaching of maths to pupils with SEN in your school?**

Appendix BB: Overview of Modules: PGDSEN 2012/13

Module number	Module descriptor
1.	Special educational needs: Theory, research and practice
2.	Exploring influences on child development, learning and behaviour
3.	Language, communication and literacy (1)
4.	Curricular provision- meeting the holistic needs of the child
5.	Practicum (1)
6.	Roles and responsibilities in relation to SEN
7.	Identifying and managing special educational needs
8.	Language, communication and literacy (2)
9.	The enabling role of ICT
10.	Practicum (2)

Appendix CC: Overview of Lectures in Mathematics: PGDSEN 2012/13

. .

	Lecture title and overview	Date presented
Lecture 1	Teaching maths to pupils with SEN: An overview (1) *Current research, A way forward- NCCA Guidelines.*	05/10/2012
Lecture 2	Teaching maths to pupils with SEN : An overview (2) *What is maths? Why is it difficult for some pupils to learn maths? Learning theories for maths instruction, Cognitive style.*	10/10/2012
Lecture 3	Teaching maths to pupils with SEN: Assessment (1) *Informal assessment measures: teacher observation, teacher designed tests, criterion referenced tests, miscue analysis, portfolios, pupil self-evaluation.*	15/10/2012
Lecture 4	Teaching maths to pupils with SEN: Assessment (2) *Informal assessment measures (contd.)*	18/10/2012
Lecture 5	Teaching maths to pupils with SEN: Assessment (3) *Diagnostic Testing: MaLT, Progress in Maths, WRAT, Dyscalculia Screener, Drumcondra Tests of Early Numeracy.*	07/02/1013
Lecture 6	Approaches to number for pupils with SEN (1) *A strategy approach to teaching addition and subtraction.*	18/02/2013
Lecture 7	Approaches to number for pupils with SEN (2) *A strategy approach to teaching multiplication and division, Calculators, Numicon.*	19/02/2013
Lecture 8	A social maths programme for pupils with SEN *Length, Weight, Capacity. Time, Money.*	21/02/2013
Lecture 9	Maths trails	08/04/2013
Lecture 10	Effective maths instruction for pupils with SEN *Dyscalculia, Planning a maths lesson, Evidence based teaching approaches, Mathematical knowledge for teaching.*	09/04/2013