Private Lives – The Work of Mathematics Leaders in Irish Primary Schools

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Declaration

I hereby certify that this material, which I now submit for assessment on the programme of study leading to the award of Doctor of Education is entirely my own work, and that I have exercised reasonable care to ensure that the work is original, and does not to the best of my knowledge breach any law of copyright, and has not been taken from the work of others save and to the extent that such work has been cited and acknowledged within the text of my work.

Signed: 

ID No.: 96362880

Date: 9th November 2020

Dedication

I dedicate this doctoral thesis to my parents: to my mother, Anne, who left no stone unturned to see her children educated, and for my late father, Michael, who would be so proud.

Acknowledgements

Simply put, I wanted to study this topic because I needed to be a better, more informed leader of Mathematics. Although my motive was primarily self-serving, there are many to acknowledge for helping me get to this point.

A sincere expression of gratitude is owed to the mathematics leaders who participated in this study. Without their involvement, this research would never have materialised. Despite their unenviable workloads, each of the ten leaders were most obliging and forthcoming during their participation in the project. Their schools are extremely fortunate to have such dedicated and skilled practitioners among their ranks. Thank you to each and every one of them for allowing me into their professional worlds.

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The Doctorate in Education programme at DCUIoE is a fantastic, but challenging process. I am grateful to the many members of the academic staff who worked with our cohort. All of their provoking presentations in some way shaped me as a questioning professional, and as a novice researcher. From my undergraduate days in St. Pat's, through the late evenings spent on campus during my masters there, and now culminating in this doctoral thesis, I have thoroughly enjoyed my time studying in Drumcondra. Ancora Imparo!

Finally, a very special thank you to my family for their support during the last four years. It feels like the whole family have been involved! Thank you Emily, Michael and Úna for the constant encouragement.

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Acronyms

CSL	Centre for School Leadership
DEIS	Delivering Equality of Opportunity in Schools
DES	Department of Education and Skills
INTO	Irish National Teachers' Organisation
IPPN	Irish Primary Principals' Network
MKT	Mathematical Knowledge for Teaching
NCCA	National Council for Curriculum and Assessment
NCETM	National Centre for Excellence in the Teaching of Mathematics (England)
NCSM	National Council of Supervisors of Mathematics (U.S.A.)
NQT	Newly Qualified Teacher
OECD	Organisation for Economic Co-operation and Development
PD	Professional Development
PDST	Professional Development Service for Teachers
REC	Research Ethics Committee
SSE	School Self-Evaluation
STEM	Science, Information Technology, Engineering and Mathematics

Abstract

Damien Burke

Private Lives – The Work of Mathematics Leaders in Irish Primary Schools

Despite the glut of recent research that examines the complex art of school leadership, little or nothing is known of the enactment of subject-specific leadership across our education system. This national deficiency is aptly exemplified by our collective unawareness of mathematics leadership in the primary school sector. Coincidentally, this recognition also comes at a time of growing expectation and rising demand being placed upon the mathematics teaching and learning provision in all schools.

This research seeks to address this gap by focusing upon ten individuals who self-identify as local mathematics leaders. Specific strands of inquiry include the nature of the duties they undertake, their generalised working habits, the supports they access and the skillset that they call upon in the course of their work.

The researcher chooses a mixed-methods approach to tease out these queries. Drawing on elements of the case-study tradition, these diverse mathematics leaders are profiled in detail. The cohort are drawn from the principal and teacher-leader communities - some are remunerated for their work, others are volunteers. The researcher exploits three research instruments to gather data: an initial participant questionnaire/profiler, a twenty-day participant activity log and a semi-structured interview format at the conclusion of the logging period.

The data-analysis process further subscribes to the mixed-methods orientation of the researcher. Comparisons are drawn between different types of leader and how they fulfil their functions. Following the merger of qualitative and quantitative data bases, a set of five cross-participant themes are identified and expanded upon. Primarily, the themes address key findings including the critical influence of context upon the working emphases of the local leader, the ever-growing complexity of the role, seeming contradictions within such leadership work, the universal absence of adequate time for mathematics leaders to lead, and, the apparent dearth of bespoke professional development and networking opportunities available to such personnel.

Following a robust benchmarking of the findings against the known international research, a comprehensive set of rationalised conclusions and recommendations are presented for consideration. Principally, they aim to address the widely held ignorance of the mathematics leadership position. Additionally, they seek to suggest tangible supports such as formalised role recognition, accompanying release time and enhanced networking opportunities in order to address this profile gap, and to practically assist the isolated practitioner on the ground. It is intended that these endorsements will speak to a broad national audience of school leaders themselves, management bodies, teacher and principal representative groups, national support services and most crucially, policy makers.

Chapter One: Introduction

1.1 Introductory Remarks

The introductory chapter of this dissertation serves a dual purpose. First, it presents the professional background of the researcher and demonstrates how his work experiences have shaped his personal interest in the research topic to hand. Secondly, and most critically, the research question is introduced and clarified. This clarification is crucial in order to present a coherent and consistent thread that must run through the entire dissertation. The chapter is supplemented by a fleeting journey through the Professional Doctorate in Education syllabus, and how it helped to shape the present work. A brief overview of the Irish primary school context is also provided, given the specific primary-school focus of the research. The chapter ends with a brief overview of the structure of the dissertation, thus orientating the reader.

1.2 The Researcher in Context

For the purpose of read-ability, and given the very personal dimension that this chapter brings to the dissertation, the researcher will self-refer in the first person for its duration. I began my primary-school teaching career in 1999, before progressing to a teaching principalship role a decade later. Three years following this, I accepted an administrative principal position.

During my initial teaching posting, an innocently expressed interest in “getting involved” led to a voluntary position on the school’s numeracy team. This was an eye-opening experience for a naive, idealistic teacher. It starkly demonstrated to me the glaring need for whole-school coherence in its mathematics provision, and the negative consequences when this reliability was absent. It also laid bare the pressing necessity to put sophisticated structures in place in order to achieve this consistency. I quickly learned, that in schools, every initiative, every plan, every idea, needed a driving force. It required a leader, or better still, multiple leaders.

Time moved on and, quite by chance two years later, my first formally assigned middle-management duties were to “mind the maths equipment, and keep the schools’ maths plan up to date in case we are inspected”. The simplicity of the direction, some twenty years on, is amusing but it is indicative of a bygone time in school management when organisational concerns dominated, and keeping officialdom happy was the key concern. Being known as the “maths person” was especially gratifying to someone who had not been particularly captured by my interest in Mathematics during earlier secondary school days. Busy, but enjoyable years ensued. Soon mentoring and administrative dimensions were added to the role, and then, invitations to present new mathematics teaching approaches to colleagues became an annual activity. The role of numeracy coordinator was evolving before me.

Although these growing duties were fulfilled to the satisfaction of my superiors, I recognised a professional malcontentment. I began to seek out professional development (PD) in order to enhance my own mathematics teaching skillset, and to complement my growing leadership brief for the subject. There was a growing realisation that the ever expanding role demanded an increasingly skilled and professionalised response. The local education centre provided very useful, if somewhat superficial opportunities. A subsequent Masters in Mathematics Education exposed me to an abundance of rich pedagogical experiences and expertise, but the leadership piece remained unaddressed. Further postgraduate studies in generalised educational leadership introduced innumerable theories. Great thinkers like Michael Fullan, Andy Hargreaves, Kenneth Leithwood and James Spillane all made an indelible impact. Undoubtedly, all contributed to a growing confidence as my leadership of Mathematics moved from the mainstream classroom, to the learning-support room and on to the principal's office. However, the elusive hybrid of mathematics-specific leadership training seemed as far away as ever. The desire, moreover the need, to learn more and act from a more research-driven foundation still endured.

A move into the world of initial teacher education, and the opportunity to meet with many school leaders around the country, led to a personal epiphany– perhaps the secret to effective leadership of Mathematics in our primary schools lay in the experiences and daily actions of those who fulfil the role in their own school setting. Informal conversations with such individuals usually centred around "*how do you find time to…?"*, "*What do you do to…?",* or "*What supports do you use…?*" The exchanges were hugely revelatory for me, and it appeared that mathematics leaders were only too willing to speak about their experiences to a like-minded colleague. Even more informative was the variety of arrangements, some formal, others more ad hoc, that hard-pressed schools were putting in place to respond to this leadership challenge. The seed of inquiry had been planted, and when an opportunity to enrol on the Professional Doctorate in Education programme presented itself, I had only one preferred area of examination – how is mathematics leadership being fulfilled in our primary schools? The subsequent section in this introductory chapter further elucidates this broad area of scrutiny.

1.3 The Research Question

This research investigates the enactment of mathematics leadership within Ireland's primary school sector. To tease out this admittedly wide-ranging aim, the exploration encompassed four intertwined sub-strands of inquiry:

- How do primary schools practically respond to the need for mathematics leadership?
- How do individual mathematics leaders conceptualise and enact their role?
- What is the nature of this mathematics leadership work and its associated challenges?
- Which supports do mathematics leaders presently exploit as part of their duties, and what additional, currently unavailable supports would make their role more impactful and professionally sustainable?

The research was founded upon the presumption of five core models of mathematics leadership currently functioning in Irish primary schools: administrative principal alone; teaching principal alone; a formally-appointed (and remunerated) teacher-leader; a voluntary (unpaid) teacher-leader, and some form of multi-person leadership collective. Again, my career experience exerted a significant influence. Having participated in four of these models during my career, I could confirm their existence in our school system. The literature also made a telling impression, and Chapter Two will supply abundant evidence of all five models across the national and international research. Each of the aforementioned leadership models were heavily embedded within my methodology, and the largely comparative analysis approach that was utilised.

Whilst mathematics education and school leadership are more than well-catered for independently within the educational research community, as will be amply demonstrated in Chapter Two, the unique fusion of the two has yet to make its mark on the Irish educational landscape. This lack of research attention propagates policy-level ignorance, which in turn translates into a dearth of practical assistance for schools on the ground. This cycle of central government unawareness begetting local abandonment is all too familiar to educationalists. Gorard (2018), in his treatise of educational equity and effectiveness, observes this recurring phenomenon. The ongoing lack of specialised training for mathematics leaders, personally observed some two decades ago, remains a disappointing feature of Irish education in 2020.

Principally, this research intended to shine a concentrated light upon a small cohort of mathematics leaders and to intimately examine their work. In setting such an ambitious aim, I was ultimately intending to address two more fundamental challenges. First, the lacunae in the literature surrounding mathematics leadership needed be highlighted. Secondly, the research sought to generate a set of rationalised recommendations to address this void, and therefore suggest practical supports that would assist mathematics leaders in their important work. A greater understanding of who does this work, what duties they perform, the frustrations they experience and the skillset they call upon, is surely an obvious starting point to build this basic awareness.

1.4 The Professional Doctorate in Education Programme

A brief review of the Professional Doctorate in Education programme offers further insight into the evolution of my initial research interest into the overarching research question introduced at the beginning of the previous section – how is mathematics leadership being enacted in Ireland's primary schools? Two preliminary and legitimate queries immediately arise: why complete a doctorate to become a better mathematics leader? Why not share good practice with like-minded colleagues and just concentrate on the role itself? Thomson and Walker capture the overriding sentiment behind the research when they describe an on-going, nagging inclination to become "more critical about (one's) own workplace assumptions" (2010, p.19). The dearth of suitable, specialised professional development opportunities led to a realisation that no external agent, no all-knowing expert, was going to provide the stimulus for me to critically reflect and professionally grow. The imperative to move "from professional to researcher-as-professional" (ibid, p.19), and pioneer the discipline of mathematics leadership in an Irish context, was the logical response. Andrews and Edwards perfectly capture this disposition to self-reflect, to question one's own professionalism and ultimately take a risk when they warn against "settling for the false security that all ticks have been marked against a list of competencies" (2008, p.5). They continue by urging the professional "to theorize, to engage with reflexivity rather than letting it leave us baffled and frustrated" (ibid, p.20). The Professional Doctorate in Education programme seemed the ideal vehicle for me to do just this.

The programme at Dublin City University is part-time, and is typically four years in duration. Candidates attend taught modules for the first two years of the programme, before retreating to their chosen area of inquiry for the final phase. Scott et al. comment on the challenges of the professional doctoral student navigating "the twilight zones between the university and the workplace" (2004, p.1). Although valid, such a compromise is necessary if the researcher is to maintain the professional awareness and credibility needed to truly interrogate their area of inquiry to the highest academic standards. Weekend modules in advanced research methodology were complemented by summer school arrangements for in-depth policy analysis workshops which helped build a greater awareness of the broader national and international educational landscape. Having opted for the leadership strand of the programme, I undertook additional modules in "*Research-based Educational Leadership*" "*Leadership and Organisational Effectiveness*" and "*Leadership in Education and Training*". All provided insight, and built a new and welcomed support network among similarly invested, yet diverse classmates.

The formal submission of a structured research proposal at the end of the second year was the culmination of a process that had begun with the completion of initial programme application forms some two and a half years earlier. In the intervening time, informal conversations with fellow candidates and university staff, presentations to the student cohort, exploration of the literature, and much personal reflection, led to the tightening of my key line of inquiry – how is mathematics leadership being enacted in Ireland's primary schools? The proposal process helped tease out the implications of this investigation, and clarified the additional sub-strands for scrutiny.

Given the very concentrated focus upon primary-school mathematics leadership in this research, it is crucial to provide an overview of Ireland's primary-school context in its entirety. This outline is provided in the next section.

1.5 The Irish Primary School Context

State-funded primary schools in Ireland operate in accordance with the rules and regulations set down by the Department of Education and Skills (DES). Whilst there is considerable diversity in terms of school patronage, all schools are obliged to teach a standardised national curriculum (National Council for Curriculum and Assessment, 1999). The curriculum encompasses eleven subject areas, including mathematics and language.

Primary school classes (or grades) are taught by non-specialist teachers who hold either an undergraduate or post-graduate teaching qualification. Typically, the class teacher is responsible for delivery of the full range of curriculum disciplines. State-accredited initial teacher education programmes usually include modules to enhance subject-matter knowledge, and to build pedagogical expertise for pre-service teachers in the various curricular areas. Teachers must be registered with the national Teaching Council, and meet their threshold to practice, in order to accept a state-funded teaching position.

Schools are governed by localised boards of management who cede daily managerial responsibility to the principal teacher. As laid down in The Education Act (Government of Ireland, 1998), this individual is ultimately accountable for the implementation of the curriculum, and the broader teaching and learning provision of the school. Each primary school also appoints a deputy principal to assist the principal in their role. Depending on the enrolment of the school, the board of management may be entitled to appoint a small number of assistant principals who are assigned specific duties to assist in the leadership and management of the school. Occasionally, and at the discretion of the board of management, these duties may be linked to particular curricular areas.

This leadership collective (of principal, deputy principal and assistant principals) is typically referred to as the in-school management team. Appointment to the in-school management team is by competitive internal process. Specifically, recruitment of principals and deputy principals is done by way of an open competitive process. Boards of management must adhere to strict guidelines, including standardised selection criteria, when making appointments to the in-school management team. As of now, there is no mandated leadership preparatory programme/course of study that individuals must complete prior to appointment to an in-school management team. Two state-supported agencies, the Professional Development Service for Teachers (PDST) and the recently formed Centre for School Leadership (CSL), are tasked to provide in-career, optional professional development for principals and other members of in-school management teams. Alongside other higher education institutes and traditional universities, both of the aforementioned agencies also offer formation opportunities to aspiring school leaders.

Irish education has witnessed many significant policy developments since the turn of the millennium. In the context of this research, the re-prioritisation of numeracy (and literacy) in the “National Strategy to improve Literacy and Numeracy among Children and Young People

2011–2020" (DES, 2011) is significant. The momentum it created was added to by a subsequent updating of the initial publication six years later (DES, 2017a). Both documents sought to focus schools and school leaders upon the need to enhance local numeracy standards, and to strategically utilise practical school-facing supports to help meet ambitious national targets. This recalibration was bolstered by the roll out of school self-evaluation cycles in all primary schools in 2012 (DES Inspectorate, 2012). Features of the new initiative included an emphasis on the gathering of data to obtain a broader sense of school performance (not solely confined to standardised testing scores), the formulation of realistic targets for school improvement and the open-publication of the strategy to achieve the targets within the broader school community. Although a relatively new initiative within the Irish schools system, initial indications seem to point to a broadly positive attitude towards the SSE process within schools, alongside a recognition of the local dividend accruing from its implementation (O'Hara et al., 2016). Both this introduction of SSE in primary schools and the notable re-emphasis of numeracy within the school syllabus, and their broader impact upon the primary school system, will be assessed in further detail in sub-sections 2.2.4 and sub-sections 2.4.5

The final part this introductory chapter details the structure of the dissertation, and provides an overview of the document. This will assist in orientating the reader to the various chapters which follow.

1.6 The Structure of this Dissertation

The subsequent literature review in Chapter Two sets a context for the research question. To this end, it straddles both the leadership and the mathematics pedagogy domains. It presents a knowledge base for both. In doing so, it underscores the critical influence of general school leadership upon mathematics headship. Well-known leadership styles are contrasted, and various, relevant models of school management are critiqued. In parallel, a strong case is made to support the specialised and taxing nature of primary-level mathematics teaching and learning, and how an added leadership demand within this milieu is now challenging researchers in North America, Australia and Europe. Where available, the review draws on this fledgling international literature that is building awareness of the great potential for dedicated school leadership in this core curricular discipline. The Irish context is deliberately foregrounded through an appraisal of the current standing of mathematics in our primary-school system. This national snapshot is further supplemented by a parallel critique of recent leadership-related developments nationally, and, a somewhat sobering account of the practical constraints that school leaders in Ireland must work under.

Chapter Three sets out the chosen methodology, thus revealing my dominant assumptions about the nature of knowledge, my primary research orientation, and my strong commitment to a mixed-methods approach. The influence of Yin's (2009) case-study model is evident throughout. Further key detail on the sampling strategy, the data-collection approach, and the associated data instruments, is provided. Ethical considerations are clearly elucidated, as are the safeguarding measures that were taken in response. An honest and frank discussion of the limitations of the research project conclude the chapter.

Chapter Four presents the findings of the study with an accompanying discussion. A preliminary description of the data-analysis procedures adds vital background information. Given the thematic analysis approach which was employed, the chapter pivots on its proposal of five themes that each hold strong foundations across both the quantitative and qualitative data sets. Either directly, or indirectly in some cases, the themes address the sub-questions that emerge from the overall research query:

- How do primary schools practically respond to the need for mathematics leadership?
- How do individual mathematics leaders conceptualise and enact their role?
- What is the nature of this mathematics leadership work and its associated challenges?
- Which supports do mathematics leaders presently exploit as part of their duties, and what additional, currently unavailable supports would make their role more impactful and professionally sustainable?

In many ways, Chapters Four and Five are intimately interrelated. Chapter Five offers a robust benchmarking of the study's headline thematic findings against the accepted wisdom of the available national and wider international literature. This juxtaposition gave added confidence to my findings. It also helped give rise to a more credible and tested set of conclusions and recommendations which are identified and discussed in the sixth, and final chapter. Many of the conclusions are multi-faceted - some are new and novel, others are more obvious and predictable. Each is complemented by a pair of companion recommendations which speak directly to an audience of policy makers, national support services, higher education institutes, boards of management, school communities and mathematics leaders themselves.

With the topography of the dissertation mapped out, it is now prudent to turn to the literature to assess what useful insights it might bring to my overarching question.

Chapter Two: Exploring the Literature

2.1 Introduction

This research investigates the leadership of Mathematics within the Irish primary education sector. In order to contextualise such an exploration, it is necessary to examine how this specific genre of leadership is portrayed in the contemporary literature. This is best achieved by starting with initial consideration of generalised school leadership, before progressing to the specific sphere of mathematics leadership.

Whilst the landscape of literature on school leadership is vast, and often perceived as chaotic and sometimes contradictory (McCloskey, 2009), the body of research specifically dedicated to the leadership of Mathematics in the primary school sector is considerably slimmer. Indeed, originating only in the late 1980's, this emerging discipline seems to have been initially confined to small and rather isolated pockets in the U.S. academic community. More recent outputs have started to emerge from the United Kingdom, continental Europe and Australia in the last two decades. These diverse sources, both national and international, form the core reference material for this chapter.

The purpose of this, or indeed any literature review, is to first and foremost "define what the field of study is" (Wellington et al., 2005, p.73). This further enables the researcher to establish what research, theories, models, methodologies and approaches have been exploited by their predecessors who have previously explored this domain. Dismissing the notion that the review simply entails a summative account of what is available in the academic space, Thomson and Kamler emphasise the necessity to "locate gaps in the field…in order to create the warrant for the study in question" (2010, p.152). In many ways, this gives the research process its raison d'être. However, it does place a heavy burden on the researcher – to present the existing literature, in all its diversity and with all its occasional incongruities, in a coherent manner that provides context to the research question. A further challenge is the parallel imperative to highlight the field's apparent deficiency in answering the proposed, and evidently important, research question as fashioned by the researcher.

The upcoming section 2.2 of this review makes the case for the absolutely critical influence of leadership within our educational system, and more acutely at the micro-level of the school. This strengthens the core rationale for the research question – why examine this specific aspect of school leadership if it has little impact on schools and their activity? This influence will be teased out in the dual context of general school management initially, and then more pertinently in light of mathematics leadership specifically. An appraisal of the Irish context, with its unique demands that are impinging upon mathematics leaders, will also help reinforce the critical and pressing nature of the research question - never has there been a time of greater demand upon such leaders. The limitations of what one can reasonably expect of leadership is also an important consideration, and this section is supplemented with a significant acknowledgement of the confines of what such leaders can achieve within their schools.

In the context of this study, section 2.3 responds to a most fundamental query – what do mathematics leaders do? Despite the aforementioned dearth of available sources, it is possible to draw a clear distinction between the curricular, pedagogical and organisational dimensions of the role. These duties are catalogued and contrasted across jurisdictions and vastly different educational systems. Given the usual teaching and learning focus of the typical mathematics leader, the researcher settled upon an instructional leadership lens is in order to demonstrate the impact of this daily work. The obvious temptation of becoming bogged down in the more managerial and logistical functions of the position is also identified and explored as a powerful threat to meaningful, and classroom-impacting leadership.

Section 2.4 examines the multitude of leadership models and configurations that schools have put in place, both nationally and internationally, formally and sometimes in a more ad hoc fashion, in order to respond to the critical need for dedicated mathematics leadership. The variety in such arrangements is illuminating as is the shifting emphasis that is attached to principal leadership, teacher leadership and committee leadership structures within this milieu. Issues of resourcing and role enactment are also teased out. Evolving leadership structures in the Irish context are also assessed, alongside localised factors which will shape the nature of general school leadership over the coming decade.

The documented skillset required for the specialised role of mathematics leader is explored in section 2.5. Initially, the abundant literature examining the general skills, traits and styles of leadership will be mined for useful insights. However, of more specific interest, the unique mathematical requirements of the role will be scrutinised - the review will draw heavily on the ground-breaking work of Loewenberg Ball et al. (2008) who pioneered "*Mathematical Knowledge for Teaching*" (MKT) as a distinct hybrid of content knowledge and pedagogical knowledge. This analysis will also examine if there are skills and competencies that are unique to the leadership of Mathematics, and without which, such leadership is severely compromised.

The final section of this review (2.6) examines the supports that specialised curricular leadership requires in order to have a positive impact on school outcomes. Practical aids, alongside more theoretical guidance and PD opportunities, will be touched upon. Once again, the Irish context will provide an interesting juxtaposition to the international norms in this area.

2.2 Leadership Matters

Bush and Glover set some context for this critique by defining educational leadership as "a process of influence leading to the achievement of desired purposes" (2003, p.5). Leithwood et al. elevate it beyond mere influence, and suggest "leadership acts as a catalyst without which other good things are quite unlikely to happen" (2008, p.28). Shin and Slater probe what these "good things" might be when they comment that the purpose of leadership "is to promote (effective) teaching and learning" (2010, p.318). In an educational context, there can be few more critical aspects of leadership work than this. Whilst all of the above emphases are aspirational and somewhat idealised, it is important to ask two salient questions: does leadership really matter in reality, and can its influence manifestly impact upon the core activities of the school? Subsequent sub-sections will assess its general impact, and will then critique its likely subject-specific influence. Cognisance of the limitations of school leadership, lest it be oversold and therefore devalued, is necessary in any balanced critique, and this will also be scrutinised. The final sub-section sets a context for primary mathematics education in Ireland right now, thus highlighting the current, pressing need for particularly effective and informed mathematics leadership at the local school level.

2.2.1 How we know Leadership Matters

Bush and Glover start with a bold assertion: "it is widely recognised that leadership is second only to classroom teaching in its impact on student learning" (2014, p.553). Heck and Hallinger reinforce this dual influence: "both (the) quality of school leadership and teaching can have a significant impact on student learning outcomes" (2014, p.653). Many others have supported this analysis - Vale et al. (2010); Coelli and Green (2012); Ng et al. (2015); Yow and Lotter (2016). Indeed, Leithwood et al.'s (2008) seminal audit and synthesis of the relevant literature in the field, was among the first coherent attempts to directly connect this leadership influence and the work of teachers in the classroom. Others concur – first Robinson (2007) and then Robinson et al. (2008) similarly report that the nature of the demonstrated leadership is central to how successfully the leader can influence student outcomes. Leaders who show greater familiarity with the "core business of teaching and learning …are more likely to make a (greater) difference to students" (Robinson 2007, p.15). Katterfeld also contributes: "Recent research continues to suggest the importance of principals' involvement with instruction" (2014, p.1126). School leaders who are well-informed about issues of instruction, and who work with teachers to improve their instructional capacity often preside over schools with the greatest improvements in a variety of student and teacher-led metrics (Supovitz et al., 2010). Coelli and Green attempt to identify which specific leader actions most positively affect student outcomes: "teacher supervision and retention, introducing new curricula (in some cases) and teaching techniques, student discipline, and student allocation to teachers and classes" (2012, p.92). Unsurprisingly, the same co-authors later note that it often takes some time before the positive impact of these actions can be manifest at the student level, thus supporting their call for patience.

Leithwood et al. (2008) note the importance of leaders focusing on improving the working conditions, and the overall motivation of colleagues. They argue that both can be addressed by nurturing stability of structure and personnel within the organisation, through shielding staff from unnecessary external distractions to their work, and, by adequately resourcing the teaching and learning process (whether this be the provision of human resources or other practical teaching and learning aids). Supovitz et al. (2010) identify three key umbrella-activities of school leaders who have a greater impact on motivation, and who achieve maximum positive influence. Unsurprisingly, they identify setting mission and goals, building trust and collaboration, and most crucially of all, offering practical "active support of instruction" (ibid, p.35).

A point of universal agreement in the literature is the fact that although leadership influences are often difficult to identify, they do exist, but often in an indirect, and sometimes subtle guise. This should not be a source of surprise – the behind-the-scenes influence of the school leader is not a new phenomenon. Over a decade after they first proposed the crucial, yet sometimes elusive influence of leadership on many aspects of schooling, Hallinger and Heck (2010) have since proposed a "mediated-effects" model in order to rationalise these indirect effects of school leadership on pupil outcomes. They argue that leaders rarely engage directly with pupils at the classroom level. Rather, their research perceives leaders as typically exerting a facilitative influence to ensure that the logistical classroom needs are met, that teachers have access to supports to enhance their professional growth and pedagogical prowess, and, that the overall school climate is supportive of the teaching and learning process. “Creating conditions that lead to greater consistency in levels of effectiveness across teachers” is the ultimate aim (Heck and Hallinger, 2014, p. 653). Such modelling contradicts more traditional hierarchically-oriented methodologies which proposed a top-down, direct influence of the leader who, notionally at least, dictates every minute detail in every classroom (Shin and Slater, 2010).

As further alternatives, DeCuir-Gunby et al. (2010), in a U.S. context, proffer a more culturally-responsive leadership construct where the leader adapts to the context of his/her school community, whilst Scott and Webber (2008) opt for a leadership model which places a pivotal emphasis on the leader’s engagement with, and encouragement of, life-long learning.

Whilst there are some models of analysis that have proposed a 3% to 7% range of variation in student achievement that can be explained by school leadership – which increases once extraneous factors such as pupil background are accounted for (see Waters et al., 2004; Leithwood et al., 2008; Shin and Slater, 2010), such models remain highly subjective and open to dispute. It is perhaps unwise to unquestioningly accept such quantitative analysis, as it often disregards locally-sensitive factors that can exert a very unique influence. Furthermore, it can also help pave the way for a crude input-output “value-for-money” examination of school leadership.

One penultimate point to note is that not all leadership impacts equally. Given the overall focus of this research on varying configurations of school leadership, it is interesting to note Leithwood et al.’s (2008, p.34) strong conclusion that “total leadership” (a multi-agent approach akin to a distributed leadership model where staff play meaningful leadership roles) yields a much stronger dividend to schools than does a more singular and traditional principal-only approach. This dividend was not only evident in pupil learning and outcomes, but also in measures of staff satisfaction, positive school reform and improvement and in effective leadership succession. In a similar vein, Robinson et al. (2008) detail how different types of leadership, primarily transformational and instructional approaches, yield differing benefits, and to varying degrees.

Ng et al. make an obvious, yet critical point as we contemplate the future of schooling: “school leadership and practices should be figured as key factors in the success of schools and educational reforms around the world” (2015, p.388). It must be acknowledged that if improvement in standards is to continue, school leaders will have to play a major (maybe a pivotal) role in making it happen. In a related vein, Robinson et al. simply opine “leadership makes a difference” (2008, p.637) - the subject-specific application of this perspective will now be scrutinised.

2.2.2 Subject-Specific Leadership

Given this dissertation’s particular focus, Katterfeld’s observation provides a useful backdrop: “patterns of math-specific leadership are similar to patterns of principal leadership more generally across subject areas” (2014, p.1125). Essentially, her thesis is that leadership practices are rarely subject specific, and the bulk of actions, skills and dispositions (as outlined in greater detail in sections 2.3 and 2.5) are generic, thus requiring little or no subject-specific nuance.

This then begs two questions – firstly, does leadership positively influence how particular subjects are taught, learned and valued within the school community (whether as generalised as Katterfeld (2014) might suggest, or as specialised and unique as Jorgensen (2016) might counter)? Secondly, is it worthwhile for schools to actually invest in subject-specific leadership structures? Spillane is reassuringly unequivocal: “when it comes to school leadership, the subject matters” (2005a, p.383). His rationale is built on the premise that certain subjects (he specifies Mathematics and Literacy) carry “more sophisticated constructions of teaching” (ibid, p.383). He continues by asserting that a specialised response to these particular challenges, beyond the typical abilities of the generalist, is essential for success, thus reinforcing the need for dedicated subject leadership. This thesis is supported by Stein and D’Amico, 2000; Burch and Spillane, 2003 and Jita, 2010, among others. Katterfeld’s proposition, although somewhat contradictory of her earlier stance, strongly captures Spillane’s core argument: “the supports that (the leader) provides to mathematics teachers may differ from the routines, tools, and supports used in language arts (for example)” (2014, p.1128).

Echoing similar emerging findings by the aforementioned authors, Heck and Hallinger provide an encouraging contribution from their own research, noting “that (school) leadership was indirectly, but nonetheless significantly related to mathematics achievement through its positive effect on the instructional environment" (2014, p.673). Whilst attainment data is by no means the only reckoner of school effectiveness, it certainly features highly on any credible metric list, and it can indeed be strongly indicative of effective school structures. Evoking an earlier point, it is important to acknowledge that the leadership pinpointed in most research on mathematics leadership centres upon instructionally-focused practices. Indeed, mention of the instructional climate also strongly resonates with the more facilitative style of leadership that is characteristic of the Hallinger and Heck's "mediated-effects" (2010, p.102) of leadership examined in 2.2.1 above.

Subject-specific guidance by specialised leaders to new or struggling colleagues also bears fruit: "the more support mathematics teachers perceive and the better they evaluate the management of their school, the higher their teaching quality is" (Blömeke and Klein, 2013, p.1029). In terms of what these supports might be, Firestone and Martinez (2007) provide a summation of mathematics-specific inputs that the mathematics leader is uniquely positioned to provide: competency support; allocation of useful teaching manipulatives; guidance on appropriate use of pupil textbooks; modelling of higher-order questioning techniques; induction into innovative assessment practices and provision of guided, and, subject-specific reflection activities. Burch and Spillane (2003) reflect the typical human tendency of leaders to allocate additional human resource, timetabling, materials and other logistical supports to particular subject areas based on their own personal affinity for such disciplines. If the school leader does not consider him/herself a mathematics leader, or if they have not appointed anyone to this position, it can be inferred that this absence of an advocate can have a detrimental effect on the status and resourcing of the subject. Mathematics leadership matters, in this sense, as it may help guarantee a physical presence around the decision-making and resource-allocating table.

Although sometimes overlooked, Jorgensen (2016) further reinforces the need for dedicated, in-house mathematics leadership on account of its PD dividend. He envisages such expert leadership as a localised response to the poor availability of bespoke PD from external providers, a means to avoid the financial and opportunity-cost associated in accessing such external support, and a medium to tap into unique insider knowledge that the leader can exploit to best shape any custom-designed upskilling. It is also instructive to look at schools that function without dedicated mathematics leadership. Jorgensen (2016) bemoans their lack of expertise, the inconsistencies across and among grade levels, and dearth of mathematical impetus that such schools experience. This is often through no fault of the school or their staff, but is typically attributable to their relative small size and/or preponderance of inexperienced, unspecialised (and unguided) teachers. When one considers Kini and Podolsky's (2016) synthesis of literature, and their clear, substantiated conclusions of strong correlations between pupil achievement and teaching experience, and also between pupil achievement and collegial, supportive working environments for teachers, the call for locally-based, experienced mathematics leadership becomes even more acute.

Notwithstanding the above arguments in support of subject-specific school leadership, a balanced discussion of the literature warrants consideration of an opposing perspective. This sub-section has already referenced Katterfeld's (2014) somewhat underwhelmed reaction to the widely acclaimed necessity for specialised mathematics leadership. Although a somewhat isolated opinion in contemporary literature on the topic, Katterfeld does receive support from others who do not concur with this stated need. Halverson et al. (2007) posit that just because school leaders may lead different curricular disciplines in different ways, this form of differentiated leadership should not be mistaken as being particularly specialised, or in some way demanding of a unique, expert level of leadership nous in that subject area. Even Spillane and Burch (2006), although clearly favourably disposed to the concept of concentrated school leadership by curricular area, tersely propose that school leaders merely use different administrative routines, structures and tools for different subjects. The inference here is that the subject-specific variety of managerial tasks which typically fall within the administrative competence of the leader, although undeniably time-consuming and labour-intensive (as will be displayed in sub-section 2.3.3), could hardly be classified as being specialised, or at the extreme of what could be reasonably considered as professionally demanding for the school leader. It would appear obvious, in this vein, that the logistical and organisational work to lead mathematics would indeed be very different to leading primary-level visual arts, for example – however, this divergence holds no particular significance, nor indicates that either role is cognitively loaded.

Field (2002), in her discussion of evidence-based school leadership, also identifies the manner in which much subject-specific leadership is often overly dominated by managerial tasks which in reality are quite generic and could be enacted by most functioning adults (let alone the upper echelons of the school leadership hierarchy). She too questions whether or not there is a real need for such leadership constructs – this leads to a justifiable curiosity whether better managerial structures and routines within schools could actually contribute to the elimination of subject leadership as it is being currently enacted? This threat to subject-specific leadership is also sharpened by a need to acknowledge what the limitations of school leadership are, whether discipline-oriented or more generally speaking, and what such leadership can realistically hope to achieve in the school context.

2.2.3 The Limitations of Leadership

If researchers into school effectiveness are seeking to detect a neat and discernible imprint of the school leader on the outcomes of learners, consistent across all schools, they may have to think again. Notwithstanding the findings of Southworth (2002); Witziers et al. (2003), and, Hallinger and Heck (2010) who all suggest mediated and mostly indirect effects of principal leadership at best, an empirically-supported appraisal of what leadership can legitimately claim to do is prudent. In the vast majority of instances, the leader's greatest asset is their influence. Perhaps the more salient viewpoint is to consider how the leader can empower and facilitate others, as opposed to what he/she can directly point to as their own work (see Hallinger and Heck, 2010). Obviously, in examining the role of influence, the actual authority a leader has comes into question. Within paradigms of leadership, the role of mid-level leaders is increasingly coming to the fore. This gives rise to legitimate questioning of the actual authority that such mid-ranking leaders have to effect real change. Brown et al. discuss the frustration of such leaders who "struggle with the responsibility to bring about change without the authority to mandate it" (2017, p.569). This might prompt one to query just how seriously peers take such collegiate leadership models, and what this says about hierarchical structures of authority in school.

The heroic, all-knowing and all-conquering individual leader is an equally problematic phenomenon: "high-flying, charismatic leaders look like powerful change agents but are actually bad for business because too much revolves around the individuals themselves" (Fullan et al., 2005, p.57). In such a climate, a generation of new aspiring leaders will never get the experiences they require, and their ambition and motivation to lead often perish as a consequence. The short–term gain of having a leader who has mastered all domains is seriously compromised by such long-lasting effects. However, it is not a simple either/or debate. To illustrate the complexity of the power dynamic at play, Law et al. (2010) and Lumby (2013) caution about the implications of over-distribution of leadership power and influence, and its long-lasting negative effect on the orderly running of schools. The advice of "everything in moderation" seems especially relevant to local distribution of educational leadership.

Given its centrality to this research, some awareness of the specific limitations of teacher leadership are particularly insightful. Principally, the literature reveals that a damaging dichotomy of role may exist (see Siskin, 1993; Brown et al., 2000; Higgins and Bonne, 2011). Is the teacher-leader more part of the management structure of the school, or do they primarily retain their teaching profile at the chalk face? Indeed, is such a dual mandate possible? Higgins and Bonne note the "double-edged" challenge of being either "management-based" or "classroom-based" when holding this role (2011, p.821). The collegiality and credibility that go hand in hand with the latter is sometimes offset by a perceived lack of influence at the highest levels of school leadership. In a similar vein, the management-oriented teacher-leader may indeed exercise this elusive influence, but this often comes at a cost to collegiate relationships that are strained by a seeming power imbalance between both parties. This tension is often heightened when the teacher-leader holds some evaluative or appraisal dimension through their role. This is somewhat reminiscent of what Siskin (1993) termed a "hermaphroditic role", neither fully teacher nor fully administrator, yet functioning as a channel for all the strains and tribulations in the relationship between the two (see Brown et al., 2000; Lárusdóttir and O'Connor, 2017).

Other constraints exist, not just applicable to teacher-leaders, but certainly unique to Mathematics: "numeracy leaders must have authenticity in their capacity to lead, both in terms of Mathematics, pedagogy and assessment practices" (Jorgensen, 2016, p.30). It can be inferred that should the leader be deficient in any of these knowledge bases, whilst remaining unwilling to compensate for this through upskilling or the use of external experts, their leadership is inherently compromised. Although referring to a second level context, Katterfeld takes this hypothesis a step further and openly questions the capacity of school leaders to provide "sufficient, detailed, content specific leadership" (2014, p.1132), not just in Mathematics but across the broad range of often heavily specialised curricular areas. The platitude of "Jack of all trades" strongly resonates in this regard.

This idea that a leader can be actually perceived as a "Jack of all trades", can sometimes morph into a perception of the leader as a "Jack of the wrong trades". For example, Bush and Glover identify the phenomenon of sometimes having the wrong leader in the wrong place, at the wrong time - “leaders with high acceptability among their colleagues are not necessarily those with the appropriate expertise” (2014, p.562). They continue by decrying that this may often lead to a scenario where the most capable individual is sometimes overlooked due to the complex micro-politics of the internal school environment – teachers will only be led if they are willing to follow. Notwithstanding issues of acceptability, Robinson et al. suggest that not all leadership approaches pack an equal punch: “transformational leadership has only a minor effect on student learning” (2008, p.227). Instead, the authors suggest that an instructional style “appears to better explain the between-school differences in student achievement” (ibid, p.227). In a somewhat understated manner, Jita opines: “what remains unclear and somewhat contentious however, is what kinds of leadership matter for the improvement of learning and achievement in schools” (2010, p.851). This highlights the rather unscientific, almost random constitution of good leadership in certain contexts – it is perhaps most prudent to suggest that a combination of all styles, when called for, probably leads to the greatest outcomes (Heck and Hallinger, 2010).

This vagueness can be problematic though, and may lead to a well-intentioned but ultimately misguided school leader misdirecting his/her attention on less important aspects of their role, whilst more critical facets of their work are ignored to a damaging degree (see Katterfeld, 2013). Irrespective of style, leadership needs time in order to see the fruit of its labour (see Heck and Hallinger, 2009; 2014). Whilst this should not be seen as a limitation of school leadership, it can outlast the patience of pressurised policy makers, eager for a quick win. Such rapidly earned gains rarely sustain in the long term, and often can result in dictatorial leadership styles that damage the enduring collaborative culture of the school (see Lamb, 2010). In a broader sense, May and Supovitz (2011) and Nazareno (2013) bemoan the fact that time and resource constraints often impede the availability of school mathematics leaders to practically engage with their staff, either as a collective or individually. The resultant, reactive mind-set is often detrimental to strategically-planned and cohesive whole-school development. One such slow-burner is the process of school change, be it in curricular, pedagogical or organisational domains. Indeed, the change-agenda, often erroneously seen as a prerequisite for leadership success, is itself fraught with danger. Fullan et al. warns “when innovation runs amok, even if driven by moral purpose, the result is overload and fragmentation” (2005, p.57). This notion of change for change’s sake is further explored in detail in sub-section 2.5.1. Even rationalised and evidently necessary change poses huge risks: “without change knowledge, you get failure” (ibid, p.58).

Bush and Glover (2014) lay down a challenge to all school leaders - in a time of growing mandated curricula and multiple effectiveness-enhancing programmes, what can the leader do to distinguish him/herself in the local school context? As far back as the late 1970's, Bridges (1977) was lamenting the constraining influence of resource allocation and external (government) influence upon school leadership. Whilst it can be argued that these constraints have undoubtedly grown in the meantime, the big game-changer is the rapid professionalisation of the school leadership cohort. Developments in our collective understandings of school leadership (as discussed in the preceding sub-sections), of mathematics teaching and learning (see sub-sections 2.5.2 and 2.5.3) and the inter-play between both have strengthened the hand of school mathematics leaders to act in a rationalised and strategic manner. However, what cannot be measured is the local and, to an even greater extent, the national context within which schools must function. With this consideration in mind, the subsequent sub-section examines the Irish perspective and the particular challenges and opportunities it presents.

2.2.4 The Irish Context

Observing the contemporary international climate, Eacott and Holmes remark that "mathematics education is currently under question nationally and internationally, as the number of students undertaking advanced Mathematics (at all levels) declines" (2010, p.84). Although stark, it does pose a timely warning to the Irish system and to its leaders – participation and achievement in Mathematics is far from guaranteed, and requires continued proactive and strategic intervention.

The Irish context also presents a number of additional local factors that further reinforce the need for prudent local and national leadership over the coming decade. On initial examination, international testing data does provide considerable encouragement. Successive TIMSS (Trends in Mathematics and Science Study) results have shown cycle–upon-cycle improvements in primary school numeracy standards in Ireland since 2011 (Eivers and Clerkin, 2012; Clerkin et al., 2016), so much so that the 2015 iteration ranked Ireland's attainment levels an impressive ninth out of 49 countries. Significantly, Ireland's fourth grade pupils mathematically out-performed their English, German, Finnish and North American counterparts. Such positive results in themselves create understandable expectations for future testing cycles, which may translate into an undue pressure at the local school level. There already exists a vast literature that bemoans the disproportionate emphasis that is placed by policy makers upon such international testing, and the potentially negative backwash effects that are consequentially created in national education systems (see Bonnet, 2002; Bracey, 2004; Grek, 2009; Bieber and Martens, 2011).

Whilst the proportion of Irish pupils operating at a superior level is steadily rising, scrutiny of the longitudinal distribution of results does indicate a stubbornly consistent percentage of the assessed cohort that seem to be operating at the most basic level of mathematical proficiency (Clerkin et al., 2016). This grouping seem somewhat immune to the myriad of school initiatives and supports to engage low-achieving learners. One suspects that targeting this group will be one of the key challenges for mathematics leaders going forward. This will entail a response that is much broader than simply affecting the mathematics teaching and learning of the classroom, but also the intertwined issues of home-school interaction, attitudinal issues, educational disadvantage and transition to second level and beyond.

Separately, other recent national assessments have also shown below-expectation performances by Irish primary pupils in specific mathematical strands and skills - measures, geometry, alongside mathematical reasoning and problem-solving skills (Shiel et al., 2014). Once again, responsibility to steer the specialised and context-sensitive local response to tackling these trends will rest on the shoulders of the mathematics leader. However, it should be acknowledged that policy makers have also displayed an acute awareness of these trends, and have attempted to respond in a coherent manner that provides a supported pathway towards improvement of numeracy standards in all schools (DES, 2011; 2017a). The subsequent paragraph outlines this policy response.

The beginning of this decade has witnessed a flurry of initiatives and government policy shifts that have placed a renewed and significant emphasis on quality teaching and learning of Mathematics in our primary schools, all of which have crucial leadership implications. The "National Strategy to improve Literacy and Numeracy among Children and Young People 2011–2020" (DES, 2011) reaffirms both the government's and society's value upon Mathematics. Ambitious targets are foregrounded to raise national attainment in Numeracy and other relevant key performance indicators are identified. Crucially, recognition of the importance of local school leadership (not solely confined to the school principal) as the catalyst for such positive improvements permeates this document: "it is critically important that leaders are engaged continually in leading, supporting and monitoring improvements in Numeracy from junior infants to sixth class in primary schools" (ibid, p.39).

The document specifies nine key supports that leaders require in order to make good on its aforementioned leadership ambition. Ranging from recommendations of specific training in effective numeracy strategies, assessment rubrics and school self-evaluative skills, to the allocation of complementary support materials, accompanied by the provision of generalised leadership preparation and development training for serving school leaders, the initial intentions of the strategy's authors were noble. Indeed, most of these provisions are now readily accessible, in some form or other. To date, taking recent attainment scores in TIMSS (see Clerkin et al., 2016) as a key indicator, it could be credibly argued there has been some demonstrable success arising from these supports. It is also likely that the introduction of a mandatory and more formalised model of school self-evaluation (SSE), some twelve months later, was an even greater influence upon the system. The rationale of this new initiative was clear:

> *"SSE empowers a school community to affirm good practice, to identify areas that merit improvement and to decide on actions that should be taken to bring about improvements in those areas."* (DES) Inspectorate, 2012, p.8)

Given its core status in the Irish education system, the teaching and learning of Numeracy was mandated as one of the three priority areas to be targeted in the first cycle of the SSE process. The challenge facing the leadership structures of the school were obvious, as was the pivotal position of local leaders in effecting change and improvement: "effective SSE requires effective leadership" (ibid, p.13). Specific requirements of gathering data, compiling an analysis of the school's current performance, negotiating targets for improvements, spearheading implementation of the school's improvement plan and ongoing monitoring and review of the entire process, all added to the leadership burden. There is some, although very limited, anecdotal evidence to suggest that some schools responded to this challenge by creating numeracy leadership teams to manage the process, thus broadening the leadership base of their school, and giving novice leaders an opportunity to influence the whole-school agenda. Whether the existing leadership cultures prevalent in Irish schools were ready or equipped to 'lead' these new SSE responsibilities is questionable. Findings by McNamara et al. (2011), just prior to the national rollout of SSE, discovered little or no evidence of any collegiate structure within Irish schools for self-evaluation and/or school improvement.

This fledgling collaborative leadership dynamic may be somewhat explained by the austerity-era (2009–2014) moratorium on posts of responsibility in primary schools – as formal middle management positions were being left unfilled, schools responded creatively. Some core curricular areas were protected where possible, many leaders multi-tasked across subjects, unpaid volunteers stepped forward, committees shared the burden, and neighbouring schools pooled expertise. Despite this innovation, there is no doubt that today the legacy of some 5,000 lost middle-management positions (Irish National Teachers Organisation (INTO), 2020) is evident in most schools where key curricular areas (which were traditionally tied to specific posts of responsibility) are without designated coordinators. There is no reason to assume that Mathematics is immune from this phenomenon, nor that it is not suffering as a consequence.

A more optimistic viewpoint would suggest that the SSE initiative is in itself the most explicit acknowledgement by the DES that Mathematics does demand a coordinating presence in schools, one which seamlessly connects to the leadership and management apparatus of the school. In this regard, recent DES circulars (2017b, 2018a) to restart middle management appointments does represent a step in the right direction. It is important to note that this research will be one of the first to shine a light on curricular leadership following the introduction of formal SSE - it is also highly likely that the work of the profiled mathematics leaders will be significantly shaped by the ongoing participation of all schools within this self-appraisal (and improvement) cycle.

The final, and perhaps most crucial, mathematics-specific leadership challenge that lies ahead in Ireland is the implementation of the forthcoming new primary Mathematics curriculum. Already beyond draft and consultation stages for infants to middle grades (see NCCA, 2017), an ambitious timeline for full implementation of the new curriculum (across the eight grade levels) during the early years of the next decade has been set out. Successful curriculum implementation is a highly complex and resource-demanding enterprise, irrespective of the curricular area (see Newstead and Bennie, 1999; NCCA, 2005; Penuel et al., 2007; Roehrig et al., 2007). Given the proposed changing of classroom emphases to learning outcomes (as opposed to learning objectives), learning "elements" (replacing key mathematical skills) and the explicit use of new progression continua throughout, a considerable challenge faces school leaders when implementing this new syllabus.

An examination of recent PD models utilised for education-specific purposes in Ireland, including the roll out of SSE (DES Inspectorate, 2012) and the initial introduction of the primary language curriculum (NCCA 2015), strongly indicates that school principals and/or designated mathematics leaders will be the first to receive input. The clear intention being that the individual leader will take their learnings back to school, as an initial stimulus to local implementation. Such a burden should not be underestimated. Once introduced, managing the legacy of curricular change also demands a specialised response. This is likely to include resetting and updating of school planning instruments and documents, likely resource procurement, educating the school community of changes in approach and emphases, and most crucially, supporting teachers in their classrooms. All of these elements will draw widely and heavily on the skillset of the mathematics leader.

Having briefly touched on the work of mathematics leaders in one very specific aspect of their role, as noted in the preceding paragraph, it is prudent to now expand that discussion in order to achieve a more comprehensive audit of the duties and responsibilities that typically accompany this position.

2.3 The Work of Mathematics Leaders

The literature indicates that there are varying interpretations of what mathematics leaders do. This and subsequent sub-sections will tease out some of the core truths within this limited knowledge base. Various models of school leadership will be critiqued. In particular, an instructional leadership lens will help to illuminate emerging understandings.

As a starting point, Sexton and Downton argue that "little is known about the leadership role of mathematics curriculum leaders in primary schools" (2014, p.3). Others challenge this pessimism, and help provide more descriptive insights in outlining the role of mathematics leaders. Vale et al. are definitive in their assessment of what mathematics leaders ought to be doing: "provide professional learning that is based on their knowledge of teachers' practices… and connect teachers' professional learning needs with agreed pedagogical directions and practice" (2010, p.63). They continue by saying that numeracy leaders should "promote and model effective practices" (ibid, p.63) whilst introducing teachers to new and innovative teaching and learning resources. Grootenboer et al. (2015) concur with the primarily pedagogical focus. Whilst such intentions are laudable, it will be necessary in due course to further explore the daily actions and interactions of mathematics leaders in order to better illustrate this important work. For the purposes of this sub-section, the leadership of Mathematics will be primarily examined through the lens of an instructional-leadership approach. However, it is important to first acknowledge the breadth of leadership styles that are evident in the literature. This initially broader focus will provide vital context for section 2.4 where a more detailed discussion of the various models of mathematics leadership enactment will be teased out. Starting with distributed leadership, three dominant alternative leadership approaches will now be briefly critiqued.

2.3.2 Leadership Approaches

Distributed leadership, or "democratic leadership" as termed by Spillane (2005b, p.143), has taken on an almost-iconic status in educational circles, though it is often misunderstood, and is frequently overgeneralised (See Bennett et al., 2003; Shava & Tlou, 2018). Critically, Liu et al. (2018) caution that such leadership is not just a matter of the leader haphazardly "dispersing leadership from top to bottom" (p.4) in an attempt to simply involve (or placate) individuals within the organisation. Shava and Tlou (2018), in a telling contribution, note that the distributive approach "is not about creating quantity but rather quality in leadership practices" (p.281).

Even allowing for the myriad of distributive patterns evident in the literature (See Leithwood et al., 2008), at its core the distributed approach is best described as a strategic process when staff, with the appropriate skillset, are involved in specifically chosen leadership functions of the organisation. It relies on the leader's strategic judgement to involve the right people, at the opportune time, for the common good. Harris and Lambert (2003) highlight this capacity to "(engage) expertise wherever it exists" (p.4). In a school setting, where the consequences of mis-delegation can become very evident very quickly, the distributing leader must tread carefully.

For the purpose of this research, it could be proposed that the simple delegation of mathematics leadership from principal teacher to subordinate does indeed meet the criteria for distributed leadership. However, if the literature cited in the above two paragraphs is to be accounted for, then the delegate must be among the most suited (and skilled) personnel for this role within the organisation. This imperative sets an important context for the upcoming section 2.5 which discusses the very specific skillset required for effective mathematics leadership. It also provokes debate about the suitability of the mandated selection processes that schools must use when recruiting mathematics leaders. Once again, this is a recurring motif which will resurface throughout this dissertation.

Spillane (2005b) asserts that one of the most prominent consequences of a truly distributed leadership approach is an increasingly collaborative mind-set amongst colleagues, who tend to be more predisposed to sharing leadership influence. This inclination gives rise to a very tangible dividend: "additional dynamics which (are) the product of conjoint activity - where people work together in such a way that they pool their initiative and expertise" (Woods, 2004, p.441). This more collective interpretation of what distributed leadership can achieve has strong resonances with the shared leadership constructs which inform the methodology of this piece of research (see chapter 3). Working on the basis that the combined yield is greater than the sum of its parts, such leadership models are based upon leader co-dependence and a genuine interest in each other's work. However, despite these democratic overtones, the vast distributed leadership literature appears to concur that some form of hierarchical structure is necessary to strategically direct the dispersal of leadership influence to the middle-management ranks of schools.

A second leadership approach that merits consideration is the transformational style. Such leadership centres more on efforts to entice followers to adopt and contribute to achieving the leader's vision, and to motivate followers "to go beyond acting in their own self-interest…(and) work for the good of the group" (Tekleab et al., 2008, p.186). This broad definition makes a number of presumptions: the leader has collaboratively formulated a vision; has clearly communicated and rationalised this ultimate objective to others; and, that all see a personal and collective benefit in working towards this agreed goal. Undeniably, such a collective buy-in by a staff is of itself a triumph of leadership, but more importantly is a powerful force for school self-improvement when harnessed correctly. In the context of a curricular area such as mathematics, the interpretation of what a school's vision might be can be multi-dimensional – it may relate to the culture of mathematics teaching and learning within a school setting, or more concretely, it may set its focus upon the identifiable standards of numeracy achieved by the pupil body in standardised testing. Consistency of teaching approaches, through the various grade levels, is also another highly desirable aim for many Irish primary schools when it comes to their mathematics provision.

Building on some three decades of their writings on the topic, Bass and Bass (2008) isolates four main components of this transformational leadership philosophy: idealised influence, inspirational motivation, intellectual stimulation, and individual consideration. Once again, the jettisoning of self-interest for the collective good immediately stands out as a defining characteristic. However, the descriptors also evoke images of a somewhat heroic individual leader who holds a quasi-messianic influence over colleagues. It is little wonder so that Gumus et al. (2014) make a strong connection between transformational approaches and charismatic leadership models. Subsequent sections in this chapter will decry the sustainability of single-person leadership constructs – in this context, one has to query the sustainability of transformational approaches given that so much of its potential rests upon the shoulders one individual, and their skills of motivation. In the school setting, is it tenable to have just one individual (however abundant their interpersonal, leadership and subject-matter abilities) to solely carry such responsibility?

A final, relevant alternative to an instructional model of school headship is servant leadership. Considered by many as the trending leadership approach of contemporary education (despite being first mooted by Robert Greenleaf in the late 1970's), it puts its concentrated focus on the people who are being lead (See Cerit, 2009). Building on the rejection of self-interest that is evident in the transformational orientation, it is the leader who deprioritises his/her personal welfare in an effort to serve the needs and desires of colleagues. This presents a challenge to traditional leadership hierarchies where the leader typically seeks to exercise authority over followers, who are duty bound to "serve" their leader in the course of their work. Undoubtedly, the professional bravery, personal conviction and sheer humility of the servant leader to challenge, and possibly subvert this traditional order, cannot be ignored (See Barbuto and Wheeler, 2006). The emphasis of servant leadership upon leader responsibility, personal authenticity, the dignity of others and the need to be truly present to the full school community at all times, displays strong similarities with an ethical leadership orientation (see Starratt, 2004). Both approaches are underpinned by a people-first, value-laden moral purpose which strives for the common good across the organisation.

Laub (1999) identifies six defining capacities of the servant leader – valuing people; developing people; building community; showing authenticity; providing leadership, and, sharing power. The social, person-centric dimension of the sextet is immediately apparent, as is the realisation that many of the six are not exclusive to this leadership approach. A majority, or indeed all, of the specified characteristics could sit comfortably in the distributed or democratic leadership realm, for example. Russell (2001) builds on these competencies and notes that the servant leader must "walk the talk" and model the self-effacement they profess. The same author further highlights the imperative to reward those who are willing to buy into the desired culture.

In terms of a possible link to curricular leadership within a school setting, Woodruff (2004) provides some direction. He outlines the compatibility of servant leadership to “placing the organisational purpose, the needs of the organisation, and the needs of (its) people” above everything else (p.17). Therefore, it is easy to envisage how the promotion of a key curricular areas (such as mathematics) could be reconceptualised as a key “organisational purpose”. In this context, it is therefore more palatable to consider how a leader might devote time to menial, organisational work which enables others to perform their more pupil-facing duties. The organisation and distribution of teaching and learning mathematics manipulatives is an example of such work. This may help to explain the more facilitative (if tedious) work of mathematics leaders as captured in the literature, and outlined in the upcoming sub-section 2.3.5.

As noted in the preceding paragraphs, different leadership styles can account for different contexts. Each approach has its positives, and no approach is considered superior to another but perhaps the real strategic requirement upon the leader is to know which approach should be called upon in a particular instance, or which is best suited when dealing with a specific challenge. The subsequent sub-section provides an introduction to the instructional leadership style and makes a case for its dominance as a signature mode amongst mathematics leaders.

2.3.3 Instructional Leadership

Seashore Louis et al. (2010) simply describe instructional headship as a leadership approach which displays an overriding concentration on improvement of classroom pedagogy. Immediately, the sharp focus of this approach is evident, as is its direct impact upon the teaching and learning process. Katterfeld teases out two supporting strands that help maintain this focus – first, the clear enunciation of an academic purpose and of accompanying high expectations, and second, the creation of a “schoolwide focus on instruction through monitoring the progress of teaching and learning” (2014, p.1127). Whilst the communication of expectations indicates a more visionary, somewhat detached style, the instructional focus dictates an active on-the-ground supervision of, and direct intervention in, the teaching and learning process. In this way, it is clear that the instructional style marries the visionary and the practical very well. The logical consequence of this approach is clear: school leaders must be authentic in the vision they are promoting, and be equally committed to “observing classroom instruction frequently" (Katterfeld, 2013, p.341). Following these observations, honest and open professional conversations aimed at reflecting upon and improving practice must ensue.

Supovitz and Poglinco (2001) progress this further by suggesting the critical importance for leaders to listen to not only the voices of teachers, but also what pupils are saying in order to integrate the learner perspective into their thinking. This clearly highlights the curricular and pedagogical burden that such a leadership style places on the leader, perhaps all the more acute in a very specialised curricular domain such as Mathematics. This will be teased out further in section 2.5. Accepting the critical influence of leadership upon classrooms, as previously discussed in section 2.2, this presumption further strengthens the case for instructional leadership-inspired approaches when leading Mathematics. Many researchers have considered the practical import of an instructional style (see Hallinger and Murphy, 1985; 1986; May and Supovitz, 2011; Katterfeld, 2014). Alongside observing teachers, other regular activities include reviewing test scores, facilitating teacher collaboration, securing resources, protecting instructional time, setting and espousing high standards for mathematics teaching and learning, promoting PD, providing incentives for teachers and for learners, and, maintaining visibility. Millett et al. provide a catchy mantra for the ambitious instructional leader: provide the "time, talk, expertise and motivation" (2004, p.251) required for effectiveness.

2.3.4 Curricular, Pedagogical and Organisational Duties

Jorgensen (2016) provides an important initial observation - mathematics leadership manifests itself in different ways, in different contexts. By providing the specific example of an influx of newly qualified teachers (NQTs) to a staff (and the unique initiation and mentoring response that this requires of the mathematics leader), he argues that the needs of the school dictate the duties of the coordinator. One size cannot fit all. Therefore this survey of the range of duties is just that - a portrayal of an expanse, rather than the provision of a mandatory list that must be fulfilled. What is immediately striking about any description of the work of instructional mathematics leadership is the sheer diversity of duties. From an Australian perspective, Sexton and Downton (2014) comprehensively display this curricular, pedagogical and organisational miscellany. They propose that the role primarily includes some or all of the following: delivering tailored PD in Mathematics for teachers; monitoring of standardised testing and other assessment data; offering practical assistance with the planning processes of teachers (including curriculum alignment); promoting and enabling change in mathematics teaching and learning (including coordination of national and state initiatives); facilitating enhancement of teachers' pedagogical content knowledge (as further described by Jorgensen, 2016 and profiled in sub-section 2.5.3); liaison with external agencies that work in the mathematics education field, and, management of the relevant organisational, human and physical resources. A British equivalent is remarkably similar albeit with the more explicit emphasis upon the "production of school mathematics curriculum documents" and "provision of in-class support" (Millett et al., 2004, pp. 20-21).

Interestingly, it is a feature of both the British and Australian systems that the mathematics leader performs these aforementioned duties alongside their own teaching responsibilities, although with a reduced load when compared to colleagues (Brown, 1998). Whilst this dual mandate is undoubtedly taxing on the individual, it does lend a certain authenticity to their leadership work. Whatever initiatives they roll out, whatever reforms they spearhead, whatever demands they make, they too must be subject to these conditions (see Jita, 2010). This dynamic, at a minimum, removes the charge that the leader is seeking standards of teaching and professional engagement that he/she is not personally subject to.

Harrison's (1995) terse description of the role of the mathematics coordinator shows the expansion of the position over the last two decades. His portrayal of mathematics leaders in the mid-1990's revealed the role to be somewhat primitive and underdeveloped. It focused on the "auditing, marshalling, ordering and taking care of the school's mathematics equipment", "keeping up to date with best practice in mathematics teaching", ensuring centralised diktats were observed, and "occasionally talking about the school's mathematics teaching to visitors, governors or advisers" (ibid, p.54). Echoes of Osborn and Black's somewhat limiting "resource gatekeeper" and under-utilised "subject consultant" roles (1994, p.27) strongly resonate here.

Towards the turn of this century, the role of numeracy coordinator had started to become noticeably more ambitious in its requirements, and more challenging in its diversity. Brown's (1998) useful provision of a pro forma job description for a school mathematics coordinator does show the beginnings of this change towards the coordinator being specifically mandated to tailor increasingly less prescriptive national initiatives to the localised context. Additionally, it heralded the offering of in-house expertise to address colleagues' deficits in content knowledge for teaching, displaying a more active interest in research developments in mathematics teaching and learning, and, the more systematic utilisation of assessment data as a stimulus for school improvement. This rapid expansion prompted Millett and Johnson, at the turn of the century, to comment on the "increasingly demanding" role of the mathematics coordinator (2000, p.393), even going so far as to call it "daunting" (ibid, p.395) in its span and its depth. Unsurprisingly, the same authors continue by documenting cases where this massive jump in responsibility overwhelmed the capacities of mathematics coordinators in many English primary schools.

Despite such cautionary tales, this enlargement of responsibility continues, as recently captured by Sexton and Downton (2014). Reflecting the changing nature of primary education, the daily functions of the mathematics coordinator have expanded commensurately. Typically, they now include: the articulation of a clear vision for mathematics teaching and learning to the school community; the leading of a some form of progressive school-wide self-evaluative process; the provision and promotion of information and communications technology in the subject; the empowerment of parental influence in the mathematical development of children, and, the ongoing and structured mentoring (as opposed to more simplified induction) of new staff (see National Centre for Excellence in the Teaching of Mathematics (NCETM), ND). Harrison's (1995) depiction of the traditional curricular leader, primarily occupied with organisational duties, is now unrecognisable. The growing prominence of demonstrating lessons to peers, involvement in co-teaching and other co-operative teaching arrangements (HM Department for Education and Employment, 2002) alongside the facilitation of video clubs and "*Lesson Study"* groups (Burghes, 2012; Yoshida, 2012) are also continuing to feed the evolution and expansion of the demands upon mathematics leaders. In the context of Grootenboer et al.'s (2015) urgings to mathematics leaders to do their utmost to directly observe and strategically influence the quality of teaching in classrooms, such professional intrusions into the classrooms of colleagues are becoming increasingly justified, and are likely to become even more pronounced in future.

A comparison with the U.S. context adds further insight to this review's survey of leadership duties. In their instructional manual for mathematics leaders, the National Council of Supervisors of Mathematics (NCSM, 2008) exploits a four-principle structure encapsulating equity leadership, teaching and learning leadership, curriculum leadership and assessment leadership. Each core element of this Principle & Indicators for Mathematics Education Leaders (PRIME) framework is bolstered with a set of bespoke indicators. Admittedly, the indicators are quite general (for example "every teacher pursues the successful learning of Mathematics for every student", (ibid, p.5)), however each is delineated with a comprehensive array of suggested leader actions. Herein lies the true leadership value of the framework. Figure 2.1 provides an overview of one of these outworked leadership principles:

Figure 2.1 The PRIME Leadership Framework – From Pillar to Action

Principle:	**Indicators:**	**Suggested Actions: (for indicator 1 only)**
Equity: *Ensure high expectations and access to meaningful mathematics learning for every student.*	• Every teacher addresses gaps in mathematics achievement expectations for all student populations. • Every teacher provides each student access to relevant and meaningful mathematics experiences. • Every teacher works interdependently in a collaborative learning community to erase inequities in student learning.	• Identify and analyse student achievement data for various populations. • Develop and apply knowledge about how to meet the diverse needs of all student populations. • Provide specific attention to those students farthest from expected standards of rigor and achievement.

(NCSM, 2008)

Underpinning the PRIME principles and indicators are the core duties of knowing the discipline intimately and of modelling best practice, collaborating with colleagues to implement agreed best-practice approaches, and crucially, advocating for the highest possible standards of mathematics teaching and learning across the entire school community. In their study of various state-controlled education systems in North America, Balka et al. (2010) opt for a six-pronged model of mathematics leadership including curriculum articulation, curriculum implementation, promoting effective instructional strategies, establishing professional learning communities, provision of feedback, and fostering of PD. Although slightly more prescriptive in the day-to-day implementation of the six components than the NCSM equivalent, the professional judgement of the leader in how to enact the recommended duties is assumed. Again from the U.S., Firestone and Martinez (2007) opt to describe the work of the mathematics leader in more general, non-specific terms. This seems to reinforce a noticeable feature in the literature: the European and Australian approaches seem to favour the listing of plainly-worded duties when guiding the work of mathematics leaders. However, much of the U.S. research aims for buy-in to broader and higher-level aims which are then achieved through the professional discretion of the local leader. His/her professional judgement in plotting the correct course for his/her school, in line with the guiding principles, appears to be more prevalent.

In comparison with the other international models, the Irish educational system operates without any centrally mandated list of duties attached to the role of mathematics leader. Indeed, the role itself is not officially prescribed. Each board of management, operating within the confines of the official model of formal in-school management structures, is free to determine if such a position is warranted, and if so, what duties should be attached to the role. Unlike other systems, all such duties must be performed independent of full-time teaching responsibilities. Although undocumented in any reliable way, one could presume that resource management, coordination of whole-school planning for Mathematics, and spearheading of promotional activities such as *Maths Week* or other mathematics showcases would form the mainstay of the leader's duties. Less clear, given the uniquely Irish context and the accompanying traditional sensitivities around teacher evaluation, are the duties attached to the provision of PD, mentoring, and the monitoring of overall standards of the teaching and learning of all school subjects, not just Mathematics (see McNamara and O'Hara, 2012). One hopes that Jorgensen's (2016) recommendation of individual schools tailoring the duties of their coordinator to their own very specific local needs, however anomalous, is guiding this ad hoc response by some or all Irish schools. Of even greater concern is the possibility that some schools attempt to operate without any functioning mathematics leadership structure. Ultimately, without specific data either from the research community or centralised government to capture the work (or actual existence) of mathematics leaders, one can only speculate on the true situation. This lack of detail concerning the Irish context provides a key rationale for the overarching research question that underpins this dissertation – how is mathematics leadership being enacted in our primary schools?

2.3.5 The Temptation of Administration

Much debate has occurred around the conflict of providing mathematics leaders with the agency and opportunity to actually engage in leadership solely focused on teaching and learning, whilst simultaneously minimising the consuming demands of administration and management. This sub-section teases out this highly complex, and frequently unachievable balancing act.

Stein and D'Amico debate the age-old conundrum of shifting mathematics leaders from "building managers (to)… leaders of the intellectual agendas of their… schools" (2000, p.7). Whilst their choice of descriptors is provocative, it does tap in to the pressing need to re-imagine the work of mathematics coordinators – moving from a traditionally narrow managerial and administrative role, towards a more instructional, creative and practice-influencing position. Old habits die hard it seems. A decade later, Jita again warns of the temptation of mathematics leaders to become overly burdened by the managerial aspect of their work, which in turn reduces availability to engage in their supposed core work of "strategising and developing structures and practices" to improve teaching and learning (2010, p.853). Fitzgerald, in her study of middle leaders in New Zealand secondary schools, similarly finds that "the tyranny of bureaucracy" (2009, p.51) is typically all-consuming, often leaving little or no time to lead.

Bush and Glover readily acknowledge that managerial leadership indeed retains an important function in ensuring that "the work of others in the organisation will be facilitated" (2014, p.556). However, the prioritisation of this work to the detriment of instructional leadership practices is prompting some to seek a re-conceptualisation of educational leadership (Bates, 2006; Eacott and Holmes, 2010). Fink and Resnick describe the daily work of school leaders as "filled by the many demands of administrative functions" (2001, p.599). Further noting the human propensity "to gravitate towards doing what they know how to do" (ibid, p.599), it could be interpreted from Fink and Resnick's comments that school leaders often lack the philosophical basis, the practical skillset and perhaps the courage to lead in the broadest sense. This also provokes deeper questions about the fitness-for-purpose of leadership preparation, and the robustness of leadership recruitment processes to identify the very best candidates.

Seashore Louis et al. (2010) suggest a need to completely separate (and subsequently delegate) the administrative functions of curriculum/instructional leadership from the more critical, pedagogical responsibilities. Although logical, this suggestion might present practical difficulties at a local level, particularly the seeming inequality of esteem and influence between sub-roles. Issues of remuneration and burden-sharing between promoted and non-promoted staff also come into play. Nazareno's observation that the creation of further layers of management through this proliferation of duties should be avoided, lest it "pull expert teachers away from students to handle important but routine matters" (2013, p.53). Indeed, Nazareno's (ibid) subsequent suggestion that schools appoint a dedicated administrator in order to release the mathematics coordinator to actually function as the leader is eminently justifiable, but it remains all too fanciful for financially-pressed schools operating within strict staffing models. Others, such as Firestone and Martinez (2007), suggest innovative leadership models that seek to involve various protagonists (from the school and from the district) in a collaborative approach that allows agents to work on the aspect of leadership they know best, be it administration or other more classroom-impacting functions. Katterfeld (2013) bluntly advises that in order to avoid role overload, instructional leaders must learn to prioritise what is really critical to student learning. In this regard, she advises that leaders should primarily focus on two core tasks: promoting a shared "academic vision" (ibid, p.338) with complementary common goals for (and negotiated with) the whole school, and putting a strong emphasis upon the systematic supervision of instruction by colleagues, at close quarters.

Given the sheer volume and diversity of work that accompanies this specialised leadership position, and the generally accepted under-resourcing of many school systems internationally, one may query the capacity of individual schools (and the designated staff therein) to meet this challenge at local level. The subsequent section assesses the various models and configurations that schools, sometimes with and sometimes without the support of central government (or district), have put in place in order to respond to this significant challenge.

2.4 Who leads Mathematics in Schools?

Stemming from the researcher's line of inquiry that queries the working arrangements and habits of mathematics leaders in our primary schools, it is necessary to examine the diversity of role-configuration across various education systems. Broadly speaking, such structures cluster around principal leadership, and alternatively, some form of (expert or dedicated) internal teacher leadership or collaborative/committee structures. Differences and similarities in the dynamics of each model are of particular interest to this researcher. Whilst this critique of international practice is illustrative and has helped inform the leadership models exploited within this study's methodology, the unique constraints of the Irish situation must also be appraised.

This should not be seen as an either/or, divisive presentation. The interdependence of all models is striking - "not only do teachers need to work together around instruction and student learning, but administrators need to be part of that process (too)" (Seashore Louis et al., 2010, p. 331, 332). However, for an even-handed critique of the available literature, each specific model warrants consideration in its own right.

2.4.1 International Models

Coming from a highly evolved U.S. system, it is unsurprising that both Balka et al. (2010) and NCSM (2008) display considerable breadth in their conceptualisation of who might lead Mathematics at the school level. Teacher leadership dominates - this umbrella term typically encompasses further sub-roles such as year heads, curriculum specialists, mathematics (instructional) coaches, maths facilitators and numeracy mentors. Australian variations include "mathematics coordinators…and…school mathematics leaders" (Sexton and Downton, 2014, p.3). In a similar vein, British equivalents typically cluster around the singular figure of the "mathematics coordinator" (see Harrison, 1995; Brown, 1998; Millett et al., 2004). Unsurprisingly, the school principal remains ubiquitous as a supporting influence, at the very minimum, within these local leadership structures.

Somewhat worryingly, Higgins and Bonne (2011) have identified a tendency for some elementary school principals to abdicate leadership of embedding and maintaining new mathematics teaching, learning and organisational reforms. Indeed, the researcher's trawl of the literature reveals a very small proportion of school sites where the principal operated as the de-facto leader of Mathematics, notwithstanding the ultimate responsibility that comes with the head-teacher role. One can safely speculate that role overload and time constraints are likely reasons for this. However, the literature is silent as to whether or not this strategic delegation may more accurately be a tacit admission that the school principal lacks the required skill-set, with a more junior colleague actually better suited.

Collaborative structures, such as internal mathematics boards and inter-school collaborative fora (described as "toolboxes" by Hopkins et al., 2013, p.208), also feature prominently in this crucial leadership space. This obvious diversity of role and structure invites an interesting juxtaposition with the Irish system. Consequently, it helped shape the various models of mathematics leadership that this study examined. These models, representative of the broad international literature, include: administrative principal alone, teaching principal alone, teacher-leader with an assigned middle management role, teacher-leader with no formal middle management role/volunteer, and committee structure. They will be further teased out in Chapter Three.

2.4.2 Principal Leadership

Although Heck and Hallinger note the growth in research that seeks to study sources of school and subject-specific leadership that exceed "hierarchical roles" (2010, p.881), the influence of the school principal, whether direct or mediated, remains transcendent and powerful – "principal instructional leadership has been found to support improved instruction" (Katterfeld, 2013, p.337). The centrality of this leadership facet is further bolstered by Elmore and Burney (1999) when they suggest that it is the singularly most critical factor in any school's instructional improvement strategy. The connection between pupil learning and principal influence has long since been established (see Fullan, 2016). However, the means through which this is most effectively done is more nebulous, often falling back on vague generalisations of teacher empowerment, staff facilitation, goodwill and other generalised support (Good, 2008). The ultimate responsibility for all teaching and learning that is conferred by the role of head teacher ensures that although influence may be shared, and perhaps diluted, all leadership derives its authority from the principal.

Over two decades ago, Hallinger et al. (1996) offered their synthesis of the core actions of instructionally-astute principals: visiting classrooms and observing teachers; reviewing school-wide test performance with colleagues; enabling teacher partnerships on instructional projects, and, sourcing and allocating resources. The same research also paid particular heed to the deliberate principal practice of maintaining a noticeable presence among the school community. Some twenty years on, despite similarities between Hallinger et al.'s (1996) contribution and other, more contemporary research (Matthews et al., 2008; Darling-Hammond et al., 2010), it is clear that principals now occupy an increasingly complex and demanding working environment. Given this new reality of school leadership, encapsulating the thirst for ever rising academic standards, the push for innovation, expanding curricular emphases and the general move away from tiered management structures, one must critically re-assess the wisdom of such responsibilities being left in the hands of one individual. Credible concerns about the practicality and sustainability of principal-only leadership for subject-specific instruction (see Seashore Louis et al., 2010) have forced policy makers to broaden their traditionally narrow understanding of who might hold leadership influence within schools. Although an outlier in the research, Jita describes a cohort of South African principals who "redefined their own roles" (2010, p.853). These leaders became directly involved in the daily teaching work of their schools alongside colleagues, even if for only one lesson per day. The resultant experience helped hone a more instructional-bent in their outlook, and in their school-wide leadership of Mathematics. Given that close to 60% of all primary school principals in Ireland hold a full-time teaching role (Hennessy, 2014; Houses of the Oireachtas Joint Committee on Education and Skills, 2019), clearly this enhanced instructionally-focussed leadership holds much potential in our schools.

Consideration of the obstacles to greater principal involvement in the instructional agenda of their schools typically make reference to the lack of time in an otherwise hugely demanding role (Fullan, 2006). Other probable limiting factors include a perceived deficit in the necessary subject knowledge and accompanying pedagogical expertise, and a misplaced belief that the principal's lack of direct experience of the challenges of daily teaching in some way undermine their authority to offer subject-specific leadership (see Jorgenson and Peal, 2008). Firestone and Martinez (2007) take account of these limiting factors, and propose three traditional core areas of activity that have typically remained principal-dominated: procuring and distributing materials, monitoring improvement, and developing people. Of the trio, the identified practice of "developing people" (ibid, p.3) is open to interpretation – on the one hand it implies the recruitment of suitable staff to fill key roles, with access to external PD as required, alongside a mandate to act decisively with the principal's imprimatur. A contrarian view of "developing staff", akin to Heck and Hallinger's "capacity building" (2014, p.658) perspective, is the direct involvement of the school principal in the PD and evolving work programme of the designated staff member. This approach is exemplified by the provision of formalised principal-to-teacher coaching programmes that function under the NCETM in the United Kingdom.

Of Firestone and Martinez's (2007) detailed description of the core duties of mathematics leadership, resource procurement and organisation could not be considered as facets of high-level subject coordination. At best, another of their specified core duties, monitoring improvement, is a typically generic responsibility that head teachers hold across the entire curriculum. Indeed, such "monitoring" is also open to broad interpretation: does it encompass classroom visits (with follow-up consultations) by the principal to personally observe, and comment upon, the teaching and learning of Mathematics? Such instructionally-focused intervention clearly is in stark contrast to a more minimalist interpretation of monitoring which solely entails the uncritical collation of test score data, in order to solely meet statutory requirements.

The Irish example is particularly demonstrative of an evolving understanding of what monitoring standards can actually mean in practice. Section 22 of The Education Act 1998 (Government of Ireland, 1998) noted the key responsibility of the principal to "regularly evaluate students and periodically report the results of the evaluation to the students and their parents". Whilst the imperative to assess, to record and to report was clear, the stated necessity to strategically react (either organisationally or pedagogically) to such assessment outcomes was conspicuous by its absence in the legislation. In the subsequent years, anecdotal evidence suggested that many school leaders considered the need to respond to assessment data as an implied, and logical demand. Most acted accordingly. However, it can also be inferred that many school leaders did not respond in such a manner, and stayed closer to a more literal interpretation of the official guidance. Despite various non-binding initiatives to more directly link the assessment practices of schools to their teaching and learning processes, it was only a decade or so later that this obligation was mandated. The arrival of a formalised school SSE approach in all schools followed through on what many school principals were already committed to - a necessity to base teaching and learning plans upon a range of reliable quantitative and qualitative sources. It advised that "teachers' views and their records (assessment data, standardised test results) are useful examples of evidence" (DES Inspectorate, 2012, p.16) and should be integrated into school-development planning processes. Although this reprise of the Irish context may primarily display an example of policy makers ultimately catching up to the practical realities in many schools, it also demonstrates the changed, and ultimately more accountable nature of contemporary school leadership, irrespective of whether it be from an administrative or curricular-based standpoint.

It is clear that the self-perception of school principals as either administrators or leaders of learning is crucial. Neither should be mutually exclusive. Seashore Louis et al.'s (2010) suggestion that principals should engage in classroom-focused PD alongside teacher colleagues is perhaps more significant in this regard. Principals certainly do need to master the whole-school picture of what needs to be done, but they should always be guided in how to achieve this by an intimate knowledge of the realities of teaching Mathematics each day – whether this be grappling with resource deficits, inadequate teacher content and/or pedagogical knowledge, the challenges of differentiation, poor whole-school planning or low motivation levels among pupils. Ultimately, the "bright line" (ibid, p.332) between teaching and administration is damaging. Ng et al. develop an analogy of empowerment: "the principal is a conductor of processes of instructional innovation rather than its composer or business manager" (2015, p.392). May and Suppovitz (2011) further urge principals to involve themselves in the particular. They argue that "principals who focus on the improvement of particular teachers in conjunction with broader approaches can produce greater changes in instructional practice" (ibid, p.332). Although gains may be small and seemingly insignificant in such approaches, the same authors continue: "principals' instructional leadership efforts may yield only small changes in practice for an entire faculty, but they may yield large changes in practice for a subset of the school's faculty" (ibid, p.348). Katterfeld (2013) does offer some solace to over-worked and over-stretched principals - it is neither uncommon nor damaging for principal leaders to rely on the instructional competence of his/her teaching colleagues. The ability to ensure an agreed and clearly articulated vision of what achievement in Mathematics looks like is perhaps the most critical of the principal's instructional functions. Equally encouraging, Ng et al. note: "it can be inferred from the literature that instructional leadership does not require that the principal be a model or exemplary teacher" (2015, p.392). Therefore, it behoves the school principal to consider the expertise that may lie among their teaching colleagues, and the potential for teacher leadership in particular areas of whole-school responsibility.

2.4.3 Teacher Leadership

Traditionally the thinking around teacher leadership tended to define its raison d'être in terms of the principal's understandable need to delegate duties to colleagues, and simply lessen his/her own burden. Whilst this is an undeniable (and important) benefit of the approach, it somewhat downplays the other stand-alone positive possibilities that such proactive delegation can deliver. Under the urgings of key thinkers in the field, such as Gronn (1999; 2003), the notion of concentrating complete and absolute leadership of a school, including everyone in it and all of their activities, in the hands of one person is an utterly unsustainable and damaging fallacy. Such thinking is now typically consigned to the most peripheral fringes of mainstream leadership theory.

Modern schooling requires the "development of broader and deeper leadership resources" (Heck and Hallinger, 2010, p.881). This realisation has given rise to a proliferation of alternative teacher-leadership constructs. Whilst it is neither new nor particularly surprising that teacher leadership can play a hugely positive, contributory part in the overall management apparatus of effective schools, the sheer weight of support for this claim does warrant consideration - Riley and McBeath, 2003; Matthews and Sammons, 2005; Leithwood and Beatty, 2007; Leithwood et al., 2008 to cite but a few. Yow and Lotter fan the flames further by noting the strong "connections between teacher leadership and student learning" (2016, p.343), a significant claim undoubtedly. Despite the innovation, enlightenment and modernity that is often implied in any description of teacher leadership, Firestone and Martinez are unequivocal in their assertion: "the idea of teacher leadership is not new" (2007, p.5). Furthermore, in spite of this supposed longevity that they assert, the same authors add "there is little consensus on what it should mean". Harris and Muijs (2005) oblige by providing a relatively uncontested view that teacher leadership involves influencing one's peers without holding any formal authority over them. This reinforces the obvious juxtaposition with the formal authority that principal leadership entails. On foot of this, it becomes critically important to query what unique strengths and opportunities such leadership offers.

Jorgensen lauds such middle leaders' ability to "bridge the gap between (the) vision of the school leadership team and the practices enacted in the classroom" (2016, p.32). This assertion aptly captures a recurring theme in the literature – by virtue of their teaching duties, and the fact that they are personally involved in, and bound by, any policies they devise or programmes they enact, teacher-leaders hold a unique credibility among their colleagues. This idea of "having skin in the game", due to their own teaching role, affords such leaders a particular kind of respect from their peers. Their colleagues feel comforted by the teacher-leader's ability to face a professional challenge with the teachers' perspective firmly in mind. This is somewhat reminiscent of Olson's "humble (teacher-) leader" who "listens to their colleagues and builds professional relationships through respect" (2004, p.3). Stakeholders in the leadership space (policy makers, support services, teacher unions and other leadership think-tanks) have directed their efforts at generalising the professional characteristics of effective teacher-leaders - they too recognise the value of this credibility factor. Chief amongst these features they have identified are the fostering of a collaborative culture among colleagues, the promotion and delivery of bespoke localised PD, the exploitation of a sound research base to improve school-wide practice, the building home-school links, and, strategic advocacy for the profession and its individual, local members (Teacher Leadership Exploratory Consortium, 2011).

Higgins and Bonne (2011) note that PD models have incrementally supported this shift towards teacher leadership – where their role among colleagues is seen as a vital "means of maintaining the impetus of the reform in the school". Yow and Lotter (2016) further proffer that engagement with, and participation in PD is often the unintended, yet nonetheless important gateway for emergent leaders to get a taste of what this role might entail. In a mathematics-specific context, Hopkins et al. describe the teacher-leader as a "central actor and broker of advice and information about Mathematics within…schools" (2013, p.200). Similarly, Jorgensen lauds the middle leader's ability to play "a key role in the development of successful numeracy practices in schools" (2016, p.32). The literature's response to the specific questions of what are the required skills of mathematics leadership, and how leaders can promote strong mathematics cultures in schools, is teased out in the upcoming sub-section 2.5.2.

Ultimately, interactions between teacher-leader and colleague are (and must remain) non-evaluative, typically taking the "sounding board" format, and rarely characterised by deference on one side and dictation on the other. Liberman and Miller (1999; 2004) similarly argue that investment in teacher leadership empowers teachers to take charge of whole-school instructional improvement. Self-evidently the more staff that prioritise school-wide improvement, the better it is for the long-term sustainability of any programme of instructional change and improvement. Olson gets more into the nitty-gritty by identifying three essential components of the work of the teacher-leader: "to redirect conversations around student thinking, create environments of sustained professional inquiry, and offer PD for colleagues" (2004, p.1). Once again, such an explicit expression of specific colleague-facing duties does seem to indicate that the dynamic surrounding teacher leadership may in some way make this model more palatable to teachers, when compared to the formal authority of the principal.

In terms of overlap between principal and teacher leadership, it is interesting to note findings of Ai Chew and Andrews (2010) demonstrating the high priority that school principals actually place on the selection and nurturing of teacher-leaders, with particular responsibility for pedagogy. This clearly harkens to Leithwood et al.'s (1999) explicit urgings to develop the (leadership) capacity of people within one's own organisation. It can therefore be inferred that teacher leadership does not simply "just happen". It is dependent on how enabling and distributed the leadership culture is. Sometimes thwarted by internal power struggles and insecurity of authority, it must be understood that the real catalyst for teacher leadership often comes from the principal in the first instance. However, such emerging leaders need a myriad of supports and influences: "teacher-leaders must be developed to support the growth of teachers and the implementation of mathematics reform" (Olson, 2004, p.1). Appropriate and specialised expertise in the specific curricular area (see Yow and Lotter, 2016), perhaps an additional, relevant qualification, on-going PD (as heavily emphasised by Shin and Slater, 2010), collegiate networks, external advice and assistance, and perhaps, a certain standing among colleagues, would all seem as reasonable demands for the teacher-leader. Adequate release time from teaching duties in order to fulfil the high expectations of the role, right up to full-time coordination duties, is a noticeable feature of most schools within the U.S. and British systems (see Millett and Johnson, 2000). Such accommodations may well be a source of envy to Irish teacher-leaders who must struggle to complete their work between lessons, or at the end of the school day. Unsurprisingly in this context, Zinn's "over-whelmed" leader (1997, p.11) who struggles to balance their teaching and leadership duties, is a widely recognised phenomenon in the literature. One can only gaze enviously at the North American mathematics teacher-leaders profiled in Hopkins et al. (2013), when they describe the access to colleagues and their classrooms which were afforded following the re-designation of their leadership roles to full-time, mathematics-exclusive positions.

Such leadership is not without its challenges. Dilemmas of authority abound – ultimately, the dual currencies that the teacher-leader trades on are collegiality and professional expertise (see Bennett et al. (2007) in the case of the latter). It is therefore counter-intuitive for them to have to assert any overt authority over colleagues, however unresponsive fellow teachers may be (to the point of obstruction). One can legitimately ask then to what extent is the response of the teacher-leader to apathy, or perhaps defiance from their peers, limited by their lack of "real" power. Furthermore, does this authority deficit have an impact on how other teachers distinguish their obligation or otherwise to respond to the coaxing of a peer? Hargreaves' "emotional geographies of schools" theory (2001; 2008) further warns the mid-ranking, teacher-leader that surface-level, visible co-operation from colleagues may only serve to mask suppressed dissatisfaction. He goes on to explain that local political considerations may prevent colleagues from critically engaging with teacher-leaders for fear of disagreement, and ensuing professional or personal conflict. An additional danger clearly exists that the teacher-leader may be perceived as a proxy for the principal, who simply does not have the skills or the inclination to make a decisive intervention. This may have negative consequences for staff cohesion, the soft authority of the teacher-leader, and for any meaningful school improvement. U.S. research highlights the deflating, and ultimately damaging, consequences that emerge from a perceived lack of collegiate support for the teacher-leader (Zinn, 1997), which can result in role dissatisfaction, anxiety and ultimately withdrawal from the position. Similarly challenging, and not unlike the professional rebirth that new principals often endure, Olson questions the capacity of teacher-leaders to transition "from living their professional lives within the walls of their classroom, to enlarging it as they assume leadership responsibilities" (2004, p.1). Responsibility for one's own classroom is now elevated to a much broader whole-school plane where the pitfalls of management and leadership are quickly evident. It is quite possible that the curricular and pedagogical reasons that initially attracted the teacher-leader to the role, may be inadequate to cope with the complexities of school management and leadership.

With these complexities in mind, and the undoubted burden that the role represents for the singular school principal or individual teacher-leader, it is little surprise that more collaborative structures have emerged as alternative leadership constructs.

2.4.4 The Rise of Collaborative Structures

Spillane (2015) is unequivocal that true instructional leadership, in what it hopes to achieve on a school-wide basis, and how it goes about achieving it using the collective effort, is an inherently social phenomenon. This dynamic is immediately apparent in collaborative or committee leadership constructs. Given the taxing nature of specifically leading the teaching, learning and promotion of Mathematics within a school, often by teachers who are also carrying heavy teaching loads, or by principals who are frequently overwhelmed by the sheer administrative burden of their office, it is unsurprising that variations of shared or committee structures have started to become evident (see Heck and Hallinger, 2010; Jita, 2010). Although far from the only description of shared leadership in the literature, Seashore Louis et al. assist with a working definition that resonates with the interpretation put forward by this research: "shared leadership is defined as teachers' influence over, and participation in school-wide decisions" (2010, p.318), typically through some collective structure. Jita sees merit in the collaborative synergy that is typical of the committee model. In his study, he noted that "more successful schools tend to distribute their work among teams of leaders…they did not rely on a single leader or an exceptional leader" (2010, p.853). His rationale is simple, yet powerful: different individuals bring different experiences, knowledge and skills to leadership, and this collective can often generate a greater benefit than the sum of its parts. In a complex discipline such as leadership of Mathematics, where the demands vary from inherently mathematical, to pedagogical, to logistical and on to administrative, it would seem prudent (and ultimately more sustainable) to assemble a committed group that are best positioned to meet these varied requirements. Hallinger and Heck provide more encouragement: "collaborative school leadership can positively impact student learning in reading and Math through building the school's capacity for academic improvement" (2010, p.95).

There is no "one size fits all" approach to the composition of such a grouping, and the membership of the principal is neither noticeably rare, nor a constant feature across various school systems. Understandably, the mathematics coordinator (if such a role/title exists) typically acts as the convenor and chairperson of the group, and generally maintains the connection between the committee and the more formal management/leadership structures of the school (see Nazareno, 2013). In support of this role, Leithwood et al. remind us that even in a committee of equals, individual leadership is required: "some hierarchy is unavoidable and necessary in a large organisation" (2007, p.57). Time to meet, and when in the day this might happen, also presents challenges for hard-pressed schools (see Vale et al., 2010). Heck and Hallinger also envisage that "networks of informal faculty relationships" (2014, p.659) may serve as embryonic collaborative structures which may ultimately develop into what we might more laterally consider as subject area committees. The informality of such steering committees can often be an important attraction for staff members who, it must be recalled, typically volunteer for such work. Vale et al. (2010) speak about the formation of teacher "communities" where clusters of colleagues with a common interest organically develop from seemingly casual and routine professional conversations. Such informal groupings also require logistical assistance and school-wide profile in order to develop into a more defined and impactful structure. In this way, they are very much dependent on the culture of the school as set down by the principal. The collaborative dynamic has particular key requirements in order to survive: "developing trust is an important ingredient for successful collaboration and collegial reflection and review" (Vale et al., 2010, p.65). Capturing and then maintaining such an elusive, rewarding dynamic is certainly the substance of real leadership (see Tschannen-Moran and Greis, 2015).

Nazareno uses an example from her personal experiences of the involvement of every teacher on staff in at least one "decision-making team" (2013, p.51). This immediately has empowering, yet democratic overtones, reminiscent of the Organisation for Economic Co-operation and Development's (OECD, 2007) urgings to all teachers to embrace leadership (at whatever level) as part of their typical work. Nazareno (2013) further details that the regularity of team meetings, and the frank sharing of ideas without reference to seniority or status of colleagues, can develop an action-oriented approach that aims to respond to the direct experiences of teachers at the chalk face. The parameters of the committee's work are guided by the mission and vision of the school, which all staff have fed into. Jita delves deeper into the profile of those "players" involved in such collaborative committees: "players range from those in positions of formal leadership within the schools to those whose leadership does not accrue from being in formal position of leadership" (2010, p.852). Inherent in Jita's critique is the suspicion that on occasion those with ambitions of formal leadership may involve themselves in such committee work as a means to enhance their "visibility" among colleagues, and indeed to learn from more experienced and formal school leaders. He continues to describe the ultimate motivation of participants "(to) have an impact on how leadership for the improvement of Mathematics is constructed and practised" (ibid, p.852). Lamb sees a professional-agency dividend emanating from such collaborations: "various members of the school community …are free to develop a shared vision and discern appropriate action" (2010, p.35). Surely this intimate involvement in vision creation and policy formation will lead to broader teacher buy-in at the implementation phase. Pounder (1999) envisages other less obvious but equally valuable, positive outcomes from such collaboration – a reduction in professional teacher isolation, and an enhanced commitment to the common good. This can only bode well for overall school (and staff) effectiveness.

Given the variety and uniqueness of leadership constructs for Mathematics, and indeed other curricular areas, it is now prudent to explore the enactment of such structures within the Irish school system.

2.4.5 Time for Innovation – The Irish Context

Historically within the Irish education system, the responsibility for, and enactment of school leadership (in all its facets) was seen as the sole preserve of the all-powerful school principal (OECD, 2007). Indeed, citing Fadden (2015), Lárusdóttir and O'Connor's characterisation of our system as "a very clear hierarchical chain of command … with the principal controlling the work" (2017, p.426) is not out of kilter with other prominent, international commentary on the topic (Harris, 2013; 2014). Stynes and McNamara (2019), in their insightful depiction of the working lives of Irish primary principals, further reinforce the disproportionate dependence of the everyday functioning of the school on the shoulders of the individual principal. Although there may be debate about the best approach to subject-specific leadership, with advantages and limitations attached to all the options laid out above, there can be no doubt that innovative approaches to all aspects of school leadership will be required for the future. The introduction and proliferation of formal and remunerated middle management grades within Irish primary and post-primary schools in the mid-1990's was a momentous development. Yet for many, it represents a lost opportunity for real and progressive distribution of leadership among teachers (see Hislop, 2015; Lárusdóttir and O'Connor, 2017). The later authors provide ample evidence of the professional frustration of middle and other teacher-leaders who believe that their roles continue to be dominated by logistical and/or administrative duties, to the exclusion of any real opportunities to influence the teaching and learning agenda of their schools.

Other independent observers query how such limited zones of management (masquerading as leadership) can really impact on the school to any impactful degree (OECD, 2007). Ireland's recently established CSL do not lay the full blame for this imbalance at the door of understandably overly-cautious school principals. Rather, they encourage a broader, more collective buy-in: "as well as teachers, those with posts of responsibility and year heads (need to) understand their (own) leadership role" (2018, p.53). The OECD, somewhat optimistically suggests that "leadership … is part of every teacher's work" (2007, p.69). An admission by Ireland's chief school inspector in 2015 is also revealing as an explanation for the current situation: "we have not invested significantly in the PD and growth of our principals and school leaders in the past" (Hislop, 2015, p.8). When these factors are combined with swingeing austerity-era cuts in school management structures, it is little wonder that the Irish system is not getting the full benefit of its school leaders, whether formal or informal.

Notwithstanding the typically traditional focus of middle management positions on the exclusive performance of management duties, we now find ourselves at a time where the need to meaningfully share the leadership burden has seldom been more pressing. The DES' Action Plan for Education 2016 – 2019 bluntly expresses the need to "change the leadership and middle management structure and the functions carried out in schools by the holders of posts of responsibility" (2016, p.36). In a sequenced choreography, subsequent DES circulars (2017b, 2018a) have each made good on the Action Plan's aspirations. These directives are underpinned by a welcomed recognition that what constitutes school leadership (including subject-specific leadership) is rapidly evolving, having long since surpassed solely traditional formal roles of principal, deputy principal and other promoted positions. The leadership potential of the entire staff, they state, must be harnessed and it is the role of the principal and the (formal) senior management team to enhance not only their own personal skillsets, but also to build the required capacity in teachers - "empower staff to take on and carry out leadership roles" (2017b, p.5). Even prior to this official democratisation of school leadership, external evaluations of the Irish system were making favourable observations: "Many teachers, outside of the post of responsibility structure, now play leadership roles in relation to programme coordination … or curriculum development at primary level" (OECD, 2007, p.66). The same report notes the price that must be paid for such a culture of leading: "empowering teacher leadership often requires principal teachers to reconceptualise their role, devolving power and autonomy to the teacher" (ibid, p.66). The rollout of the SSE process in primary schools has also helped further broaden the leadership base of individual schools. Anecdotally, there is evidence to suggest that some principals have delegated responsibility for one or more of the target areas (such as Numeracy) to teacher-leaders. Other schools, as confirmed through testimonials and exemplar plans on the official SSE website (DES Inspectorate, ND) have responded by establishing representative committees of teachers to spearhead self-auditing and subsequent action for improvement in mathematics teaching and learning, amongst other areas.

While there may be a reluctance on the part of principals to loosen the reins of leadership, other obvious impediments still persist within the Irish context to thwart this plurality of leadership. Time and its availability is one of the primary obstacles. The OECD clearly recognise this, stating their regrettable observation of the Irish school landscape: "the absence of time for performance of (leadership) duties and absence of structured meeting times during the school week" (2007, p.65). Despite the welcome aspirations of the DES, there remains no specific time provision or mandatory, universal programme to provide the required PD and training that implementation of such "new leadership" needs. A dearth of data examining the prevalence of these aforementioned leadership models within the Irish primary-school system is also a concern. Although well-intentioned, a strong fear persists that such school leadership policy is solely based on fanciful assumptions about an idealised leadership capacity in primary schools, without a reliable insight into what is actually happening on the ground, and the existing expertise of those expected to lead.

At this point in the review of the literature, having established the criticality of mathematics-specific leadership, the broad diversity of functions that fall under this leadership role, and the localised and national responses to role creation and enactment, it is now prudent to focus in on the individual leader – the person behind the role. What are the characteristics, the skills, the dispositions that set him/her apart as a leader? Even more critically, what are the additional, possibly specialised competencies that are essential in order to provide effective leadership of the teaching, learning and promotion of Mathematics?

2.5 The Required Skillset

This research is built on a simple premise: the leadership of Mathematics within the primary school is specialised and demanding work. It then follows that in order to execute the role successfully, this calls on a diverse and unique range of high-level aptitudes. For this researcher, Leithwood et al.'s words ring true: "for greatest impact some leadership functions need to be performed by those in particular positions or with special expertise, not just anyone in the organisation" (2007, p.57). This section illustrates the nature of this skillset, ranging from the more generalised leadership competencies, through to a mathematics-specific capacity. An initial discussion of these more generic skills follows.

2.5.1 The General Skills of School Leadership

Gronn (1999) laments our contemporary era of architype leadership, where potential candidates are scrutinised against checklists of over-idealised abilities and skills. Ribbins (2003) equally bemoans such approaches as overly simplistic, thus creating a false "quick-fix" impression of what leadership is, and how it should "always" be enacted. However, there still remains benefit in a recognition of, and familiarity with these “barest distinguishing essentials” (Gronn, 1999, p.12). Leithwood et al. provide encouragement to all pretenders with their insightful assertion: “almost all successful leaders draw on the same repertoire of basic leadership practices” (2008, p.27). Unsurprisingly, an ability to build and promote a shared vision, associated networking, a focus on maximising the potential of the school’s people, a willingness to adapt the organisation to evolving contexts, and a genuine and action-oriented focus on the core teaching and learning activity of the school, all feature prominently on Leithwood et al.’s (2008) recommendations. More critical than these actions or capacities, the authors suggest, is the means through which they are implemented and the extent to which the leader remains sensitive to the context they operate in. The capacity to manage both of these imperatives sets the successful leader apart.

Built on an understanding of the technical, social and moral dimensions of leading, Hart (1992) provides an alternative, yet seminal audit of U.S. leadership-related research in education. This work describes twenty-one core traits that have been identified as characteristics of effective leadership. They span from academic intelligence, through to commonly-accepted interpersonal competencies such as sociability, political nous and alliance-building capacity. There is no obvious reason to believe that such skills would not be required for successful leadership of curricular areas too, including Mathematics at the school level. Given the pre-eminence of Michael Fullan in this field, his recommendation to school leaders to focus on the “development of teachers’ knowledge and skills (and of) professional community” (2002, p.16) warrants strong consideration. It also exemplifies the shift in leadership theory from the simplistic notion of the leader having to master all aspects of the organisation and its work, to a more sustainable model. Such a viable approach is distinguished by leaders who empower, and build the capacity of others to drive the effectiveness agenda. There is also an emotional intelligence demand in order to build and maintain the critical relationships that are necessary for “buy-in”. “Emotionally intelligent leaders are able to build relationships because they are aware of their own emotional makeup and are sensitive and inspiring to others” opines Fullan (ibid, p.18). This is made all the more salient when one considers emerging European research that is making a clear and positive correlation between the emotional intelligence of school leaders and the job satisfaction of teachers, including their receptiveness to engage in reform and change practices (see Taliadorou and Pashiardis, 2015).

Other leadership theory counters that leadership is best characterised by an unrelenting effort to manage tensions - a capacity to strike an equilibrium between competing imperatives, stakeholders and needs, that best allows followers (teachers in this case), systems and organisations to flourish. Day et al. (2001) evoke this by reference to the eternal struggle between school improvement through innovation, and careful consideration of the need to safeguard what already works effectively. In a somewhat complementary manner, Bryman (2004) notes the critical importance of maintaining a realistic and sustainable change agenda as a key component of successful leadership, without the excess of change just for the sake of it. He unpacks this further by noting the need to "secure commitment to the change process", attend to unique local factors throughout, consistently demonstrate the need for change, and "instil a vision of …what the future state of the organisation will look like" (ibid, p.751). Stein and D'Amico provide more simplified, but equally important initial advice to leaders who are spearheading a change agenda: "be aware of what the new reforms are asking teachers to… be able to do; develop understandings of why teachers are experiencing… difficulty and what might assist them" (2000, p.44). For any leader, an intimate knowledge of their school context is crucial - its strengths, it challenges, its people, its organisation. Acting without this "high degree of (local) sensitivity" (Bryman, 2004, p.31), however well-intentioned and strategised, is doomed to failure.

Although often disregarded, or relegated to a lower status than other leadership competencies, the capacity to master the administrative and bureaucratic requirements of any leading position cannot be discounted. In his exploration of the co-existence and intertwining of educational leadership and associated administration, Eacott describes a historical "artificial partitioning" of both fields (2017, p.196). Even at the turn of the last century, Dewey was preaching the need to master the "mechanics of school organisation" (1904, p.22). Given the rapid expansion of the administrative side of leading, as documented internationally (Sorenson et al., 2016) and also in Ireland by Fullan (2006), in conjunction with the Irish Primary Principals' Network (IPPN), it is an aspect of leadership that cannot be ignored.

Whilst this discussion has thus made broad observations about school leadership, the next sub-section focuses in on the specific leadership toolbox that sets the successful mathematics leader apart.

2.5.2 The Skills of Mathematics Leadership

Some of the general skills noted above often have a particular mathematics-specific application. The previously discussed sense of context, and the need for the leader to take cognisance of it in their daily work, is directly applied to Mathematics by Eacott and Holmes: "before a leader can engage in the politics of educational leadership there is a need to be critically aware of the value placed on mathematics education by a diverse range of (local) social groups" (2010, p.91). Bryman's (2004) urging for local sensitivity, and intimate knowledge of one's own setting, strongly resonates here. To this end, it can be proposed that fully knowing the mathematics climate of one's school entails the leader being aware of the administrative and resource capacity available to the subject, whilst holding an appreciation of the standing of Mathematics within the broader school community. Other probable characteristics include demonstrating familiarity with the quantitative and anecdotal data that profiles overall school performance, possessing an ability to analyse what this data is saying about standards, and lastly, but crucially, displaying an intimate knowledge of the "lived experiences" of practitioners and their pupils practicing Mathematics. Eacott and Holmes eloquently summarise this final component: "(regarding) mathematics education reform specifically, leaders need to be fully cognisant of the status quo with regard to mathematics classroom practice" (2010, p.90-91).

Jorgensen (2016), in his study of Australian numeracy leaders, identified two key, complementary characteristics of successful and effective heads: an openness to, and experience of specialist practical training, combined with additional university-based, theoretical study in Mathematics and/or mathematics pedagogy. Whilst it is fair to assume that leadership for each and every curricular area is deserving of such upskilling, the subsequent sub-section below makes a compelling argument as to why this demand may be more acute, and more specialised, in the case of Mathematics. Darling-Hammond et al. posit that "teacher learning and teacher leadership are inseparable" (1995, p. 91). Whilst the literature is somewhat conflicted on whether the leader needs expert knowledge (exceeding that of his/her colleague teachers), Vale et al. (2010) present a strong argument for some degree of mathematical knowledge, skill or specific expertise that are not typical in the regular school environment. They note "the leaders' knowledge of effective mathematics teaching practice enable(s) them to mentor teachers …and to support the practices of professional learning teams within their school" (ibid, p.47). This harkens back to Fullan's (2002) earlier (and more generalised) encouragement that leaders need to prioritise the advancement of PD among their colleagues.

Undoubtedly, the provision of mentoring support and bespoke PD does imply a requirement of specific skills, reinforced by a theoretical knowledge base beyond the norm.

As noted earlier, leadership requires emotional intelligence (Taliadorou and Pashiardis, 2015). The emotionally intelligent mathematics leader not only requires the very particular skills of forging and maintaining relationships with key stakeholders, but they may also be faced with very particular circumstances. In light of recent Irish research which found notable deficits in mathematical competency amongst primary teachers (see Delaney, 2010) and given the long-established prevalence of mathematics-based phobias in the general population (see Burns, 1998; Boaler, 2009), it is likely that a mathematics leader may have to deal with a colleague who is struggling with their own mathematical competency. This colleague may also 'suffer' from a second, associated ailment: namely an anxiety surrounding Mathematics, and a deficit of self-confidence in their personal ability to competently teach the subject. This mathematical apprehension, and its negative manifestations, is detailed by Bekdemir (2009). Given the natural connection between a teacher's attitude towards Mathematics and their arising methodological stance towards teaching the subject, as reinforced by Leavy et al. (2017), responding to acute teacher discomfort around mathematics teaching is an obvious priority for the mathematics leader. In the first instance, before any coaching or mathematics-specific support is offered to such a struggling teacher, the situation demands personal sensitivity and diplomacy that is the hallmark of the emotional intelligent leader (as described in sub-section 2.5.1).

Given the landscape of primary mathematics education in Ireland, it is inevitable that leading change is and will remain a constant demand on school leaders. However, one may rightfully wonder if centrally mandated change (such as what schools in Ireland are now experiencing through SSE), with its high degree of standardisation, will threaten the flexibility and responsiveness that is inherent in Bryman's (2004) aforementioned localised situational awareness. In the case of Ireland's steadily climbing primary school attainment levels in Mathematics, leaders must be able to identify which existing practice is effectively contributing to this upturn, and so deserving of ring-fencing and enhancement. This is somewhat complicated by a contemporary climate in education that ceaselessly demands change and innovation from all schools, not only in mathematics teaching and learning, but also in leadership constructs (see section 2.4).

Yow and Lotter (2016) see a tri-fold alliance of content mastery, pedagogical know-how and leadership capacity in the work of the effective mathematics leader. Once this trio is mastered, it is possible to start influencing the teaching and learning of Mathematics at the school-wide level. The subsequent sub-section will further explore the content and the pedagogical domains that the mathematics leader may be expected to call on most typically.

2.5.3 The Mathematics behind the Role

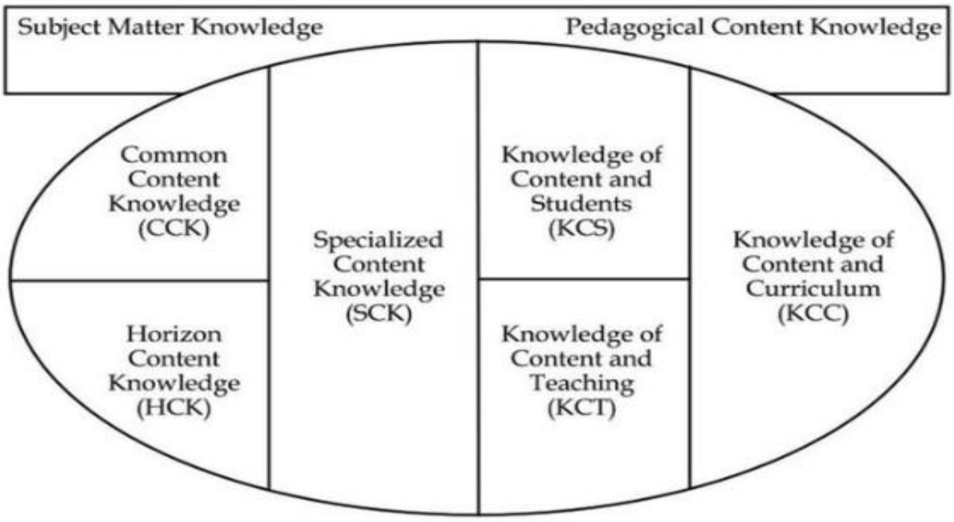
There is merit in starting with the somewhat contrarian standpoint of Fink and Resnick: "(leaders) have to have content knowledge - enough to enable them to judge the teaching they see. But they don't have to be content specialists" (2001, p.600). Whilst this may be more relevant to principal leadership, given its more evaluative remit than is typical of teacher leadership, it does provoke two important questions – how much content knowledge is considered adequate for the mathematics leader, and what types of content knowledge are most crucial? Jorgensen answers, to an extent, by noting a sub-classification of the mathematical knowledge that such leaders require: "strong mathematical content knowledge" and "strong mathematical pedagogical knowledge" (2016, p.34). Whilst the content knowledge implies a strong personal competence in Mathematics, which would be widely accepted as a minimum baseline competency for any teacher or leader involved in the delivery of mathematics instruction, the minutiae of pedagogical content knowledge do require further unpacking.

In the modern era, the renowned educationalist Lee Shulman was one of the first to resurrect a particular interest in the distinctions and sub-competencies of teacher knowledge, a topic which had exercised eminent thinkers like John Dewey during the early 20th century. Spurred on by the cognitive psychology movement of the 1970's that postulated learning (and teaching) as subject-matter specific rather than generic (see Stein and D'Amico, 2000), Shulman proposed "categories of the knowledge base" (1987, p.8) for teaching. These categories included content knowledge, general pedagogical knowledge (broad principles of effective teaching), pedagogical content knowledge, curriculum knowledge (in order to meet societal expectations of what is to be taught in schools), knowledge of learners and other additional insights related to the sociology of the educational enterprise. Whilst generalist in its focus, Shulman's musings needed a subject-specific lens in order to test its applicability. Mathematics was one of the first disciplines to assess this transferability.

Despite embryonic attempts to interweave mathematics-specific content knowledge and pedagogical content knowledge (see Loewenberg Ball and Bass, 2000), it wasn't until a decade later that a more coherent construct was developed. Loewenberg Ball et al.'s (2008) pioneering work on content and pedagogical knowledge found that successful mathematics teaching drew on six core domains of teacher knowledge (see figure 2.2 below). These domains were clearly demarcated by their emphasis on either subject-matter or pedagogy. Mathematical Knowledge for Teaching, or MKT, had been born. This work has informed much of the discourse in modern times on the teaching of Mathematics, and its leadership at the local school level. Accordingly, it provides a critical backdrop to this researcher's key question on how Mathematics is being led in our schools, and the associated sub-question as to what skills and knowledge bases mathematics leaders utilise in their work. Whilst all six domains of MKT are interdependent and are in no way considered superior to the others, three do bear further examination in order to assess how they might inform the capabilities of mathematics leaders. The first domain to be examined is Common Content Knowledge (CCK).

CCK implies a basic mathematical competence that most typically-functioning adults would possess - the ability to complete a calculation, or to recognise a correct or incorrect response to a primary-level mathematics problem. For teachers, it is about knowing the material they teach, akin to professional competency. Therefore, it is an obvious standard for mathematics leaders to meet. As the level of education increases, from junior primary to senior primary and on to second level, so too does the CCK demanded of the teacher and the leader.

Figure 2.2 Domains of Mathematical Knowledge for Teaching



(Loewenberg Ball et al., 2008)

The second domain of particular relevance is Knowledge of Content and Curriculum (KCC). Whilst teachers are not expected to commit reams of curriculum objectives/learning outcomes to memory, there is an anticipation that they are broadly familiar with what the curriculum demands, and how this links in to the curriculum experiences that pupils have had in the past, and the ones they are likely to have in the future. Seeing this big picture, across the school and it various pupil groupings, is a crucial element of the mathematics leader's remit. At a basic delivery level, the curriculum must be enacted, and the leader must ensure that this is being done in a systematic and appropriate manner.

The third key domain directly addresses mathematical pedagogy and its unique nature: Specialised Content Knowledge (SCK). Typical manifestations of this competency include looking for patterns in student errors, evaluating non-standard approaches to calculations, appraising the accuracy and usefulness of various mathematical representations, responding to the "why" questions of pupils, and unpacking key conceptual understandings behind mathematical procedures. Loewenberg Ball et al. note that "teaching requires knowledge beyond that being taught to students" (2008, p.400). Everything beyond this is specialised, hence SCK. It should be noted that some ten years before the publishing of Loewenberg Ball et al.'s theories, Chinese-U.S. mathematics educator Liping Ma (1999) had pre-defined SCK as the ability to not only know how, but also the capacity to say why. This encapsulated a baseline mathematical competency to execute the Mathematics, but also a mathematical knowledge base sufficiently specialised to justify one's teaching approach. Given the emphasis on observing mathematics teaching, offering feedback to teachers (perhaps in a coaching scenario), and delivering bespoke PD as key components in the typical work description of mathematics leaders (as described in section 2.3), it is little wonder that SCK would be considered as a key competency in their professional armoury.

The need for sure-footed mathematics leadership is made even more pressing by the somewhat troubling finding about low levels of MKT among some primary school teachers in Ireland (Delaney, 2010). It is little wonder that this report's author stresses the need for leaders themselves to enhance their own MKT in an effort to begin a localised movement towards higher standards of MKT acquisition among teachers. Of particular relevance here is Leithwood et al.'s (2008) retrospective discourse which indicates that despite lofty intentions and clear encouragement from the literature, there is scant evidence of school leaders personally building staff capacity in mathematical content knowledge which could be described as being professionally useful to colleagues. It is unclear whether this is due to deficits in the leaders own subject-specific knowledge, or other localised obstacles. This pessimism is offset somewhat by examples of best practice from the U.S. where Olson notes the centrality of enhancing pedagogical content knowledge in leadership courses that were ostensibly described as "increasing leadership capacity of elementary school teachers in Mathematics" (2004, p.1). The positive leadership dividend for the participants in this study is manifest. Webel et al. (2017) confirm this pedagogical content focus has broadly proliferated in mathematics leader/specialist training in many North American states. Similarly, Australian mathematics leaders also display a welcomed professional receptiveness to MKT – Sexton and Downton (2014) note a strong expectation among both teachers and leaders that developing one's pedagogical content knowledge is primarily a personal responsibility.

Notwithstanding all of these classroom-based insights, Burch and Spillane (2003) make a relevant observation: "Although much is known about the importance of school leadership and subject-matter knowledge…, there is limited understanding of how these factors interact" (2003, p.119). The same authors do later venture, however, that the broader a leader's subject knowledge, the greater the potential of what they may do to improve instruction. In a similar vein, Stein and D'Amico (2000) note the pivotal influence of the leader's personal experiences of, and expertise in, Mathematics upon their mathematics-specific patterns of leadership. Whilst solid content and pedagogical knowledge does not automatically beget success in the efforts of any mathematics leader, it can be safely assumed that their absence all but guarantees poor outcomes for the leader, their staff and ultimately, the pupils and their experience of Mathematics in the classroom. As an apt summary, Jorgensen notes that the leader "needs to have a strong knowledge of both Mathematics and mathematical pedagogy if the role is to be a viable and productive one" (2016, p.36).

That said, even with such intellectual competencies assured, however supplemented by the skillset required for effective leadership (as described in sub-sections 2.5.1 and 2.5.2), successful subject-specific leadership will always require additional ancillary, logistical and other professional support. The subsequent, final section of this literature examines the broad and varied nature of these crucial supports to lead.

2.6 Supports to lead

As has been proven time and time again in this literature review, leading is a highly complex enterprise which draws on many skills and competencies. This already extensive demand is clearly intensified in the case of mathematics leadership, given its critical importance to schools, and the subject's own particular features (see sub-sections 2.5.2 and 2.5.3). In this context, it is obvious to assume that the local leadership structure must have access to an array of supports in order to successfully execute the role, thus positively impacting the teaching, learning and promotion of the subject. This section outlines three of the most critical conditions/supports, in both the international and the Irish context, for mathematics leaders: adequate time to fulfil the role; the PD backing to enact best practice, and finally, the availability of bespoke frameworks to guide (and delineate) the crucial work of the mathematics leader. The examination of all three now follows.

2.6.1 Position and Opportunity

Although it might seem an obvious point to begin with, the funding of a dedicated mathematics leadership role itself (whether full or part-time) is an important official recognition of the criticality of the work. Jorgensen captures the challenge in many educational systems, including Ireland: “funding such a role is an issue for schools as this role is surplus to the usual funding models … in other (countries), there is no specific or targeted funding for the role” (2016, p.35). Ring-fenced release time and budget to perform one’s mathematics leadership duties (as is typical in large swathes of British, U.S. and Australian primary schools - as per sections 2.3 and 2.4) should be considered as the minimum standard. Once again the Irish system presents a paradox – only since 2017 have the DES explicitly specified that the duties attached to promotional posts within schools should be completed “outside of the standard school day” (2017b, p.17). Prior to this, it was unclear when such additional duties were being carried out. A related point bears consideration - in the absence of release time during the working day, mathematics leaders may only be turning to their duties when their colleagues’ working day has ended, a time when their peers are under no obligation to be on site. This presents obvious limitations to peer observation, mentoring, and other “real time” professional conversations about mathematics teaching and learning. One could also speculate about the ethical merits of having unpaid volunteers, who according to the INTO (2020) are stepping into such leadership/coordinating positions in their droves, remain after school in order to fulfil a function that ultimately they are unpaid for, and could step away from without notice. Indeed, in terms of the time that can be reasonably allocated to the role, the sustainability of principal leadership of Mathematics, or indeed any other curricular leadership, is equally troubled. Principal advocates are repeatedly expressing concern about role overload, lack of administrative and other basic supports that comparably sized private sector businesses take for granted (Cottrell, 2014). A continuation of this spiral is likely to lead to a more reactive leadership style that simply lacks any element of the direction and tactical nous that is needed to steer Mathematics within an already pressurised school system.

2.6.2 Ongoing PD

Access to additional and ongoing PD is another critical support:

> *“It was important for (the mathematics leader) to also access professional learning so as to expand their repertoire and be better able to support teachers and inform the leadership team of innovations and research in quality practice in mathematics education.”* (Jorgensen, 2016, p. 35)

Targets set in place by Ireland’s DES some nine years ago mandated teacher education agencies to provide PD to school leaders that built familiarity with “effective approaches to the teaching of Numeracy (including numeracy development within disciplines and across the curriculum)" (DES, 2011, p.40). This description gives the impression of a more teacher/classroom-focused training, rather than provision that targets the leadership of mathematics teaching and learning in its own right. Whilst the offerings of education centres across Ireland are typically full with a broad range of promising mathematics courses that are aimed at improving delivery in the classroom, leadership-specific mathematics options are conspicuous by their absence. An audit of the "Teacher Summer Course Handbook" for 2018 and 2019 (DES, 2018b; 2019a) revealed no dedicated mathematics leadership education offerings. In an international context, although isolated instances decrying the lack of adequate PD to mathematics leaders are evident (see Lamb, 2010, as an example), the literature is stacked with studies describing best-practice in this domain (see Fink and Resnick, 2001; Olson, 2004; Firestone and Martinez, 2007; Hopkins et al., 2013; Akiba et al., 2015; Yow and Lotter, 2016). Given the insights of sub-sections 2.5.2 and 2.5.3, it is obvious that strengthening the mathematical pedagogical content knowledge and the mathematical subject-matter knowledge of such leaders is a crucial component of any upskilling. Online platforms are also an option to enhance these required knowledge bases (see Webel et al., 2017). Akiba et al. note the importance of leaders leaning on "outside experts" (2015, p.257) in order to address their own deficits. Others characterise such interaction as an informal habit of simply pitching an idea or a query to a fellow practitioner in the hope of constructive feedback (Jorgensen, 2016). Although not a support available to all, Ferucci (1996) and Hopkins et al. (2013) consider the benefits of creating links with local universities as a means of exposing leaders principally (but other teaching staff also) to cutting edge, research-driven initiatives in Mathematics.

In a related vein, whilst the Irish post-graduate landscape caters very well for further studies in leadership, and to an increasing degree for mathematics education, both exist within their own silos. A crossover hybrid of the two has yet to emerge. It is quite likely that such an offering would be highly attractive to mathematics leaders nationwide. For now, we can only look enviously at post-graduate programmes such as the "Leading Mathematics across the School" offered by some Australian universities (specifically The University of Melbourne), along with similar provision in the U.K and North America. Their bespoke modules, addressing the complexities of subject-specific leadership in Mathematics, must present a tempting prospect to Ireland's school leaders.

Structured opportunities to network with fellow leaders is another crucial aspect of PD. Akin to Vale et al.'s "communities of practice" (2010, p.52), the ensuing professional conversations of these networks often facilitates a beneficial deconstruction of one's mathematical context, whilst still availing of an impartial opinion. Regular gatherings of such leaders also has other system-wide dividends. For example, in many districts of New York state, "monthly principals' conferences are the primary vehicles for developing and building allegiance to the shared professional point of view of the district" (Fink and Resnick, 2001, p.601). Bush and Glover (2014) also identify the need to not solely concentrate on the Mathematics of the role, but to also consider the development of an applicable leadership skillset that will arm participants with the tools to enact the subject-specific goals they have set. Olson references other more generalised leadership competencies such as familiarity with the design principles for in-house PD, and deep "understanding (of) the change process" (2004, p.4). Vale et al. describe mathematics leadership courses that courageously abandoned Mathematics, and instead focused on modules in "analysis and strategic use of data, leading professional conversations and leading the school community in promoting a vision of the future" (2010, p.59). When it comes to such a broad conceptualisation of what leading Mathematics entails, one can infer that preparation and on-going support of mathematics leaders in Ireland has a considerable journey to make. Yow and Lotter's summation must surely be the goal: "effective PD should be situated within the practice of teaching, build teachers' (and leaders') content knowledge, immerse them in inquiry experiences, address beliefs, involve collaborative communities and provide long-term support" (2016, p.326).

2.6.3 Guiding Frameworks

Whilst acknowledging the critical importance of understanding one's context and the need to sometimes spontaneously respond to what this localised environment might give rise to (see Bush and Glover, 2014), there is also a growing exploitation by mathematics leaders internationally of the guidance of explicit (typically centrally mandated, but occasionally voluntary) professional charters. Such frameworks of best-practice serve a useful function in strategically steering the work of the mathematics leader. This guidance is not just on a day-to-day basis, but also as leaders look to the establishment of a successful, long-lasting culture of mathematics teaching and learning in their school (see Yow and Lotter, 2016). Whilst not seeking to standardise the work of all leaders, nor to distil it down to an over-simplified "How To" guidebook, such documents can provide worthwhile stimuli for mathematics leaders to reflect upon the "principles, indicators and actions" that are most crucially aligned to successful mathematics leadership (NCSM, 2008, p.xi). Stein and D'Amico (2000) reference the need for such direction in order to help focus the leader on what is really important in his/her mathematical context.

Whilst the initial publishing and subsequent updating of the inspectorate's quality framework for primary schools in Ireland (DES Inspectorate, 2003; 2016) does provide a welcome instrument for more sustainable improvement processes across general school leadership and management, the guidelines are not intended to provide subject-particular prompts or benchmarks. As currently constituted, these guidelines lack the specificity of focus that effective leadership in Mathematics (or indeed any curricular area) requires. Interestingly, and deserving of commendation, the most recent version of the framework (DES Inspectorate, 2016) does have a more broad-based and democratic vision of school leadership that does seek to move away from traditional, hierarchical roles. However, the generalist focus of the guidance itself is made clear at the very outset: the framework "is designed for teachers and for school leaders to use in implementing the most effective and engaging teaching and learning approaches and in enhancing the quality of leadership in their schools" (2016, p.6). The "Leadership and Management" section of the document does not make one single reference to any specific curricular area, let alone Mathematics. By way of contrast, and based upon their leadership domains of equity, teaching and learning, and curriculum/assessment, NCSM's (2008) aforementioned PRIME Leadership Framework encapsulates a mathematics-specific leadership construct that identifies specific principles, indicators, knowledge and skills for mathematics leaders. The prescribed activities address organisational, mathematical and pedagogical demands. Particular emphasis is laid upon the requirement to "advocate and systematize" (ibid, p.14) good mathematics teaching across the entire school community. This comprehensive set of recommended actions for U.S. leaders of Mathematics also heavily influenced the list of duties that appeared in the study's activity log, which respondents were asked to engage with in an attempt to describe (and quantify) their daily leadership work. More details of the methodological approach used in this study follow in the next chapter.

Alternative, and equally insightful charters for mathematics leaders continue to emerge from the U.S. Barnes and Toncheff, (2016) exploit a useful four-pronged approach to enact the most beneficial, context-sensitive vision of mathematics teaching and learning in schools. Balka et al. (2010) propose a leadership model that straddles curriculum articulation and implementation, promotion and proliferation of effective instructional strategies, observation and feedback, formulation of bespoke PD and the establishment of truly collaborative learning communities. More specifically, a similar publication by the same authors sets out a comprehensive rationale and explicit guidance for mathematics leaders who seek to enhance their coaching ability with colleagues (see Hull et al., 2010).

Whilst one may choose to either agree or disagree with some or all the emphases of these aforementioned frameworks, one cannot deny their value in prompting school leaders to critically self-examine their role. As of yet, the Irish system lacks such specific stimuli to provoke focused reflection and self-evaluation among leaders, or indeed to provide a description of what best practice in mathematics leadership might look like. However, nearby British systems do provide more realistic expectations of what is possible: the aforementioned NCETM in England provide detailed descriptions of the key responsibilities of mathematics leaders, along with useful prompts to begin the formulation (and then activation) of a coherent vision for Mathematics in one's school. E-training modules in the various components provides round-the-clock support to leaders. Detailed case studies of real practitioners working in real schools give additional impact to the content. Comparable to Ireland in terms of the size of its overall education structure, the Welsh system also provides detailed guidance and development opportunities for primary-level mathematics leaders through their curriculum support infrastructure (CfBT Education Trust, 2015).

Although not a stated intention of the DES, the NCCA or the curriculum support services in Ireland, one may legitimately wonder if the forthcoming implementation of a new mathematics curriculum in our primary schools does in fact present the ideal time to consider the formulation of a mathematics-specific leadership framework. Given the demonstrated international example, the encouraging initial success of the DES' rollout of its refined leadership framework and subsequent SSE initiative (proved relatively effective in varying contexts by McNamara and O'Hara, 2012; Mangan, 2014; Ladden, 2015) and the challenging context that the Irish system faces over the coming decade (see sub-section 2.2.4), it is perhaps an opportunity that cannot be forsaken. Both present and upcoming demands and responsibilities upon mathematics leaders have never been so arduous – it stands to reason that the policy makers should make every conceivable effort to support them in their challenging role.

2.7 Summary

This research investigates the enactment of mathematics leadership within Ireland's primary school sector. To tease out this broad aim, the exploration encompasses four contributing sub-strands of inquiry, each of which carry resonance in various sections of the literature review:

- How do primary schools practically respond to the need for mathematics leadership?
- How do individual mathematics leaders conceptualise and enact their role?
- What is the nature of this mathematics leadership work and its associated challenges?
- Which supports do mathematics leaders presently exploit as part of their duties, and what additional, currently unavailable supports would make their role more impactful and professionally sustainable?

The current chapter provides a context for the investigation, and familiarises the reader with the current standing of mathematics leadership within the Irish and broader international educational landscape. Initially, a reprise of the literature supporting the widely accepted positive impact of effective leadership upon the micro-school environment was essential. Multiple direct and indirect references to the findings of respected international researchers such as Michael Fullan, Philip Hallinger, Ronald Heck, Karin Katterfeld, Kenneth Leithwood and James Spillane all offered weight to this assumption. Next an examination of the catalogued work that mathematics leaders typically engage in was essential. This section helped illuminate the curricular, pedagogical and organisational dimensions of the role, and the heavy burden that this three-pronged construct entails.

The subsequent section set out the practical arrangements that some national systems (and individual schools) have sought to put in place to respond to the need for localised mathematics leadership – the juxtapositions between principal-led, teacher-led and more collective arrangements provided a useful context that directly fed into the researcher's methodological choices.

Overall, this review of the literature has clearly established a fundamental truth - mathematics leadership is a demanding and complex enterprise. By presenting a detailed examination of the general skills of school leadership, and the more specialised skillset that is required by mathematics leadership, this understanding is further secured. The chapter's scrutiny of the Mathematics that is both implicit and explicit in the role is particularly instructive. With a nod towards possible recommendations that are likely to emerge from this piece of research, the review concludes with a survey of the supports that are currently available to leaders of Mathematics in Ireland's primary schools. Whilst patchy, they do represent a basis upon which more impactful measures can be based.

With the context of the key research question firmly established, it is now timely to turn to the researcher's rationalised strategy which was utilised to answer his queries. The subsequent methodology chapter begins with a reprise of the key research paradigms, and progresses to assert the researcher's inquiry orientation. The practical considerations and decisions that flowed from this alignment are described in concise detail.

Chapter Three: Research Design

3.1 Introduction

This methodology chapter comprehensively details the multi-step research process put in place by the researcher in order to answer his overarching question: how is mathematics leadership being enacted in Irish primary schools? The chapter begins by setting out the fundamental assumptions about knowledge, reality and values that underpinned the researcher's overall approach, which thus gave rise to his rationalised and considered research design. Based upon this, the resultant mode of inquiry which was implemented and its relevant data collection instrumentation and procedures are detailed. The particular features of the sampling plan for the project are also clearly identified. Complementing this detail, presentation of the four-phase data-analysis process forms a crucial component of this chapter. The key ethical considerations that informed the research design, and most importantly guided the actions of the researcher whilst in the field and beyond, are described in detail. Finally, to conclude the chapter, the limitations of this research project are delineated.

Given the need to lay solid defensible foundations for the project and its rationale, it is prudent to begin by positioning the researcher's orientation within the landscape of research methods.

3.2 Research Paradigms

Slife and Williams (1995) wryly observe that despite their considerable influence, philosophical ideas often remain hidden and unseen within research. This section addresses this lacuna by foregrounding the researcher's metaphysical orientation. It provides a clear understanding of what is commonly understood as a research paradigm. It also details the broad, core assumptions that contributed to shaping the researchers' choice of research paradigm, and hence position it within the pragmatic research tradition.

3.2.1 Paradigm as Worldview

Creswell succinctly describes research design as "the intersection of philosophy, strategies of inquiry, and specific methods" (2009, p.5). Strategies for inquiry and specific methods will be examined in the forthcoming sections of this chapter. The present section and its related sub-sections concentrate on the project's underpinning rationale.

Both Creswell (2013) and Mertens (2003) draw a clear parallel between one's philosophy or worldview and one's choice of research paradigm. Elsewhere, Creswell notes how one's "discipline orientation", one's "research community" (advisors and mentors) and one's "past research experiences" (2018, p.7) all exert considerable influence on the shaping of the researcher's worldview. This notion of a research paradigm being an all-encompassing way of seeing the world, thus informing and guiding the pursuit of knowledge about its phenomena, is supported by many (Creswell, 2009: Cohen et al., 2011). Guba sees it as "a basic set of beliefs that guide action" (1990, p.17). Greene and Caracelli posit that paradigms ultimately are "social constructions… (which are) highly mutable and dynamic" (2003, p.98). The researcher can be reassured that as their assumptions about reality, values and knowledge change, so too can their preferred research paradigm(s). In surveying the dominant contemporary research paradigms, ranging from the positivist, deductive and confirmatory tradition to constructivist, inductive and exploratory conventions, Johnson and Onwuegbuzie help add a more practical perspective when they equate a paradigm to "a research culture" (2004, p.24), with all the practices and traditions that this entails.

3.2.2 Core Assumptions

Greene and Caracelli (2003) propose that assumptions about the social world, social knowledge and the purpose of science in society, form the basis of philosophical paradigms. Teddlie and Tashakkori further delineate the three core components of a research paradigm: "ontology refers to the nature of reality, epistemology refers to the relationship of the knower and the known, and axiology refers to the role of values in inquiry" (2003, p.45). Importantly, it is also asserted that ontological assumptions act as a catalyst for epistemological perspectives, which when combined with value-based judgements, help inform the methodological decisions of the researcher (Cohen et al., 2011). It is now prudent to examine these three vital and inter-related philosophical dynamics.

3.2.2.1 Ontological Assumptions

Originating from the Latin term "ontologia" meaning the "science of being", ontological concerns essentially pivot on the nature of reality, and what we understand as the true essence of existence – "the principle of pure being" (Wellington et al., 2005, p.100). The positivist view proposes a single reality, "tangible and fragmentable" (Teddlie and Tashakkori, 2009, p.86).

Its adherents see reality as "objective, out there (and) independent of the researcher" (Creswell, 1994, p.4), and therefore accessible and measurable by use of survey or some other comparable unbiased instrument. The opposing naturalist paradigm suggests multiple realities, constructed in light of specific situations and circumstances. Wellington et al. suggest that these resulting realities are "socially constructed, subjectively experienced and the result of human thought" (2005, p.100).

Both aforementioned orientations, the positivist standpoint and its contrasting naturalist perspective, give rise to two substantially differing data classifications. Both of these categories will feature heavily in the remainder of this chapter, so it is important to set a clear distinction between the pair at this juncture. With its origins in the empiricism that is evident in the hard sciences, quantitative methods generate data which can be "counted, measured and expressed using numbers" (Pickell, 2019), often through various statistical techniques. Rumsey (2019, chp. 2) describes quantitative data as "numerical" and continues by noting its capacity to "record measurements or counts". Commonly used quantitative research instruments include tests, experiments and surveys. O'Dwyer and Bernauer are unequivocal in the quantitative researcher's quest for impartiality: "quantitative research aims to minimize the attachment between the investigator and participants and to quarantine the values of the researcher as much as possible" (2014, p.47). It is this philosophy that guides the use of overtly objective data-collection methods, and the rigorous application of various statistical/mathematical techniques to the data in the hope of finding patterns (and some degree of meaning). The opposing qualitative approach "implies that the data (is) in the form of words as opposed to numbers" (Rudestam and Newton, 2001, p.36). Rumsey (2019, chp. 2) describes qualitative data as "categorical" and further notes its capacity to "record qualities or characteristics about the individual". A large array of sources are utilised to generate qualitative data, including textual documents, various forms of recordings, interviews and observations. It is understood that the researcher and the object of study have an inevitably closer relationship within the qualitative paradigm. During the subsequent analysis process, qualitative data is typically "reduced to themes or categories and evaluated subjectively" (Rudestam and Newton, 2001, p.36). This contrasts decisively with the descriptive or inferential statistical options that are available to the quantitative researcher when embarking upon data analysis. Despite the seemingly clear lines of demarcation between both approaches, it is important to note that there is growing evidence of overlap in the use of once-traditionally quantitative-only methods by quantitative researchers, and vice versa (See Denzen and Lincoln, 1998). Such examples of both philosophical and methodological flexibility did influence the researcher in his ultimate choice of data collection methods for this piece of research. These methods will be described in more substantial detail in subsequent sub-sections of this chapter.

The core line of inquiry of this research drew from both positivist and naturalist traditions. By asking participants to record and classify the work that they engaged in as part of their mathematics leadership role, and inviting respondents to do so within the highly structured and standardised activity log template, one could reasonably expect a revealing quantitative data set to emerge. This data was further complemented by the opportunity for the participants to also qualitatively record their thoughts and personal feelings at the end of each logging day. The resulting predominantly quantitative data, complete with frequencies and a raft of other ancillary information, can justifiably be offered as a fair and objective representation, within the confines of this research, of the actuality of mathematics leadership in Irish primary schools today. As such, this data set had a strong positivist basis. Morais posits that such aggregated findings signify “a single apprehensible reality” (2010, p.841) owing to the objective and scientific nature of the data collection process, and instrumentation used.

However, by qualitatively delving in to the everyday challenges experienced by these individuals through the specific use of semi-structured interviews (at a later stage in the project), in an attempt to garner the essence of their daily work, multiple and differing realities of experience emerged. No hierarchy was contemplated, with a more naturalistic sense of the research enveloping the work where each respondent’s reality was as valid, authentic and real as the others. This resulting data base could best be characterised by what Creswell describes as a “reality (that) is subjective and multiple as seen by participants in a study” (1994, p.5). Within these realities, and their interpretation, the epistemological assumptions of the researcher were also pivotal.

3.2.2.2 Epistemological Assumptions

Creswell muses “what is the relationship of the researcher to that researched?” (ibid, p.5) The positivist tradition proposes a clear distinction at the core of its epistemological assumptions: “knower and known are independent” (Teddlie and Tashakkori, 2009, p.86). Unsurprisingly, the opposing constructivist paradigm emphasises the inseparable and interactive relationship that must exist between the researcher and their subject. As expected, both these perspectives were reflected in the distinct lines of inquiry at the core of this dissertation.

In quantitatively establishing the range of mathematics leadership models within Irish primary schools, the professional characteristics of those involved, and the frequency with which these individuals engaged in particular duties associated with their leadership role, the consistent use of standardised research instruments kept the respondent and researcher at arm's length from each other. This allowed for "hard, objective and tangible" knowledge to emerge (Cohen et al., 2011, p.6).

However, to access the lived experiences of leading the teaching, learning and promotion of Mathematics and all the challenges that this entails, a more intimate, up-close and progressively reactive form of investigation was warranted. The elicitation techniques that were part and parcel of the interviewing phase of this study, enabled the researcher to engage each respondent in a manner that best facilitated the emergence of their "personal, subjective and unique" story (Cohen et al., 2011, p.6). It also allowed the researcher to respond in a more personalised manner to the narrative being told. In straddling both the positivist and constructivist traditions, this researcher conformed to Creswell's response to his own question as set out at the opening of this sub-section: "(the) researcher interacts with that being researched" (1994, p.5). Having established this relationship, it is prudent to assess the role of values within the orientation of the researcher, and how they were accounted for within the research process.

3.2.2.3 Axiological Assumptions

Axiological assumptions relate to values, the role of value judgements in research and how their influence can be understood, and possibly offset if necessary. Creswell notes the constructivist standpoint: "the inquirers admit the value-laden nature of the study and actively report their values and biases" (2013, p.20). This transparency also applies to the "value-laden" nature of data gathered in the field. Such an approach contrasts sharply with the "value-free" positivist perspective which argues that the scientific rigor implicit in its approach provides the required objectivity to neutralise any trace of bias, or researcher-principle (see Philips and Burbules, 2000).

Given this researcher's previous personal experience of, and interest in, school-based curriculum leadership for the last twenty years, it was inevitable that personal values, beliefs and experiences should come in to play. Fundamentally, by formulating a research question centring on the leadership of Mathematics in the primary school system, the researcher made a significant statement of personal interest and priority. A preferred research orientation has also been revealed. This demands acknowledgement. However, such considerations rightfully did not become a source of excessive concern or distraction, and in no way did they detract from the initial impulse to examine this worthwhile phenomena (see Teddlie and Tashakkori, 2009). Irrespective of the researcher's personal interest in the topic, the review of the literature lent significant weight to the need to examine the leadership of Mathematics within the primary school system in Ireland. It is also important to note that the researcher's insider perspective is delineated and accounted throughout this dissertation. Such demarcation further fortified the researcher's extensive efforts to ensure reliability, validity and high ethical standards within the research design (see sections 3.8 and 3.9 for further detail).

3.2.3 Pragmatic Research Paradigm

Given the trio of ontological, epistemological and axiological considerations unique to this research piece, a pragmatic paradigm emerged as the best fit for the research approach as elucidated below. Originating towards the end of the 19th century, and initially pioneered by American philosopher Charles Sander Peirce, pragmatism is a worldview steeped in common sense, unashamedly geared towards functionality, and uniquely focused on consequence of an action/phenomenon as the pathway to its true appreciation (see Garrison, 1994; Maxcy, 2003). It represents a compromise between the opposing positivist and constructivist traditions: "the project of pragmatism has been to find a middle ground between philosophical dogmatisms…to find a workable solution" (Johnson and Onwuegbuzie, 2004, p.18). Greene further expands this conciliatory dynamic noting the pragmatist as being "between realism and constructivism as ways of knowing, or between objectivity and subjectivity as stances of the inquirer" (2008, p.10). Its utilitarian emphasis on "doing what works" in order to best answer the research question is comforting, and somewhat liberating to the researcher. As a case in point, this researcher's choice of activity log provided an obvious manifestation of this functionality. Given the insurmountable logistical burden of participant observation, it was felt that the activity log would enable the researcher to faithfully capture the daily work of the mathematics leaders. This could be done without any degree of intrusion or the need to physically accompany the participants for every moment of the logging periods. The utilisation of two logging windows during the school year was a further pragmatic response by the researcher to capture the nature of mathematics leadership across the school year, given the impossibility of extending the logging window for the full year itself. The face-to-face administration of the questionnaire/profiler also demonstrated a practical bent in the approach of the researcher. Being physically present when the participant completed the profiling instrument ensured greater compliance, allowed the partaker an opportunity to seek clarifications if needed, and enabled the researcher to provide the participant with detail (and instructions) for subsequent phases of the research project.

Cherryholmes provides further encouragement in the researcher's quest to reclaim control of his/her enterprise: "Pragmatic choices about what to research and how to go about it are conditioned by where we want to go in the broadest of senses" (1992, p.13). Pragmatism's rejection of the futile either/or debate between positivist and constructivist approaches (see Teddlie and Tashakkori, 2009) and its ambivalence towards "frames, platforms and other worked out in advance templates of beliefs" (Maxcy, 2003, p.76) hold obvious attractions to doctoral students. Such student-researchers are understandably more preoccupied with the practicalities of research design and implementation, and less constrained by age-old and increasingly irrelevant paradigmatic affinities.

Pragmatism is not without its detractors, consequently this elicits a strong defence. Citing support from Denscombe (2008), Cohen et al. strongly dismiss the charge that pragmatism is an "anything goes, sloppy, unprincipled approach" (2011, p.23). Their observation goes on to emphasise the rigor inherent in the approach, and its unwavering focus on the research question to hand. Dating back to the paradigm wars of the 1980's, the "compatibility thesis" (Teddlie and Tahakkori, 2009, p.15) further questions the reconcilability of contrasting positivist and interpretative epistemological frameworks within the one research design - a design that exploits both traditionally quantitative and qualitative research instruments either sequentially or simultaneously. However, the proliferation, and success, of pragmatic research is in itself a contradiction of this thesis (Creswell, 2009). Johnson and Onwuegbuzie express discomfort at the fact that many researchers come to pragmatism seeking "a way to get around many traditional and ethical disputes" (2004, p.19). The implication of pragmatism being used (and possibly abused) as a convenient cloak of respectability for a multitude of design solutions, sometimes justifiably so and sometimes not, merits reflection. Ironically, pragmatism's near-universal appeal, and the temptation this brings, may threaten its hard earned status.

Undoubtedly, the pragmatic standpoint offers a methodological expanse: “pragmatism opens the door to multiple methods…as well as different forms of data collection and analysis” (Creswell, 2009, p.11). This diversity of method will form the cornerstone of the next section.

3.3 Research Methodology

This section makes a strong connection between the pragmatic research paradigm and mixed-methods research design. The mixed-methods approach is detailed, and is critiqued in light of contemporary commentary.

3.3.1 Mixed-Methods Research

Greene posits that “pragmatism is a leading contender for the philosophical champion of the mixed-methods arena” (2008, p.8). Lying between positivism, and its typically associated use of quantitative methods on the one hand, and constructivism, defined by its qualitative approaches on the other, Greene (ibid) reinforces her thesis by noting the ability of mixed methods to see, hear and make sense of the social world from a multiplicity of standpoints. This variety of approach is often required by increasingly complex and multi-pronged research questions that simultaneously demand generality and particularity, neutrality and advocacy, objectivity and subjectivity (Greene, 2008). Teddlie and Tashakkori assert that mixed methods represent a synthesis: “a type of research design in which qualitative and quantitative approaches are mixed across the stages of a study” (2006, p.16). Creswell warns against an overly simplistic view that reduces mixed-methods research to singularly collecting and analysing both types of data, without any degree of association between the two: “it also (must) involve the use of both approaches in tandem so that the overall strength of a study is greater than either qualitative or quantitative research” (2009, p.4). Writers such as Leech and Onwuegbuzie (2009) have recognised the somewhat vexed issue of where and how such mixing might occur, and have attempted to bring clarity. These mixing options will inform subsequent sections.

3.3.2 Benefits of Mixed-Methods Research

Whilst much of the literature notes the current status of mixed methods as the trending research paradigm of the early decades of the new millennium (see Teddlie and Tashakkori, 2003; Johnson and Onwuegbuzie, 2004), a critical awareness of its specific purpose is necessary. Amongst these purposes, Greene (2008) proposes its facility for triangulation (thus boosting substantiation), complementarity (allowing enhancement of the topic to hand), initiation (allowing the researcher to refine the research focus), development (facilitating the interweaving of research methods traditionally viewed as irreconcilable) and expansion (enabling the enlargement of research activity through polymodal research). All of these functions offered attraction and possibility to this novice mixed-methods researcher.

Most commentary on the advantages of mixed -methods research are based upon the principle of a fusion of methods having obvious superiority over any individual monomethod, whilst simultaneously avoiding the bias and limited perception inherent in that single method (Denscombe, 2008; Leech and Onwuegbuzie, 2009). Yin specifies further when noting the ability of mixed-methods research to specifically address complicated research questions through the generation of a “richer and stronger array of evidence” (2009, p.63). Greene and Caracelli conclude that such a variety of evidence (premised on a philosophical and methodological flexibility) facilitate more “ways of knowing toward better understanding” (2003, p.97). Other contributors laud its inferential ability to simultaneously both endorse and explore within one single research design (Teddlie and Tashakkori, 2003). Given the complex nature of this project’s core research question, and its dual aim to not only classify and quantify the work of mathematics leaders, but also to interrogate their views about the very nature of this work, the capacity of mixed-methods research to confirm and also to probe mathematics leadership became even more enticing. Essentially, it provided the ideal platform to analyse the varied and layered nature of mathematical leadership though the mixed-method lens of participant questionnaires/profilers, activity logs and semi-structured interviews.

3.3.3 Criticisms of Mixed-Methods Research

Given its broad remit and its multi-pronged nature, the obvious temporal and human-resource demands of managing any mixed-methods research project can be considerable (Teddlie and Tashakkori, 2003). This is of particular relevance for a time-bound piece of doctoral research, and for its researcher who must display competence across a wide range of research tools within a compressed time scale. Although dismissed in a previous section of this dissertation, concerns surrounding the compatibility of seemingly opposing paradigms are also evident in the methodological arena of mixed methods (Teddlie and Tashakkori, 2003; 2009). Cohen et al. speculate that perhaps in mixing different methods, one conspires to "dilute and adulterate" their singularly unique strengths (2011, p.26). Potentially, this could have led the researcher to fall between two stools, and ultimately fail to respond to the requirements of the research question. This possibility was somewhat offset by the researcher's successful, although small-scale exploitation of open-ended questioning within the largely quantitative activity log instrument. Both formats sat comfortably alongside each other, thus providing a pragmatic and convenient outlet for participants to simultaneously record both their activity, and their thoughts and reactions, within the one instrument.

In response to concerns about the need for overarching standards for mixed-methods research, which perhaps have their roots in an uninformed view of pragmatism as disordered, and unprincipled, Chen (2006) and Johnson et al. (2007) reassure by detailing recent advances in standards development and typology structures for enhanced validity within mixed-methods research. For example, Chen's (2006, p.80) strategy of "contextual overlaying" (to give depth to description and analysis by use of triangulated data from multiple, yet differing research instruments) provided welcome guidance to the researcher. This is particularly evident in section 3.7 which describes how the initial quantitative logging data helped lay contextual understandings that facilitated a clearer emergence of themes from the interview transcripts.

With a firmly anchored mixed-methods research approach chosen, this chapter will now move on to discuss the specific mode of inquiry that best suited the overarching research question concerning the enactment of primary school mathematics leadership.

3.4 Research Mode

Undoubtedly, this dissertation's overarching research question, focused as it was on leadership of primary-level Mathematics, was multi-layered and consequentially, it could not be adequately answered by simply one research method or instrument. Somewhat akin to Creswell and Tashakkori's (2007, p.207) "what and how" compound inquiry model, the project was best suited to a mixed-methods approach. This need for methodological heterogeneity is the very manifestation of Johnson and Onwuegbuzie's "workable solution" (2004, p.16), echoing the core pragmatic maxim of prioritising the research question itself, and how best it can be responded to. It was proposed that the case-study mode best allowed for this required methodological pluralism, facilitating as it does a range of research instrumentation, yet within a tried-and-tested framework that facilitates the depth of inquiry that the research question calls for. This sub-section will forensically examine the case-study mode, assess its merits and its limitations, and crucially detail the accompanying and varied research instruments that it encompassed in this study.

3.4.1 Case-Study Mode

By way of a useful starting point, Van der Ham tersely suggests that a case study is "an analysis of (a)…real-life situation or event" (2016, p.1). Similar to all other research methods, case study is ultimately oriented to answer specific research questions as comprehensively as possible (Gillham, 2000). As the question changes, so too does the nature of the case study and how it is operationalised. However, full appreciation of this mode demands additional unpicking of its core principles.

Reflecting the relatively recent evolution and expansion of case-study research, and an associated growth in the complexity of phenomena it examines, Yin (2009) proposes that any definition of case study must include reference to the scope of the inquiry, alongside its more technical features. The scope refers to a realisation that the phenomenon under scrutiny can only be understood in its "important contextual conditions" (ibid, p.18), not in isolation. In light of this, the technical requirements of the research process encompassed justifiable data collection and analysis procedures that flowed from a pre-developed theoretical perspective. For example, the considered and rationalised selection and subsequent utilisation of questionnaires/profilers, activity logs and semi-structured interviews as the project's preferred data collection instruments is detailed in section 3.6. Although more simplistic in his analysis, Creswell makes a useful contribution: "case studies are a strategy of inquiry in which the researcher explores in depth…one or more individuals (etc.)…using a variety of data collection procedures" (2009, p.13). This span of research instrumentation within the case-study approach is further vaunted by Yin: "case study's unique strength is its ability to deal with a full variety of evidence – documents, artefacts, interviews, and observations" (2009, p.11). Given this study's desire to examine and contrast different models of mathematics leadership in primary schools, the chosen multiple-case design with its three-pronged instrumentation strategy sought to guarantee this variety of focus, but with sufficient depth and perspective per participant to reveal significant findings. Byrne sees case study as a vehicle to move beyond a "destructive tradition in the social sciences that have set quantitative and qualitative modes of exploration, interpretation and explanation against each other" (2009, p.9). This presented an attractive option given the researcher's underlying philosophical and methodological orientation, as discussed earlier.

Yin notes that "the more that your questions seek to explain some present circumstance (the "how and why"), the more that the case-study method will be relevant" (2009, p.4). Similarly, this piece of research aimed to examine mathematics leadership within the "present circumstances" of each leader, in their own school setting. Such depth of inquiry is a theory supported by Creswell (2013). Answering these difficult "how and why" questions becomes a more viable enterprise via case study. Stake (1995) reinforces this idea of case study as a suitable mode to study certain particularisations. Whilst the generation of, and ability to handle, an extensive amount of data from a multitude of sources had obvious benefits for the researcher, it also reinforces a significant ability of case-study research to examine contemporary events in real time, and from as many different angles as possible (Yin, 2009). This allows the same author to conclude that case study "allows investigators to maintain the holistic and meaningful characteristics of real-life events" (ibid, p.4). There is also a universal acceptance by all commentators that although case studies are bound by time and their unique context, the period of inquiry must be sustained if it is to yield significant insight. Finally, as initially hypothesised by Adelman et al. (1980), and later articulated by Cohen et al.: "case studies are a step to action"; they are action-focused in their choice of subject, and aim for findings that may be "directly interpreted and put to use" (2011, p.292). In conclusion, one could say that case studies not only seek to chronicle, but also to impact upon the real world.

3.4.2 Criticisms of Case-Study Mode

Yin (2009) makes a strong case in re-categorising some of the criticisms of case-study research. He claims they are borne of ignorance - by-products of the relatively less frequent use of the mode by the broader research community, in comparison to other better-established approaches. Charges of sloppiness and a laissez-faire attitude towards recognised research procedures are nothing new, however the use of more traditional methods within the case-study format have helped bring a greater degree of consistency and standardisation (Yin, 2009). Denigration of case study's generalisability can also be somewhat countered by a realisation that case-study research does not strive to generalise for large groups or populations, but rather it seeks to draw parallels to theoretical arguments: "case study does not represent a sample" (Yin, 2009, p.15). In concurring, Stake notes "case-study research is not sampling research" (1995, p.4).

Whilst the variety of mixed-method sources used to generate data is an undoubted strength of this approach, it also places a heavy logistical and expertise burden on the researcher. The skillset required is broad, and is often underestimated by novice researchers who may find that "case studies take too long, resulting in massive, unreadable documents" (Yin, 2009, p.15). Finally, Nisbet and Watt's (1984) warning of case study's susceptibility to observer bias is valid, and is acknowledged by this researcher (see section 3.9). Their caveat builds upon long-established and heavily-supported recommendations by Becker (1958), amongst others, to comprehensively understand the particular phenomena from as many perspectives as possible, even when contradictory towards each other. An openness to contrarian findings is a crucial bulwark as the case study (and its analysis) enters its most critical phases. Notwithstanding these considerations, it is necessary to establish a clear working definition of what the core elements of a case study constitute – a case and a unit.

3.4.3 What is a Case? What is a Unit?

A clear definition of what a case encompasses is an essential preliminary understanding: Gillham suggests "a unit of human activity embedded in the real world" (2000, p.1). Harvey's analogy of a unit as a "one-of-a-kind" (2009, p.20) strongly resonates with the unique nature of what this specific situation or event represents in the real world, and what it can reveal to the researcher. Based on these understandings, it can be inferred that the unit may represent a smaller part of a larger case such as in this research – the overarching case represented a particular model of leadership, whilst the units per case were represented by individual leaders. Of Ragin and Beckers's (1992) iconic case-classification model, this researcher was most drawn to an understanding of unit as "found" – "presumptively real, social entities not unlike other natural phenomena given to experience" (Harvey, 2009, p.20). Therein lay the attraction in looking at the minutiae of a single, unique environment/individual. Gillham provides further methodological room for manoeuvre – "you can also (simultaneously) study multiple cases (units): a number of single parents; several schools; two different professions" (2000, p.1). This abundant structure, which examines five models of mathematics leadership, with each model being represented by at least one leader participant, was clearly evident in the researcher's chosen approach.

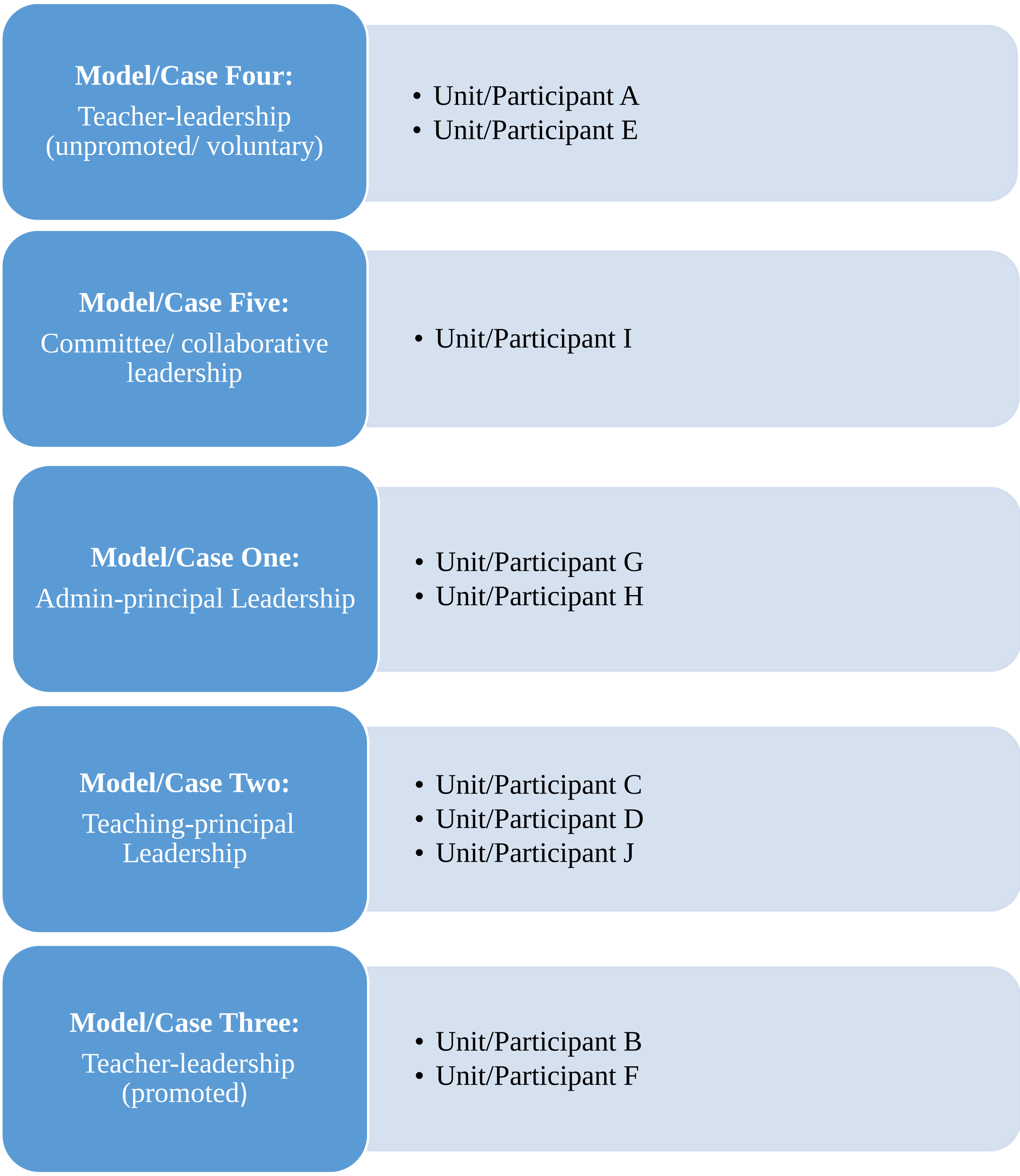
3.4.4 Multiple-Case Design with Multiple Units

Following careful deliberation, an approximation of Yin's "multiple-case design" (2009, p.46) was selected as the best fit for this project (see figure 3.1). The five recognised models of mathematics school leadership (administrative principal alone, teaching principal alone, teacher-leader with an assigned middle management role, teacher-leader with no formal middle management role (volunteer), and committee/collaborative structure) were each represented by at least one unit (or individual participant). Each model signified a distinct case for analysis.

This design could also be considered as "holistic" (ibid, p.50) given that it sought to investigate only one specific aspect of each leader's work, i.e. their leadership of Mathematics. However, the researcher was cognisant that this was merely a lone, isolated aspect in the myriad of emphases and actions that form part of the enactment of school leadership, in its broadest sense, by these individuals. In the busy professional lives of the participants, competing demands and arising situations (frequently unanticipated) often played a decisive role in determining the amount and quality of their mathematics leadership work. This becomes even more crystallised by the fact that six of the participants were principal teachers, thus ensuring a broad suite of critical, additional responsibilities beyond their mathematics role. Therefore, it is misleading to simply isolate and forensically examine one facet of isolation without due regard for the broader context. The researcher's approach was heavily influenced by Yin, originating as it does "from prior hypothesising of different types of conditions and the desire to have subgroups of cases covering each type" (ibid, p.59). These types of models/cases directly related back to the career experiences of the researcher and more significantly, to the earlier review of the literature. The review clearly established the enactment of principal-controlled, middle management-led, and, other committee-forms of school leadership across a range of jurisdictions. This was an important manifestation of the impact of contemporary research on the researcher's methodological decisions.

The resultant capacity to contrast and compare within and between units and cases, along with the "safety in numbers" that multiple units bring, all bolster the defence of the research design. Of Yin's (ibid) six possible sources of evidence in case study (documentation, records, interviews, direct observations, participant observation and physical artefacts - many of which are also advocated by Stake, 2005), it was decided to exploit documentation (via activity log) and two contrasting interview approaches (the more traditional semi-structured interview alongside a more formalised quasi-questionnaire, profiler format). These specific approaches will be teased out further in the subsequent data collection section.

Figure 3.1 Case-study Design



(Adapted from Yin's (2009, p.46), "Holistic multiple-case design")

3.5 Sampling Methods

At a practical level, Tashakkori and Teddlie define sampling as a means of "selecting units in a manner that maximises the researcher's ability to answer research questions" (2003, p.715). This implies intentional decisions about which units (or individuals) to study from the target population. In an ideal word, the same authors note, where access to the entire target population is assured, sampling procedures would be irrelevant and unnecessary. However, issues of convenience, manageability and cost dictate a rationalised sampling strategy. To raise the stakes further, Cohen et al. note that the overall quality of a piece of research is highly influenced by "the suitability of the sampling strategy that has been adopted" (2011, p.143).

Essentially, the literature indicates two main methods of sampling: probability and purposive approaches. A more detailed synthesis of the same literature designates that probability sampling draws randomly from the broader population, thus facilitating a contingent degree of generalisability "from a subset of the population…to a larger defined population…" (Kemper et al., 2003, p.277). In contrast, the purposive sample consciously selects individual units "because they can purposefully inform an understanding of the research problem and central phenomenon in the study" (Creswell, 2013, p.156). Of particular significance to this study, Babbie (1990) notes the sometimes extremely useful, convenient nature of such purposive sampling. Before elaborating upon the project's approach, it is prudent to note the key considerations that should inform such a plan. Issues of sample size, sample representativeness, access to the sample, ethics, specific sampling strategies to be employed and, the overall efficiency and practicality of the approach, must be carefully deliberated upon in order to create a sampling strategy that is fit for purpose (see Kemper et al., 2003; Teddlie and Tashakkori, 2009; Cohen et al., 2011; Creswell, 2013). These considerations inform the arrangements set out below.

3.5.1 Sampling Plan

Whilst a nationwide, fully representative probability sample of the some three thousand primary schools in the state was (and remains) the most desirable approach to capture the true enactment of mathematics leadership in our primary education system, implementing such a comprehensive sampling approach was deemed impractical. The required financial cost, concerns surrounding participant access, and, overall project manageability within a time-bound doctorate programme were all key limitations for the researcher. Therefore, a more realistic, yet empirically robust alternative was required. Purposive sampling became an obvious option - the fact that it dictates "no clear rules on the size of the sample" (Cohen et al., 2011, p.161) immediately appealed. It's less dogmatic approach to sample generalisability also strengthened its attraction. Moreover, its capacity "to elucidate the particular" (Creswell, 2013, p.157) by empowering the judgement of the researcher to choose the units and cases most likely to comprehensively answer the research question(s), further cemented its credentials. Teddlie and Tashakkori note the imperative to choose "information-rich" (2009, p.173) cases that will provide the maximum yield. In light of Yin's recommendation to have "at least two individual cases (units) within each of the sub-groups" (2009, p.59) in order to have a sufficient quantity of theoretical replications, the researcher complied, and chose to involve two leaders per leadership model for detailed case-study investigation. Typical case sampling ensures that the chosen cases "are the most average or representative" of the particular sub-group (Kemper et al., 2003, p.280), and this imperative bore influence on the researcher. Finally, Stake notes a basic, yet key practical consideration of convenience: "pick cases which are easy to get to and hospitable to (your) inquiry" (1995, p.4). Although somewhat elementary, this was a key concern for the researcher.

Akin to Creswell's (2013, p.119) "single-stage" sampling approach, the researcher primarily exploited known individuals within the primary education sector to directly recruit likely participants, and/or to seek referrals of potential contributors. Given the similarity of this referral strategy to snowball sampling, Noy's telling comment that such sampling "is essentially social" (2008, p.332) strongly resonated, particularly in light of the researcher's initial reliance upon acquaintances, former colleagues and others within his immediate social network. Individuals with a particular background and interest in Mathematics, who held mathematics leadership positions within their schools (principals or others from the middle management strata) and with whom the researcher would have interacted with when working as a school leader, were prioritised.

There was an acute awareness of the potential for researcher bias within this aspect of the sampling approach that initially relied on a social/collegiate network, and also of Diener and Crandall's (1978) recommendation that potentially all uncontrollable biases should be acknowledged and foregrounded. To this end, it is important to note that the initial dependence on known contacts was not exclusive. A *Recruitment Advertisement* (Appendix A) was also issued to all primary school principals in the country via *E-Scéal*, the monthly electronic newsletter of the Irish Primary Principals' Network (of which the researcher is an active and longstanding member). This brief insert, in the October 2018 edition, directed interested parties to a dedicated website that was created to help build awareness of the project: https://leadershipinmathematicsproject2018.wordpress.com/ Along with providing contact details for the researcher, the website contained an overview of the project and its underlying rationale, along with a copy of the *Initial Approach Letter to Schools* (Appendix B). This same letter of invitation was also directly e-mailed to the aforementioned targeted individuals who had been previously identified as possible participants. To the disappointment of the researcher, despite the website attracting a modest number of hits during the months of October and November 2018, this recruitment tool failed to directly recruit any of the final participants.

Importantly, the application of Yin's suggested "operational criteria" (2009, p.91) additionally ensured that eligible candidates fully met the specified criteria and were chosen solely on that basis. Chief amongst such criteria was the obvious stipulation that the participant was the recognised and de facto mathematics leader, or alternatively a key member of the mathematics committee within their school. Notwithstanding the efforts to promote participation, the researcher did not anticipate having a sufficient volume of interest to be overly pernickety in his ultimate choice of participants. As this anticipation did come to pass, Stake's strong assertion did supply some reassurance - "we do not study a case primarily to understand other cases" (1995, p.4). The chosen participants may or may not have been representative, and there were no obvious negative consequence for the project of either orientation. The cases stood in their own particular context, and were documented and analysed as such.

3.5.2 Sample Diversity and Representativeness

In order to maximise the appeal and potential audience for the research, some further "criterion-based selection" (LeCompte and Preissle, 1993, p.69) was desirable. Three of the ten chosen leaders worked in schools located in geographical areas classified as educationally disadvantaged. Such schools are typically categorised as DEIS schools, referring to their participation in the government's social inclusion programme: Delivering Equality of Inclusion in Schools (DEIS). This "proportional stratified" approach (Teddlie and Tashakkori, 2009, p.173) was intended to somewhat exceed the some 19.6% of primary schools nationally that are classified as such (DES, 2017c). Similarly, it was also decided that at least two of the participants would be located in rural schools. It was permissible that one participant school may simultaneously meet both aforementioned criteria (i.e. a disadvantaged school in a rural setting). The specific inclusion of teaching principals as one of the core models of leadership guaranteed that a minimum of at least two smaller schools (of 176 pupils or less) were included as research sites. Given the unique challenges that they face and their outlying potential within the sample, the researcher also determined to include at least one school leader located in a Gaeltacht school, and a further mathematics leader working in a start-up ("developing") school that had been in existence for less than five years. Of the ten leaders, eight were based in county Dublin and as such are classified as urban. The remaining two units were in rural settings in the mid-east and west of the country respectively. Figure 3.2 (below) provides a useful overview of the profile of the ten participants. Given the miscellany of school leaders and their varied locations, the researcher was encouraged by Carden's (2009) proposition that diversity within a multiple-unit design sample is an important feature in strengthening the confidence in any common findings that may emerge. This assertion takes on an added significance when assessing the project's findings, and their implicit reliability, in the subsequent chapter.

Once credible expressions of interest and contact details were received from possible participants, the researcher allocated each leader to one of the project's five particular leadership models, and then continued to seek further participants until all five models were represented, and the specified criterion (as set out above) were met. Despite the considerable efforts of the researcher, only one participant representing the collaborative/shared model of leadership expressed an interest, and ultimately committed to the project. To compensate, and maintain the overall sample at ten, a reserve participant was added to the teaching principal model, thus giving a total of three participants in this case. Over the month of November 2018, the researcher successfully met with each potential participant at their place of work in order to further explain the nature of the project and the likely consequences of participation. Electronic copies of the *Plain Language Statement for Participants* (Appendix C) and the *Informed Consent Form* (Appendix D) were sent to individuals in advance of the meetings. At these face-to-face meetings, hard copies of these documents were utilised as the basis of the discussion. Key details were reviewed, participants were offered multiple opportunities to seek any clarifications deemed necessary, and finally written consent was sought in order to formalise participation. Mutually convenient arrangements were then agreed in order to begin the data collection process with each of the ten leaders.

It is now prudent to turn to the data collection techniques that were exploited with the chosen cohort of participants.

Figure 3.2 Overview of Participants

	Leadership Model for Mathematics	Years of Teaching Experience	School Location	School Size (No. of pupils)	DEIS Status	Developing School Status	Gaeltacht School
Participant A	Teacher Volunteer	6 - 10	Urban	>300	No	No	No
Participant B	Teacher (promoted)	20+	Urban	>300	No	No	No
Participant C	Teaching Principal	11 - 20	Rural	<100*	No	No	No
Participant D	Teaching Principal	11 - 20	Rural	<100*	Yes	No	Yes
Participant E	Teacher Volunteer	11 - 20	Urban	101 – 200*	Yes	No	No
Participant F	Teacher (promoted)	11 - 20	Urban	>300	No	No	No
Participant G	Administrative Principal	11 - 20	Urban	>300	Yes	No	No
Participant H	Administrative Principal	11 - 20	Urban	>300	No	No	No
Participant I	Shared/Committee structure	1 - 5	Urban	>300	No	No	No
Participant J	Teaching Principal	11 - 20	Urban	>300	No	Yes	Yes

(* considered as a "small school" for the purposes of this project

3.6 Data Collection

Reflecting its pragmatic bent, a variety of data collection techniques were exploited during the multi-phase rollout of this project. Its case-study methodology comprised of an initial questionnaire/profiler, a participant activity log and a semi-structured interview, which followed this ordinal sequence over a six-month period from November 2018 to April 2019. This diversity of approach, principally entailing two of Creswell's (2013) basic forms of quantitative and qualitative data collection allowed the researcher to best address his overarching research question: how is the leadership of primary school mathematics being enacted in our schools?

3.6.1 Questionnaire/Profiler

Greene notes that the use of survey-research instruments helps "answer questions about incidence, frequency, and co-occurrence of social phenomena for a given population" (2008, p.9). Creswell concurs, and augments this definition by noting survey design's overall generalisability through its capacity to identify the "attributes of a large population from a small(er) group of individuals" (2009, p.146). This should be seen in light of the small sample that participated in the study, alongside its purposive, largely convenient nature. It is important to take cognisance of Cohen et al.'s (2011) assertion of the time-specific nature of survey-generated data. Given this researcher's stated intention to verify the existence of various models of school-based mathematics leadership, the characteristics of the individuals involved, and the general nature of the work they undertake, it was proposed that a questionnaire/profiler be exploited as the most appropriate initial-stage survey instrument available.

Johnson and Turner explain that a questionnaire is a "self-report data collection instrument", (2003, p.303) typically custom-constructed by the researcher. By exploiting either a closed-response, open-ended or mixed-methods questioning style, its typical response formats include Likert scales, semantic differentials, check-lists and orders of rank (Teddlie and Tashakkori, 2009). Many of the strengths of survey research are mirrored in those specifically associated with questionnaires: time efficiency and speed of turnaround, suitability for individual and group administration, implicit safeguards of anonymity and confidentiality, combined with a capacity to faithfully extract respondent attitudes (Johnson and Turner, 2003; Teddlie and Tashakkori, 2009). Morrison (1993) also posits that survey research generally gathers data which lends itself to statistical and correlational analyses, thus reinforcing its positivist foundations.

The Participant Questionnaire/Profiler (Appendix E) was orally administered to participants in advance of the logging period. Bearing similarities to Patton's "closed quantitative interview" (1980, p.206), the face-to-face encounter enabled the researcher to build a rapport with the participant, which may have helped sustain their participation through the subsequent logging and interview stages. Given its capacity to facilitate the probing of unclear or incomplete responses, the face-to-face meeting also allowed for a more comprehensive and accurate collection of the required data.

In keeping with Johnson and Turner's recommendation, a deliberate combination of "rating scales, rankings (and) semantic differentials" (2003, p.304) were utilised as response formats. Considerations of language (clarity of instructions, precision of question wording, neutrality of statements/questions), overall respondent ease-of-use, along with piloting procedures were informed by best practice in the field (Johnson and Christensen, 2014). Essentially, the researcher aimed to create an extensive profile of each participant – their professional characteristics (teaching experience, relevant PD, self-assessed mathematical competency, self-assessed role-effectiveness etc…), some background data about their school and their initial perceptions of the leadership work that they do, including their overall (and task-specific) effectiveness. Such profile-building can be time-consuming but its completion at the pre-logging interview stage ensured that the post-logging interview schedule could devote more attention to substantial trends and themes of mathematics leadership, rather than being a mere fact-gathering exercise. One further benefit of the face-to-face administration of the questionnaire/profiler was that it also afforded an ideal opportunity to introduce participants to the daily activity log, and to offer personalised instructions for its completion before the second phase of the project.

Piloting of the questionnaire/profiler gave rise to three main lines of feedback. Both trialists were educators, one of whom had extensive experience of research methodologies, the other an experienced teacher educator. Indeed, the same duo offered a critique of all three research instruments during the design/piloting phase. The first element of feedback on the questionnaire/profiler related to the physical size of the document (some fourteen pages in the piloted draft). It was suggested that this was excessive and potentially off-putting for participants. This led to the disposal of some unnecessary questioning (such as seeking the participant's initial teacher education details), and the minimising of unnecessarily large font size and response/comment boxes. This led to a slimmer ten-page long final version. The second strand of feedback related to the trialists urgings to give the participants an outlet to express their feelings (even if negative) towards their leadership role. One of the trialists cautioned that if the format was too restrictive and overly-factual in its approach, this could give an impression that the person behind the role was of no interest to the researcher, thus compromising their willing involvement. With the mantra of "let them vent" ringing in the ears of the researcher, items 18, 22 and 23 were included for this purpose. The items (in differing formats) facilitated participants to self-express their attitude about the level of support they typically receive in their role, and to evaluate (and rationalise) the level of personal satisfaction they derive from their work. Finally, trialists commented favourably upon the use of different question-and-response formats within the profiler, and their capacity to add variety to the completion experience.

3.6.2 Participant Activity Log

Inspired by Spillane and Zuberi's (2009, p.375) "Leadership Daily Practice" (LDP) log, each mathematics-leader participant was asked to complete a log of their mathematics leadership-related activities for a combined, but staggered four-week period during the 2018/19 academic year. Such logging approaches "give…access to events that researchers cannot personally record" (Morrison, 2002, p.309) and more importantly, help overcome "measurement errors associated with one-time surveys" (Camburn et al., 2010, p.708). Practical considerations of restricted release time for the researcher and the risk of unnecessary intrusiveness at the research sites (particularly during the working school day) all contributed to the rejection of observational data collection methods, in favour of the logging approach.

Although more globally discussing the benefits of documentary data sources, Yin lauds the unchanging "stable" nature of the resultant logging data, and the "broad coverage" that it can provide (2009, p.102). The *Participant Activity Log* (Appendix F) contained a standard format that sought identification and description of the mathematics-leadership activity engaged in during each specified school day by the participants. Additionally, it required supplementary detail such as whether activities were planned or spontaneous, the time demand involved, the specific expertise it required and an evaluation of the effectiveness of the intervention. Twelve core duties associated with leading Mathematics were noted as headline prompts for each day.

The literature, as set out in sub-section 2.3.2, and the personal experience of the researcher, were key sources in the formulation of these dozen core duties that were embedded within the log. Harkening back to the range of duties comprehensively documented by Sexton and Downton (2014), it was crucial that the curricular, pedagogical and organisational dimensions of the leadership role were represented within the log. Given the relative novelty of video clubs and "*Lesson Study*" within most non-Japanese school systems (see Murata, 2011), including Ireland, the researcher opted to exclude the delivery of PD by leaders (specifically the facilitation of such video clubs and "*Lesson Study*" teams) from the list of duties.

Piloting of the activity log also indicated that including more than twelve specified duties in the log may have led to an unwieldy and overly demanding document. Suggestions to simplify the wording of the duties, and to minimize the clauses in some of the prompts, were also accepted unreservedly from the piloting phase. Despite a pointed query from the researcher, the trialists did not offer any additional domains of mathematics leadership activity that should be included in the log. Along with the guidance of an extensive trawl of the literature, this bolstered the researcher's confidence that all of the major duties of mathematics leadership were adequately captured in the log. Further feedback on the design of the activity log itself, including the use of colour and other attractive graphics to break up text and to differentiate between the two separate logging windows, were also incorporated.

The specified dozen duties in the activity log were:

1. Curating and/or (re)developing the school plan for Mathematics.
2. Articulating the school's agreed vision for the teaching and learning of Mathematics.
3. Coordinating ongoing school SSE processes in Numeracy.
4. Procuring, organising or distributing resources to teach Mathematics.
5. Informing colleagues of CPD opportunities and other new developments in the area of Mathematics.
6. Promoting the status and importance of Mathematics in the broader school community.
7. Advising and mentoring new colleagues on mathematics-specific teaching, learning and planning issues.
8. Advising and mentoring existing colleagues on mathematics-specific teaching, learning and planning issues.

9. Engaging with external services/providers to enhance the provision of mathematics teaching within the school.
10. Preparing materials for, and/or involvement in the administration of, student mathematics testing/other assessment.
11. Monitoring the standards of mathematics teaching and learning within the school.
12. Seeking and/or utilising the support of parents to enhance the teaching and learning capacity of Mathematics in school and/or at home.

It was intended that a fifteen-minute completion window would be required per logging day. The logging booklet was foreworded with a set of detailed instructions (which had already been communicated in person), contained a reminder of the contact details of the researcher if assistance was required, and further included a glossary of abbreviations that might be useful to speed up log completion (e.g. Prompt C: *Which expertise did you draw on?* OS: *organizational skills*, MC: *mathematical competency*, PK: *pedagogical knowledge*, CK: *curricular knowledge*, MS: *mentoring skills*, FS: *facilitation skills*, AS: *analytical skills*, and CS: *consultation skills*). Participants were offered a daily text message service to remind them of the need to complete the log. Where possible, the researcher took back the logs between logging windows. This primarily ensured safe-keeping of the journals but also allowed for initial analysis of emerging data patterns across participants, along with an opportunity to respond to errors or unforeseen logging difficulties before the second logging window began. Of the five logs returned to the researcher, all were found to be maintained to the required standard with no obvious difficulties in using the given format.

Morrison's (2002) refrain advising clarity of purpose, ease of completion, and sensitivity to context, guided the research design. This aforementioned evaluative element of the activity log (Prompt E: "*Rate your Effectiveness"*) is in keeping with a growing research trend of logging where an interpretive demand (rather than a simply descriptive requirement) is placed upon the participant (see Morrison, 2002). Staying true to the project's pragmatic foundations, the mostly quantitative data that each participant provided in their activity log was further complemented by an option for them to make an unprompted comment/reaction to the day's events. This qualitative facility offered the participant an additional descriptive, interpretive and indeed emotional outlet should they feel so inclined.

Given the fact that such leadership activities may not occur daily, it was anticipated that there would be non-entries for specific days with respondents simply being asked to record this. In undertaking data analysis and interviews, units where logging gaps arose were examined. The "Experience-Sampling Method" (ESM) as advocated by Camburn et al. (2010), with its random recording of events, was deemed unsuitable as the researcher aimed to record all of the mathematics leadership-related activities during the period, not a selection.

Similarly, and although valid, Spillane and Zuberi's assertion that the researcher is best to seek multiple logging points across the school year in an attempt to best capture "seasonal changes in leadership" (2009, p.394) was set aside on logistical grounds. Such a prolonged demand on individuals/schools would likely negatively impact upon willingness to participate. The required time frames of this research and the necessity to sequence the various stages demanded a more pragmatic solution. As a workable compromise, two separate fortnight-long logging windows were arranged. The first logging period began in November 2018 and the second commenced in late January, stretching into February 2019 (see figure 3.4 for methodology timeline). It was intended that the two bouts of logging, when combined, would give a realistic, yet longitudinal picture of the mathematics leader's typical workload across the school year.

For demonstration purposes, Appendix G provides a sample of one day's logging which was taken from one of the participant's activity log.

Whilst praising the capacity of logs to capture contemporary events, Spillane and Zuberi note a limitation: "they are not optimal for capturing how events in the past structure and give meaning to current practice" (2010, p.407). This inadequacy provides a strong rationale for the subsequent follow-up interviews and the enhanced depth that they would provide.

3.6.3 Interviews

Stake provides a compelling rationale for the use of interviews within a multiple-unit case-study structure, such as the one implemented for this study: "the interview is the main road to multiple realities" (1995, p.64). To this end, it was agreed to interview each of the leaders within six weeks of completing their final entry of the second logging period. This proximity was important as it confined the already substantial window of overall participation for those involved, and it helped to maintain their relative recall of the two logging periods. Yin (2009) notes the absolute centrality of interviews in informing the case-study process, whilst Warren similarly identifies the unique capacity of the interviewee to be the "meaning maker" (2001, p.83) behind accompanying data sources.

The *Interview Schedule* (Appendix H) comprised of seven core areas of inquiry, each denoted by a foundation question. The core areas were:

- The mathematical context of the interviewee's school.
- The personal journey to mathematics leadership.
- The core responsibilities of the role.
- Essential competencies for role success.
- Commitment required by the position.
- Available (and idealised) supports for the mathematics leader.
- Overall role satisfaction/frustrations.

The two initial areas of inquiry (local mathematical context and journey to leadership) facilitated a degree of context building and also afforded the interviewee an opportunity to become comfortable within the format, before the more probing component of the interview. The five subsequent domains of inquiry (responsibilities, key competencies, required commitment, essential supports and role satisfaction/frustrations) aimed to stimulate a broad critique of the realities of leading Mathematics within a school. Furthermore, each of these five lines of questioning map directly on to the overarching research questions and its specified sub-strands of inquiry.

Given certain similarities between some of the interview questions and the prompts embedded within the activity log, it was understandable that interviewees drew on experiences from the logging windows in an attempt to express their perspective. The interview format, however, allowed for a degree of probing that the activity log could not, hence its specific utility in this research design. The researcher made a deliberate effort to include a series of personalised questions per interviewee that were based on the data generated solely from his/her own logging. This data included their most or least frequent duty, skills they drew on least/most heavily, noticeable variations between the first and the second logging windows and other outlying or exceptional trends. A sample of this personalised *Logging Data Summary Sheet*, for one of the participants, is demonstrated in figure 3.3 below. This integration of insights gleaned from the activity logs into the formulation of the interview schedule, and the degree of personalisation per participant it afforded, is a very obvious manifestation of Teddlie and Tashakkori's recommended mixing of "qualitative and quantitative approaches (and data)… across the stages of a study" (2006, p.16).

Figure 3.3 Logging Data Summary Sheet

Total Planned:	7
Total Unplanned:	2

Before Contact time:	1
After contact time:	3
During contact time:	4
During break time:	1
During staff meeting/CP:	0

Less than 5 mins:	1
5 - 15 mins:	5
Around 30 mins:	0
Around an hour:	0
More than an hour:	3

Organisational skills:	6
Maths Comp:	0
Pedagogical know:	5
Curricular know:	3
Mentoring skills:	0
Facilitation skills:	2
Analytical skills:	0
Consultation skills:	0
	16

Effective:	7
Somewhat effective:	2
Not effective:	2

	Plean	Vis	SSE	Res	CPD	Status	New	Existing	External	Test	Monitoring	Parents	
Yes	0	1	0	1	1	1	0	0	0	3	0	2	9
No	20	19	20	19	19	19	20	20	20	17	20	18	231

[redacted]

The inclusion of the penultimate area of inquiry in the interview schedule (supports) was very much in response to the lacuna that exists in the Irish context. As illustrated in the review of the literature (section 2.6), supports for mathematics leaders in Irish schools are lacking by international standards. Therefore it is important that this research project ensured that the legitimate demands of mathematics leaders were heard and amplified. It was hoped that the clear articulation of these required supports, ideally to a policy-making audience, would be a legacy of this research.

The interviews took place at the interviewee's place of work, after normal school hours, and typically had a one-hour duration. Interviews were audio recorded on the researcher's mobile phone, before secure transfer to a protected digital storage platform. Issues of consent and data protection will be dealt with in detail in a subsequent section (3.8). Pre-piloting and piloting of the interview schedule was conducted in March 2019. The researcher's informal network of school leader colleagues again assisted in this regard. On foot of the feedback received, a number of the questions were shortened and simplified. It was suggested, for ease of clarity, that "Essential Competencies for Role Success" and "Commitment Required by the Position" be separated into two distinct, independent areas of inquiry within the schedule. This suggestion was accepted. Issues of time-management also emerged during piloting, with one trialist afterwards commenting that some of the seven core areas of inquiry were discussed at length, whilst others were rushed to the extent that they were treated much too superficially. This critique impressed upon the researcher the need to allocate approximately equal time to the seven core areas of inquiry, and to ensure that the time allocated to each core area was monitored (and acted upon) during the course of the live interview.

A semi-structured interview format was exploited. In doing so, this design decision was informed by the work of Gillham (2005) who stipulates the key distinguishing features of this approach. Principally, he identifies the use of the same (seven, in this particular instance) core questions with all respondents, approximately equivalent interview time for all, and use of probes or supplementary questions in order to allow development of the core topic to hand. Whilst the common structure of all the interviews, particularly the foundation questions, facilitated subsequent comparison and analysis, a degree of flexibility when probing helped facilitate "a strong element of discovery" (Gillham, 2005, p.72) of each interviewee's unique experiences and perspective.

Johnson advocates taking advantage of potentially unexpected turns in an interview: “consider following for a while where the informant wants to lead” (2001, p.111). As has been previously detailed, the interview schedule was neither exclusively based upon the activity log nor the logging periods, nor was the interview intended to entail a retrospective of the combined four-week logging period. Whilst the interviewees were free to reference experiences from this period, the various lines of inquiry were not time-bound and did deliberately involve the respondents having to draw on a range of experiences throughout their professional careers. Creswell’s (2009; 2013) repeatedly strong recommendation to adhere to the schedule and to make use of clear and logical procedures in the conducting of the interviews, alongside Johnson and Weller’s (2001, p.491) “elicitation techniques” (such as taxonomic and free-recall elicitation) all helped to further inform the process.

Finally, in keeping with the recommendation of Stake (1995), the researcher kept a personal diary during field work where informal records, random thoughts, observations and ideas were collated. It was felt that such a record may have a potential import at a particular time during the analysis process, or during a post-project review.

With an accumulated data base comprising of ten participant questionnaires/profiles, ten participant logs and ten accompanying hour-long transcribed interviews, the data-analysis process was now ready to commence.

Figure 3.4 Methodology Timeline

Action:	Timescale:
Formulation of research instruments (questionnaire/profiler, interview schedule and participant activity log).	July/August 2018
Dublin City University ethical approval.	September 2018
Piloting and modifying of initial research instruments: questionnaire/profiler and activity log.	September/Early October 2018
Finalisation of sample and fulfilment of consent requirements.	Late October/Early November 2018
Individual meetings with participants to administer questionnaire/profiler, and to distribute activity log and provide instructions for completion.	Mid November 2018
Logging window one.	26th November – 7th December 2018
Review of returned logs.	January 2019
Logging window two.	28th January – 8th February 2019
Compilation and initial analysis of logging data.	February – early March 2019
Piloting and modifying of semi-structured interview schedule.	March 2019
Semi-structured interviews.	Late March – April 2019
Transcription of semi-structured interviews.	April – June 2019

3.7 Data-Analysis Procedures

When it comes to the analysis of any data base, Creswell succinctly describes it as "the process…of making sense out of (data)" (2009, p.183). Although this may seem relatively uncomplicated and eminently achievable, the burden on the researcher is onerous. Basic quantitative and qualitative description of a chosen phenomenon is important, however it is merely a forerunner to Cohen et al.'s other competing aims of data analysis, principally the imperative "to discover patterns…to generate themes…to interpret…" (2011, p.538). All three demands held particular relevance within this study. This section outlines the quantitative and qualitative data-analysis procedures employed by the researcher to achieve this three-fold aim. Its detail is supplemented by further insights that can be found in sections 4.1 and 4.2 of the subsequent findings and analysis chapter.

As a prelude to this discussion, it is necessary to identify and clarify some key statistical terms and understandings that underpin the study's proposed analyses processes.

3.7.1 An Overview of Statistical Analyses

Rumsey (2019) reminds us that statistics are not just about analysing data, but rather they are "about the whole process of using the scientific method to answer questions and make decisions" (chp.9). This sweeping objective reinforces the imperative for the researcher to hold a broad understanding of statistical methods, and to display an ability to choose the most appropriate statistical techniques (in light of the harvested data) that best answer the research question to hand.

It is widely accepted that there are two main forms of statistics, each with their own set of accompanying analyses methods: descriptive statistics and inferential statistics (Rudestam and Newton, 2001). Both are commonly exploited in data-analysis processes, and no hierarchy between the two is implied. Each serve a distinct, yet important complementary function in helping the researcher to extract pattern and meaning from the data.

Put simply by Cohen et al. descriptive methods help to "describe" (2011, p.622) what is happening in the sample. Mertler (2016) notes that descriptive methods "simply (study) the phenomenon of interest as it exists naturally, no attempt is made to manipulate the individuals, conditions or events" (p.111). Within the descriptive domain, various numerical measures can be calculated (through fixed mathematical procedures) which then may be utilised to illustrate key features of the data set to hand. The chief sub-categories of descriptive methods include measures of central tendency (such as the mean, median and the mode), measures of spread (such as the range, variance and the standard deviation) and skewness (see Frost, 2019).

Descriptive methods hold a common organisational benefit for researcher and the consumer of the data as they summarise the data itself, and therefore allow for headline findings and patterns to become more evident. This would be considerably more difficult were the full set of data simply presented in a raw, dis-organised fashion. Crucially, descriptive statistics do not attempt to enable the researcher to make judgements, or to reach conclusions, beyond the data. It does not seek to apply its patterns or suppositions to a larger population. Such descriptive methods simply present as detailed a picture as is possible of the sample, as captured in time by the research instruments.

On the other hand, inferential statistics allow for generalisations to be extracted from a sample of a defined population. These abstractions can then be applied to that larger population. Allua and Bagley Thompson (2009) succinctly summarise: “inferential statistics are calculated with the purpose of generalising the findings from a sample to the entire population of interest” (p.168). Understandably, logistical constraints (such as time, access and funding) typically prevent researchers from examining each member of a given population. However, analysis of the findings from a representative sample, drawn from the larger target population, often can carry significance for that wider cohort. As a preliminary and crucial step in the process, Allua and Bagley Thompson (2009) emphasise the dependence of inferential statistical accuracy upon “appropriate sampling methods to ensure maximal representation of the population of interest” (p.168). Inferential statistics typically identify variables (characteristics) among the sample and then analyse the relationships between these variables in an effort to make informed predictions about how these same characteristics might apply to the larger population (see Mertler, 2016). Goos and Meintrup (2015) sound a note of caution to the researcher: “one can never make statements with (absolute) certainty about the population” (p.6). In order to offset this valid, if problematic acknowledgement, the same authors proceed to emphasise the necessity of using “statistically valid methods” (p.6) when collecting the data from the sample.

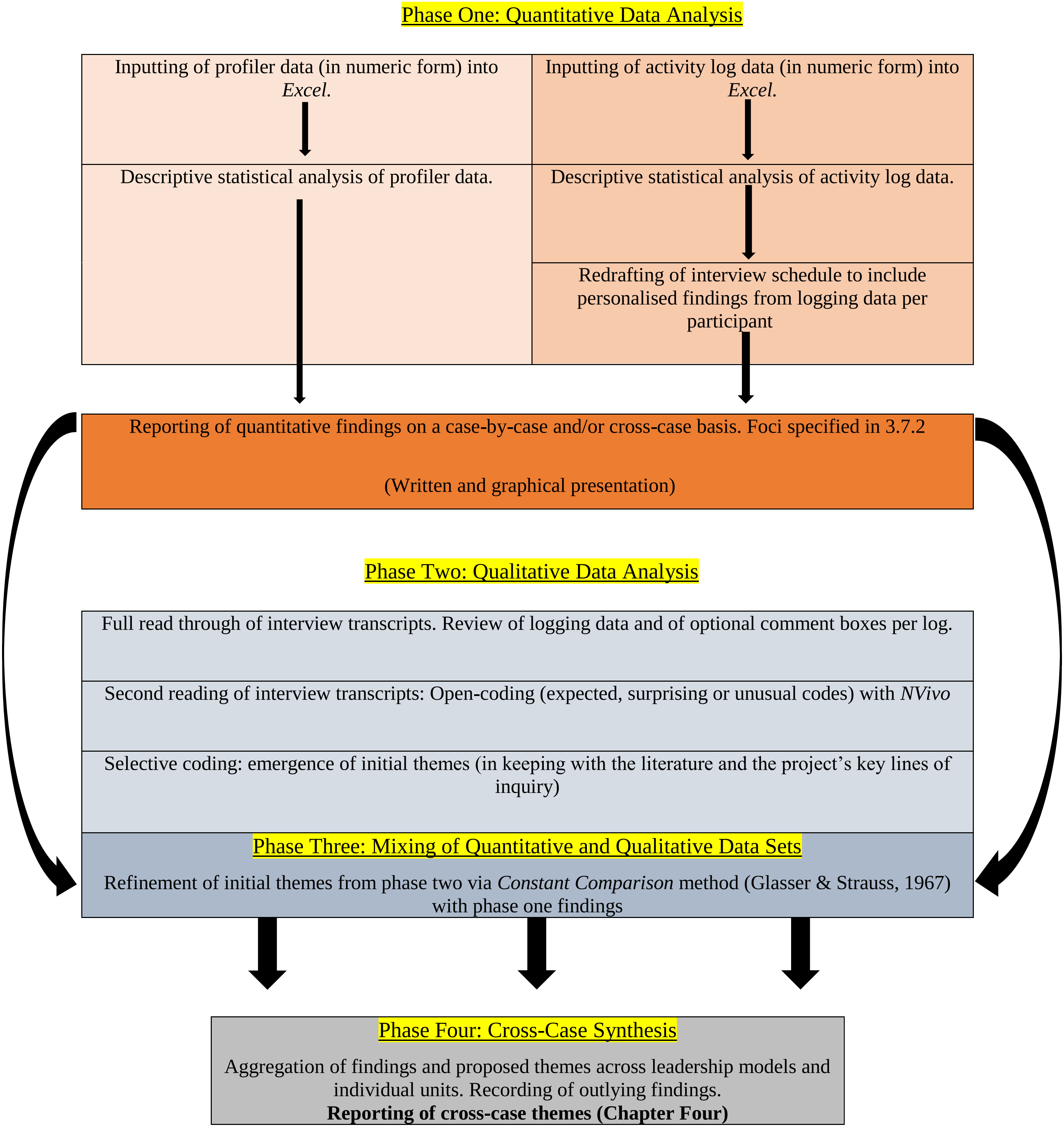
Descriptive statistics are applied to complete populations. The properties of populations, such as the mean, are called parameters. Rumsey (2019, chp. 7) elucidates: “(a parameter is) a single number that describes a population”. They characterise the whole target population. Given the accepted non-generalisability of case-study research, and the fact that the ten diverse participants formed the researcher's target population, this study predominantly exploited descriptive methods. These methods are further detailed in sub-section 3.7.3. This approach was facilitated by the use of mostly nominal variables within the Participant Questionnaire/Profiler and the Participant Activity Log. A sample question from each format illustrates this orientation - the second item in the questionnaire/profiler asks: "*What role do you hold in your current school*?" before providing five role options, ranging from teaching principal to special education teacher. No ranking or quantity is implied by any of these five options, or their positioning. Similarly, the Participant Profiler asks, in the case of each recorded act of mathematics leadership, "*Was this a pre-planned action?*" Once again, the two obvious response options (yes or no) are presented in a neutral, non-hierarchical manner. Goos and Meintrup (2015) affirm the compatibility of such nominal variables to "calculations of frequencies and percentages" (p.9) – this adequately met the needs of the researcher in his proposed data analysis.

One further statistical distinction is necessary before proceeding to the discussion of the specific data analysis methods exploited by the researcher – "inferential statistics can be classified as either parametric or nonparametric" (Allua and Bagley Thompson, 2009, p.168). Parametric statistics, the more widespread of the two within the inferential statistics domain, are built on the assumption that data generated from a sample has a normal distribution, thus making it more malleable to predictability and application. Non-parametric testing is built upon the opposing postulation that the collected data does not follow a specific, predictable distribution. It should also be appreciated that because of its nature, non-parametric testing is considered as being "very robust to outliers" (Potvin and Roff, 19993, p.1617). The difference between both types of inferential data carries a profound implication for the types of statistical tests which the researcher uses in the analysis phase. Unsurprisingly, the suite of tests that fall under the non-parametric category are sometimes referred to as "distribution-free" tests (see Conover, 2009). Examples of such tests include the Mann-Whitney *U* and the Wilcoxon T test, both of which are used to evaluate group differences. Parametric equivalents include the traditional *t*-Test and ANOVA which help determine statistical significance (see Allua and Bagley Thompson, 2009).

3.7.2 Sequential Quantitative Qualitative Analysis

Researcher objectivity and rationalised procedure are essential bulwarks to ensure that the analysis is as rigorous and as revelatory as possible. In order to meet this required standard of analysis, Yin is unequivocal: "your analysis should show that you attended to all the evidence" (2009, p.160). In order to harness the complete data base, key features of Onwuegbuzie and Teddlie's "Sequential Quantitative Qualitative Analysis" model (2003, p.367) were exploited. As per this research, it entails forming groups of people/settings on the initial basis of quantitative data, which then facilitates a subsequent qualitative data-driven comparison of these units. Pre-analysis procedures, such as the practicalities involved in creating and curating the data base (see Robson, 2011), were given careful consideration by the researcher. Figure 3.5 on the next page provides a graphical representation of the four-phase sequential data-analysis strategy that was employed. Each of these phases will now be described.

Figure 3.5 Sequence of Data Analysis



3.7.3 Phase One: Quantitative Data Analysis

Gillham opens this sub-section with an important point: "case study does not equate qualitative methods and data only" (2000, p.80). He goes on to laud the capacity of quantitative data to "add to the overall picture" of the case. Inspired by this inclusivity of approach, this sub-section later outlines the analysis procedures for the activity log, but first, it deals with the participant questionnaires/profilers.

The quantitative analysis of the questionnaires/profilers (despite the relatively small number of units) demanded both frequentist and descriptive statistical methods. As will be demonstrated in the subsequent analysis chapter, presentation of this data complied with Teddlie and Tashakkori's recommendation: "descriptive statistical methods include techniques for summarising numeric data in easily interpretable tables, graphs, or single representations of a group of score(s)" (2009, p.258). Although time-consuming, the researcher implemented McCormick et al.'s advice to convert as much of the profiling and logging data as possible "into the form of numbers" (2015, p.13) in order to facilitate the analysis process. A practical example of this was the use of numeric values when inputting specific profile data from the questionnaire/profiler, as evidenced by item 4: *How many years teaching experience have you?* Each of the four answering options was assigned a value from one to four, and if a participant choose *11 – 20* (the third option), for example, their response was inputted as 3. In this and in other questionnaire/profiler items, the use of ranges of data (such as age bands in this instance) narrowed the number of available options, thus simplifying completion for the participant and making the data inputting process more manageable for the researcher. A further example from the questionnaire/profiler asked: *How would you rate your overall effectiveness in your role of leading Mathematics*? Again, each of the five response options was assigned a numeric value of one to five. This simple system allowed tallies of accumulated responses to be built up, which facilitated swifter statistical calculations, such as simple frequencies. This inputting method was replicated for all of the questionnaire/profiler's other items, save the open-ended questions (items 12, 19 and 23 which sought explanations for preceding answers). Other ordinal data collected from the questionnaire/profiler, principally the importance attached by the participants to various aspects of the mathematics leadership role, also enabled the reporting of various measures of central tendency and dispersal (see Cohen et al., 2011; Robson, 2011). The *Excel* software package provided an ideal host to record and tabulate this quantitative data set.

The logging data of the participants was also ideally suited to various descriptive analyses. Gillham (2000) acknowledges the use of records as one of the most basic data sources for any descriptive analyses. Once again, measures of central tendency were important indicators when assessing the type of duties that mathematics leaders engaged in most frequently, the average time demand per day/week to execute these duties, the expertise that they were calling upon most and least often to carry out their specialised leadership work, and, their self-assessed effectiveness for each interaction. Given the centrality of the five contrasting models for primary school mathematics leadership within the project's design, a categorical comparative analysis of this quantitative data was also possible (see Gillham, 2000; Maxwell and Loomis, 2003). Similarities and differences in the working emphases and patterns of administrative school leaders and of those who retain teaching duties (especially teaching principals) was an obvious area of curiosity, as was the potential contrasting workload and prioritisation in schools of differing size and context.

The specific foci for comparison across the five models of leadership were:

- Which duties were more/less prevalent? Or completely absent?
- When were (specific) duties most likely to be carried out?
- Were the duties more likely to be administrative in nature rather than pedagogically/mathematically focused?
- What were the headline difference (i.e. in time allocated to the specific role) between those with, and those without full-time teaching duties? And between teaching and administrative principals?
- Did the work of leaders in smaller schools differ from their counterparts in larger schools to a noticeable degree? If so, in what way?
- Did the work of leaders in schools classified as disadvantaged differ from their counterparts in non-disadvantaged schools to a noticeable degree? If so, in what way?

Whilst such findings were very useful in gaining greater insight into the characteristics and the working habits of the sample, a more explanatory orientation was also required in order to tease out the true import of the activity log and interview transcript data. This shifting focus is evident in the second phase of the data analysis.

3.7.4 Phase Two: Qualitative Data Analysis

Creswell strongly asserts that any qualitative analysis must first begin with a full read-through of the collected data: “a first step is to obtain a general sense of the information and to reflect on its overall meaning” (2009, p.185). This “reading with a critical mind-set” (Van der Ham, 2016, p.17) of both the activity logs (for the second time, but in particular the optional comment boxes at the end of each logging day) and the interview transcripts helped form the basis for subsequent lines of inquiry for the researcher.

Before elaborating upon the analysis methods employed for the interview transcripts specifically, it is necessary to address the crucial process of data coding, and the working definition that it held in this project. Creswell and Creswell describe coding as the process of “organising data by bracketing chunks or segments” into categories and then “assigning a word/words” to represent (and possibly explain) this category, thus facilitating ease of analysis (2018, p.193). The same authors continue by proposing three broad, self-explanatory categories of codes: expected, surprising and codes of unusual or of conceptual interest. The researcher was receptive to all three classifications during his initial code search. Creswell (2013) outlines the project’s sequential approach to the process: the initial coding of the data, the subsequent amalgamation of codes into broader categories or themes, and finally, the communication of the data and its inherent comparisons and contradictions.

The initial open-coding, followed by selective coding of the interview data entailed the researcher “capturing what he sees in the data in categories that simultaneously describe and dissect the data” (Charmaz, 2001, p.684). Yin (2009) warns that despite the autonomy afforded by the coding process, codes must be clearly rationalised and must bear obvious correspondence with the initial research design, and therefore with the initial research questions(s). As one of the most agile software options available in the “code-and-retrieve” space (Fielding and Warnes, 2009, p.274), it was decided that the *NVivo 12* package would be utilised to expedite the logistical aspects of the coding process. The benefits of such coding tools are clear: “the efficiencies afforded by software release some of the time used to simply manage data and allow an increased focus on…(the) meaning of what is recorded” (Bazeley and Jackson, 2013, p.2). During the twelve-month period prior to the data-analysis phase, the researcher undertook and completed two 2-day practical courses on the application of the *NVivo 12* programme at the university campus. The coding process employed by the researcher will be further illustrated by quoted examples from the data in Chapter Four.

3.7.5 Phase Three: Mixing of Quantitative and Qualitative Data Sets

Once the process of "categorical aggregation" (Stake, 1995, p.74) was completed with the interview transcripts, these embryonic themes were further informed (and tweaked) by insights previously gleaned from the participant logs, and the participant questionnaires/profilers. This "mixing" was a further manifestation of the researcher's faithful commitment to the mixed-methods approach, and its comprehensive implementation. Glaser and Strauss' (1967) iconic "Constant Comparison" approach loosely guided this assimilation process, and it ensured consistency of interpretation across the varying data bases. Given Stake's assertion that the (log) recorder "is (sometimes) a more expert observer" than the researcher (1995, p.68), one can reasonably expect additional insights and more precise, refined themes to emerge as a consequence. On multiple occasions, it was found that a comment made in the activity log gave enhanced meaning and impact to the emerging interview themes. Again, specific examples of this evolution will be provided in the next chapter.

Participant comments were typically made in the heat of the moment (i.e. when the leader was going about their leadership work), and therefore their spontaneity and authenticity added considerably to the validity of its corresponding code. Both Stake (1995) and Yin (2009) make it clear that owing to the nature of the data involved, and the necessity to concentrate on the sometimes rare, yet highly significant single instance or event, analysis of case-study data is an interpretative process. Therefore, it places a particular burden to "develop strong, plausible, and fair arguments" firmly grounded in the data (Yin, 2009, p.160). This drawing of supportive data, from across the three data sources in this research project, to substantiate its findings provides an enhanced degree of confidence in the emerging conclusions and recommendations which will follow.

3.7.6 Phase Four: Cross-Case Synthesis

The concluding feature of this project's data-analysis and data-presentation processes requires elucidation. Yin (ibid) outlines a range of possible analytic techniques for case studies, however a cross-case synthesis was proposed as being the most suitable given the researcher's chosen research design, and the implied comparative nature of the research question itself (i.e. how is mathematics leadership enacted in *different* primary schools?). Whilst treating and comprehensively analysing each unit/participant as a significant entity of itself, the technique of cross-case synthesis also provided the flexibility to subsequently aggregate findings and themes across leadership models (and other clusters of units also, if insightful). The capacity to allow for individual description and interpretation, and then the broader synthesis of themes and conclusions from questionnaires/profilers, activity logs and interview transcripts across the entire sample of leaders, held a particular attraction to this researcher. Outlying findings (related to individual units or to models of leadership) were also recorded for comparative purposes. These added additional depth to the findings.

Ultimately, this four-phased analysis process gave rise to a set of five fully-evidenced and robust themes. Identification and interrogation of these themes forms the cornerstone of Chapter Four.

Whilst the procedures for sampling, data collection and analysis tend to dominate the thoughts of the researcher, ethical considerations must also be of paramount importance before and also upon entering the field. These considerations will be explored in the next section.

3.8 Research Ethics

Robson simply posits that “ethics refers to the rules of (research) conduct” (2011, p.197). Various notable authors in the field (see Creswell, 2009, 2013; Cohen et al., 2011) have consistently emphasised that ethical issues may arise at any time during the research process, from initial conception through to final reporting. Creswell (2009) further lauds the ability of the experienced researcher to anticipate these possible dilemmas, and to have rationalised protocols in place to respond. Reassuringly, Teddlie and Tashakkori also suggest that ethical issues associated with mixed-methods research are no different from other forms of research “except that they must consider the context and demands of both qualitative and quantitative research settings” (2009, p.201). Whether it be the general aim to enhance the reputation of the research community, or the more acute need to minimise “the potential for harm, stress or anxiety” for the participant (ibid, p.194), an audit of a project’s ethical foundations is a necessary preliminary step (see an example of such an audit in Cohen et al., 2011, p.103 – 104). Based on a university-required ethical audit of the project (see below), it was the researcher’s view that in light of the nature of the project, and the prominent role held by all ten participants, there was a minimal risk of maleficence to the relevant schools and participants therein.

3.8.1 Dublin City University Ethical Approval

The researcher submitted an application for ethical approval for this project to the university's Research Ethics Committee (REC) in August 2018. Through an online portal, the application document demanded specific detail on the nature of the proposed study, the general profile of the likely participants, procedures for recruitment of same, the range of ethical issues that the project gave rise to (its inherent risk) and the planned protocols that would be put in place to proactively respond to these issues (Risk Management Plan). Subsequent sub-sections of this chapter will detail the main elements of this plan. The *REC Application Form* (Appendix I) was also supplemented by copies of the project's promotional literature, *Initial Approach Letter to Schools, Plain Language Statement for Participants, Informed Consent Form, Participant Questionnaire/Profiler, Participant Activity Log* and *Interview Schedule*. Given the recent enactment of new European Union-wide data handling procedures (European Union Commission, 2016), a detailed *Personal Data Security Schedule* for the project was also submitted (Appendix J). This schedule served to identify all of the personal data generated by the project, and the retention, deletion and security measures to be applied over this information by the project's nominated data controller (i.e. the researcher). Ethical approval, without further recommendation, was granted by REC in early September 2018.

3.8.2 Informed Consent

Warren's logic for informed consent presumes that "the respondent will understand the intent of the research, as it is explained by the researcher…" (2011, p.89). The burden on the project's principal investigator is clear, as specified in Robson's (2011) four adapted steps in obtaining informed, voluntary consent. In the first instance, Teddlie and Tashakkori pinpoint the necessity to "educate" gatekeepers (2009, p.202) about the nature of the study. Conventional etiquette would dictate that school principals would be the first point of local contact for initial institutional access. Given that not all of these principals were the actual participant (two of the specified five leadership models specifically excluded the principal), principal-gatekeepers had to be adequately briefed prior to identifying a likely participant among their staff. This imperative helped inform the design of the project's recruitment notice, and the subsequent invitation letter sent to schools. In an effort to build a rapport and engender trustworthiness, it was the preferred method of the researcher to visit and to personally speak directly to each potential participant before a decision on their personal participation was taken. Coercion from an ill-informed gatekeeper was unacceptable. The researcher emphasised his own previous teaching/leadership experience in a bid to establish collegiality and common interest between both parties.

If and when the conversation yielded a positive response to participate, the formal *Plain Language Statement for Participants* and the *Informed Consent Form* were then issued to the potential partaker, who was given a further cooling-off period to consider their initial expression of interest. Specifically, the *Informed Consent Form* sought to simultaneously inform the likely participant of the precise nature of the research, the potential risks (if any) arising from involvement (see Teddlie and Tashakkori, 2009), the practical scope of their required participation, and, their unfettered entitlement to withdraw from the project at any time (without justification). Most crucially, this document aimed to provide reassurance to the recipient about the protective safeguards in place, as inspired by Creswell's explicit recommendations to protect the "informant's rights" (2009, p.198). Chief amongst the precautions specific to this project were its protocols of anonymity and confidentiality.

3.8.3 Anonymity and Confidentiality

Stake concedes that almost all "educational case data gathering involves at least a small invasion of personal privacy" (1995, p.57) and whilst this is inevitable, there is now a widespread assumed expectation that researchers will make all reasonable efforts to maintain the anonymity and confidentiality of participants. Robson builds on this assumption by noting that "confidentiality should extend beyond not naming participants, to not revealing personal details which might reveal a participant's identity" (2011, p.208). Creswell's recommendation to use "aliases or pseudonyms" (for participating school leaders' names) (2009, p.91) was particularly useful for the qualitative reporting and analysis phase of this project where the detailed discussion of the small number of unit schools, albeit in a relatively large geographical area, carried some risk. The random alphabetical labelling of participant leaders was an obvious measure in this regard.

Other ethics-enhancing practical procedures, such as the member checking of interview transcripts (see Poland, 2001) to exclude specific references to individuals and/or locations, also helped reinforce anonymity and confidentiality. Physical and electronic data storage procedures complied, and continue to comply, with best practice. The sharing of any element of the data, other than aggregated findings, with third parties remains strictly forbidden. Clear timelines for the irrevocable deletion of all data, physical and digital, generated by the project were clearly specified in the *Personal Data Security Schedule*.

Flick (2002) does raise the thorny issue of legitimate participant fears about potentially negative consequences that may arise, within their own organisation, following critical comments made that are subsequently repeated in the findings and/or analysis. It was vital that the initial consent process made it clear that comments made by participants (either during their interview or through their log) could potentially be cited by the researcher. However, duty of care dictated that should the researcher form the opinion that the raw data collected from any particular individual/case may inadvertently damage the personal and/or professional standing of the individual (or another third party), this concern would be communicated to the participant. In such an instance, the partaker would be empowered to make the final decision concerning its redaction, complete omission or inclusion within the project. Fortunately, this eventuality had not arisen up to the time of this dissertation's publication.

3.8.4 Additional Ethical Considerations

Stake (1995) notes that "almost always, data gathering is done on somebody's home ground" (p.57) – this is particularly salient to this project, as logging was most likely to occur at either the place of work or the home of the participants. Additionally, for convenience, interviews were almost universally held in the participants' school setting. The researcher made a concerted effort to ensure that site visits or any contact with participants did not occur during teaching hours, thus ensuring that precious instructional time did not suffer as a consequence of the project, nor was there any other generalised disruption at the site. Creswell's strong recommendation "to respect (the) research sites" (2009, p.90) rang in the researcher's ears. In this spirit, any incidental or unintended observations that the researcher made whilst visiting the participants' schools, but which were extraneous to the research project, remained unrecorded and confidential. Coincidentally, given the relative safety of the school environment for interviewing, it was also assumed that these research locations offered little or no danger from a "researcher safety and risk" perspective (Robson, 2011, p.209). This proved to be the case, as the researcher worked unhindered at all times.

3.9 Limitations of the Project

Whilst the researcher made strenuous efforts to ensure the highest methodological and ethical standards within this research project, there is a recognition of limitations within the design and its enactment. Merriam begins with the most obvious source of all: "the investigator as human instrument is limited by being human – that is, mistakes are made, opportunities are missed, personal biases interfere" (1998, p.20). It is important to foreground the full range of limitations in order to facilitate a more robust critique of the emerging findings and analyses which follow in subsequent chapters.

The sample size was undeniably small, capturing as it does the leadership of Mathematics within only ten schools, out of a national total of over three thousand. This is particularly acute in the inclusion of only one participant representing the collaborative model of leadership. Despite considerable, but ultimately futile efforts by the researcher to overcome this dearth, perhaps it is indicative of a genuine paucity of such shared leadership configurations nationally, despite anecdotal indications to the contrary. A charge that the study merely represents a snapshot of mathematics leadership between November 2018 and March 2019 is equally valid – it is difficult to state with any confidence that the findings are applicable to the actions and opinions of all mathematics leaders nationwide during that five-month window, or that the findings would be replicated with a different sample of leaders. Although Stake's (1995) previously cited observation noting the incompatibility of the case-study mode and generalisability of findings does provide much comfort, it is highly likely that a larger sample may have generated a more varied body of findings, which would have further enriched the analysis.

The Irish primary school system is rapidly evolving: enhanced mathematics-specific entry requirements for pre-service teachers, the ever-increasing availability of curricular and leadership-specific PD, curriculum change, significant diversification of school ethos and patronage, and, the legitimate rise of parental influence. Future studies of specific subject-area leadership may seek to cast their net wider in terms of participant and school profile. For example, scrutiny of mathematics leadership in the post-primary sector was beyond the confines of this study. The more specialised nature of teacher expertise in these schools, and the likely different leadership duties and approaches that this may give rise to, would provide for an interesting juxtaposition with that of primary schools.

Given its deliberate design, the data collected and analysed in this study comes exclusively from the experience and perception of the leader him/herself. The voice of the teaching colleague, the pupil or indeed the parent may have offered the researcher an enhanced appreciation of the work of mathematics leaders, and even more crucially, may allow for a more rigorous appraisal of their impact as understood across the entire school community.

As previously outlined, this project was undertaken as part of a broader part-time doctoral programme. This is a relevant consideration as the time-bound nature of this programme, and of the study itself therefore, did have methodological consequences. Time in the field was therefore at a premium. This led to the exploitation of two fortnight-long activity logging periods, as opposed to the idealised observation of each of the participant's in their place of work for prolonged periods of time. This is the very manifestation of the pragmatic bent that runs through the research design.

The researcher was, and still remains, an undeniable insider in the field of mathematics leadership in the primary school sector. This can be viewed positively in that it contributed to a personal awareness of its virtual non-recognition within the Irish research community, which by extension strengthened the personal incentive to examine the topic. It is difficult to consider that a researcher without personal experience of leadership, and without an interest in Mathematics, would sufficiently value the topic to investigate it to any great depth. This insider status also carries another implication – it demands that the researcher lays bare his pre-research assumptions about mathematics leadership. The dissertation's introductory chapter clearly illustrated that his career path had not only reinforced to him the benefits that come from strong, localised school (mathematics) leadership, but it also displayed the considerable logistical, administrative and intellectual demands that go hand-in-hand with such a role. These challenges have been experienced first-hand, and undoubtedly this has exerted some form of contributory influence upon the process. In essence, the researcher had already held an elevated appreciation of the role and, for many years, had strongly supported the view that it should enjoy enhanced status within the leadership structure of all schools. This acknowledgement put a particular onus on the researcher to allow the participant data speak for itself, and not to project personal feelings upon the data base and its interpretation. The rigorous and fully rationalised data-analysis strategy (see section 3.7) provided reassurance that researcher bias and personal agendas did not go unchecked.

However, given the participant recruitment strategy, it could also be suggested that the participants were themselves insiders. They were approached on the basis of their leadership experience and their known positive disposition towards Mathematics. Although no evidence exists to this effect, it must be at least considered that this outlook towards Mathematics may have motivated them to provide data that may have presented their mathematics leadership in a particular, most likely positive light. It is also a possibility that participants may have altered their typical behaviour during the logging windows, for example frontloaded a specific duty, to ensure that it appeared in their logging data. Furthermore, it cannot be fully discounted that participants, in an attempt to facilitate the researcher in his work, may have logged in a manner they believed would be helpful - they may have simply recorded what the researcher would like to read. Such participant bias is a strongly documented phenomenon of both quantitative and qualitative research instruments (see Goodwin, 2010), and must be acknowledged. One particular precaution taken by the researcher was to reassure participants, when completing the activity log, that the recording of no mathematics leadership activity in any given day was of itself an important finding that the researcher was interested in. It was emphasised that there was no gain in feigning activity as this would distort the extent of participants' work and would misrepresent the obvious time constraints that leaders were subject to from multiple sources.

By extension, both the logging and the interview components of the study were heavily contingent upon participant memory. Whilst the sample were urged to complete logs on a daily basis, it is naïve to assume that this happened universally. Given the length of the school day, the flood of demands that it places on leaders, and the miscellany of other non-mathematics leadership-related aspects that may arise, it is understandable that participant recall may have been compromised on occasion, thus resulting in (unintentional) inaccurate logging.

Whilst all of these limitations warrant consideration, it is the researcher's contention that the methodological and ethical procedures put in place (and heavily detailed in this chapter) does provide sufficient reassurance to the reader when assessing the integrity of the study's findings.

3.10 Summary

This chapter has set out the broad philosophical basis upon which the project's resultant research methodology was conceived, and was subsequently operationalised. Its fundamental pragmatic bent, and its corresponding core assumptions about the nature of reality and true knowledge, and how both can be accessed by the inquirer, led to the exploitation of a flexible mixed-methods approach. This approach was deliberately and firmly embedded within the case-study mode. Such a strategy was determined as the most convenient, manageable and revelatory means to answer the researcher's overriding and multi-layered research question: how is the leadership of Mathematics being enacted in our primary schools?

More specifically, the chapter detailed the rationalised procedures for sampling, data collection and the project's subsequent four-phase analysis process. Considerations of arising ethical issues, spanning the entire research process from initial conception to final reporting, also inform the chapter. Complementing this discussion, there is an explicit acknowledgement and interrogation of the limitations of the project. This fully rationalised research approach allowed for a more assured rollout of the methodology during the crucial fieldwork element of the project, followed by a strategic analysis of the emerging data.

With these methodological considerations now clearly aired, the context is set to report the findings of the research, and to set forth the analysis of what the data base says about the targeted phenomenon of mathematics leadership.

Chapter Four: Findings and Data Analysis

4.1 Introduction

This analysis chapter intends a crucial, yet simple purpose. It strives to set out the principal findings of this multi-phased mixed-methods study, centred upon exploring how Mathematics is being led in our primary schools. Chiefly, it does this through the presentation of five key cross-participant themes which each draw heavily on both the quantitative and qualitative data sets. This mode of data presentation is entirely consistent with the mixed-methods approach underpinning the project, as set out in sub-section 3.3.1. If Teddlie and Tashakkori's (2006) recommendation is to be heeded, then a mixing methodology is not simply confined to having an assortment of quantitative and qualitative tools, but also the mixing approach must be evident in the analysis and presentation of the findings that these research instruments have generated. A seamless, concurrent presentation of quantitative and qualitative data will ultimately strengthen the researcher's conclusions, and subsequent recommendations. Given the case-study mode that permeates this project (as set out in sub-sections 3.4.1 and 3.4.4), it is unsurprising that the researcher has opted for a narrative format that combines thick, qualitatively-supported depiction, underpinned by additional descriptive statistical data. Yin makes a point of stressing the need to supplement the narrative with "tabular as well as graphic and pictorial displays" (2009, p.170), and this suggestion heavily influences the presentation.

Building on Creswell's (2009) analogy of data analysis as a process of sense-making by the individual researcher, it must be acknowledged that this thematic analysis is built upon the prioritisations, interpretations, and indeed biases of this researcher. It is entirely permissible that another researcher, with differing professional and research experiences, and a diverging perspective therefore, might generate an alternative thematic base. Consequently, it is crucial that the researcher can support his thematic findings (and hypotheses therein) with ample data, across the three varied, qualitative and quantitative sources described in section 3.6.

4.2 The Data-Analysis Process

Before examining these thematic findings, a brief reprise of the project's data-analysis processes is prudent. This review is vivified by recollections and screen grabs from the researcher's own analysis archive. As outlined in considerable detail in section 3.7, and as graphically represented in figure 3.5, this method entailed a four-phased progression.

Phase one of the data-analysis process involved the collation of the quantitative data generated by each of the ten questionnaires/profilers and their accompanying activity logs. This classification process, despite its functional nature, did facilitate an early insight into the professional background of the participating leaders, their self-declared leadership priorities and their domains of most/least prolific mathematics leadership activity. Researcher familiarity with the skills and competencies they utilised (mathematical or otherwise), and their self-assessed efficacy in their work, was also hugely enlightening in establishing a knowledge-base to inform the subsequent analysis. The *Excel* software package provided an ideal host to record and tabulate these quantitative outputs. Whilst this investigation did generate individual and aggregated data across the ten leaders, it also provided insight on a leadership model-by-model basis. As described in sub-section 3.4.4, leaders across five leadership constructs were examined in this study: administrative principal alone, teaching principal alone, teacher-leader with an assigned middle management role, teacher-leader with no formal middle management role (volunteer), and teaching leaders involved in committee/collaborative structures. The comparative data generated from these various constructs of mathematics leadership formed the key planks of the thematic analysis which follows.

As advocated by Creswell (2009), phase two began with a full read-through of the interview transcripts. This preliminary review, and the recording of the initial reactions of the researcher (whether detecting recurring patterns, identifying outlying findings or simply observing personally significant results), provided important signposts for the analysis. A record of these initial responses to the data is provided below for illustrative purposes (see figures 4.1a and 4.1b). These preliminary reflections were collated and reshaped to establish initial embryonic categories for a secondary, more structured examination of the qualitative data. The *NVivo* 12 software package added significant capacity in this recording and allocation process. These broad categories were further refined through cross-referencing with the project's key research questions, and the specific emphases emerging from the literature. Preliminary themes were beginning to emerge.

Figure 4.1a Researcher Diary Screen Grab – Initial Responses to the Data

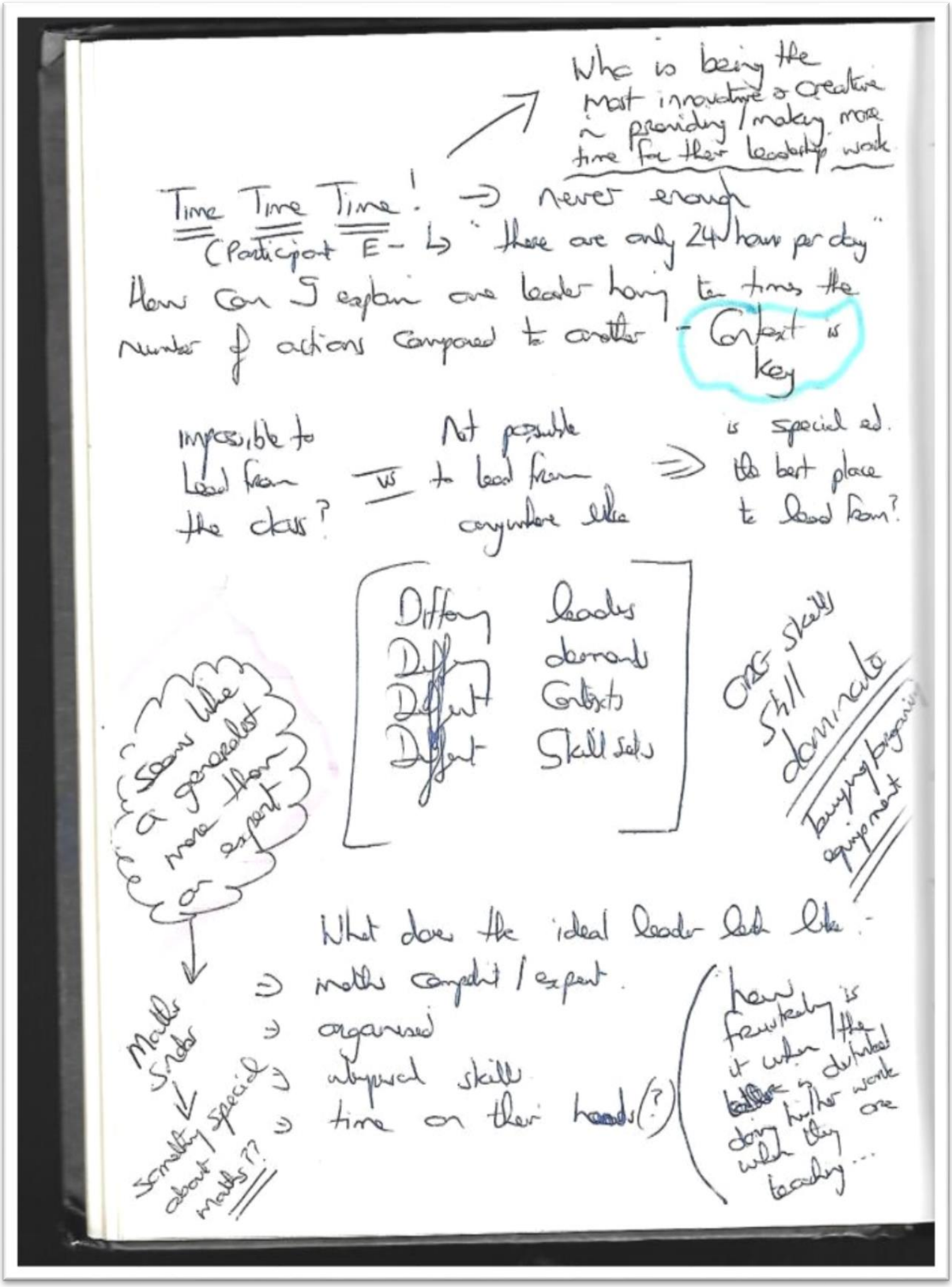
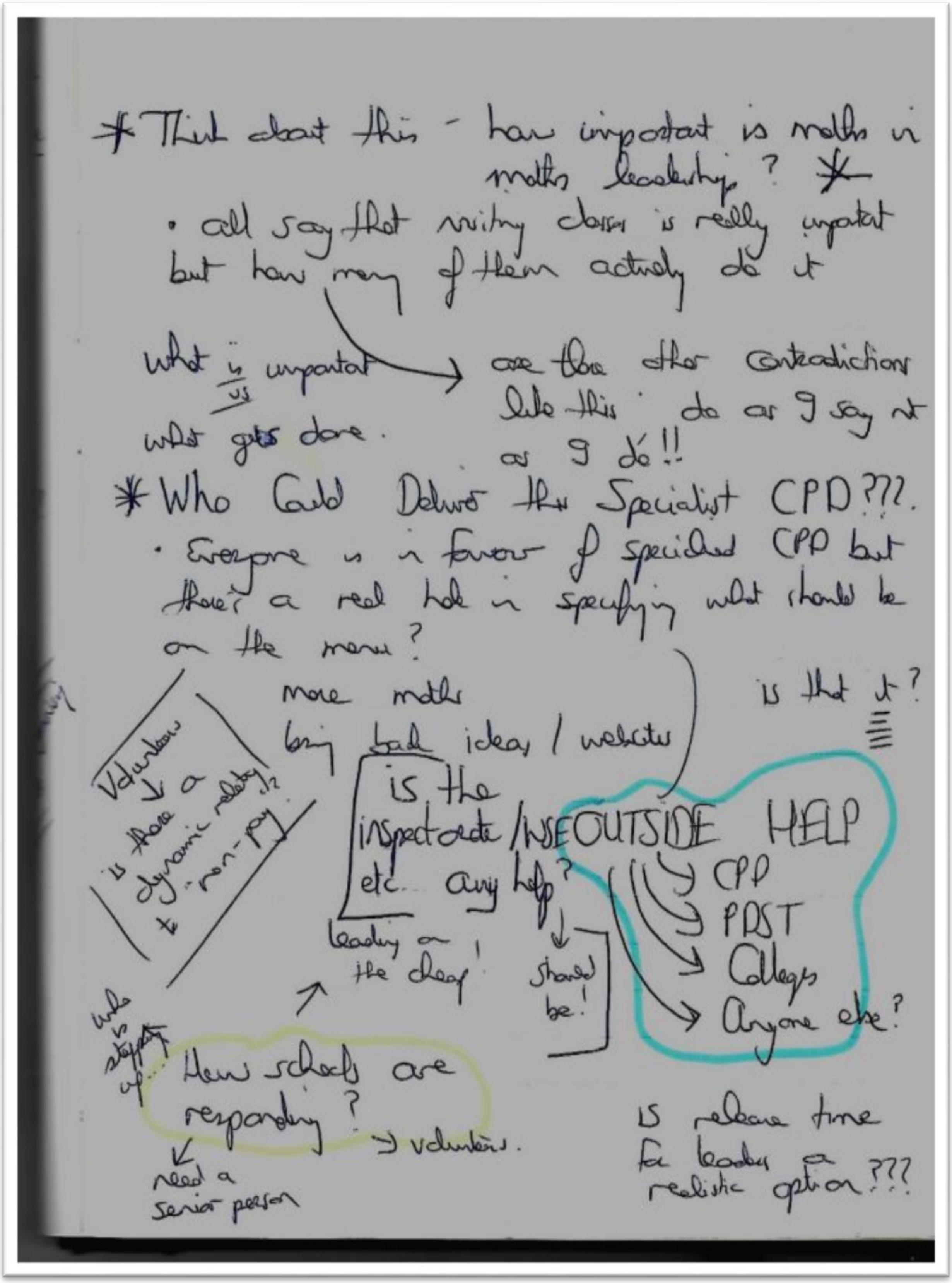


Figure 4.1b Researcher Diary Screen Grab – Initial Responses to the Data (contd.)



At this juncture in the analysis process, it was necessary to begin to combine the insights emerging from both data bases into one set of coherent, broadly applicable interpretations (phase three). The researcher elected to exploit the aforementioned embryonic categories emerging from the qualitative data as core understandings, and to seek either corroboration or contradiction of each from the largely-quantitative participant questionnaires/profilers and activity logs. The exploitation of Glaser and Strauss' (1967) "Constant Comparison" method, as noted in sub-section 3.7.4, ensured that all of the emerging themes held a strong foundation in, and a consistent interpretation across, all data bases. Although this approach ultimately did bear fruit, it was not a linear process and it did force the researcher to often re-consider his initial reactions to the data. Consequently, this re-evaluation did influence the evolution of the earliest data categories into a set of toughened themes which took a more considered account of what the qualitative and quantitative data bases were saying, whether seemingly in agreement or incongruous.

The above approach also resonated strongly with Corbin and Strauss' (1990, p.12) "Open Coding" technique in its intention to generate significant categories of meaning across the entire data base. Given the additional specialist capacity of the aforementioned *NVivo 12* software package to simultaneously handle both qualitative and quantitative data sources, it was decided to utilise these broad categories of meaning as the "nodes" (or classifications) to begin the more rigorous formal coding of both data bases. Figure 4.2 shows the co-location of both quantitative data (questionnaire/profiler results, individual and aggregated logging records, and comparative logging data) alongside qualitative sources (participant interview transcripts) within the harvested data base. Figure 4.3 presents a screen-shot of the *NVivo 12* interface during this coding process.

Having accumulated a set of over a dozen categories (or nodes), each with supporting data, project manageability dictated that the researcher undertook a process of refining, often through merging, renaming and occasionally discarding nodes, in order to build towards a small, yet tighter collection of themes. Cross-case synthesis (phase four) also ensured the broad representativeness of the finalised themes, not only to individual units but across the various models of leadership examined in the study. Outlying findings (related to individual units or to models of leadership) were recorded for comparative purposes. Figure 4.4 illustrates an example of the emergence of one of the project's five key themes through various stages of the data-analysis process. Specifically it demonstrates the considered evolution of initial musing to fully rationalised theme.

Figure 4.2 *NVivo 12* Screen Grab – Data Sources

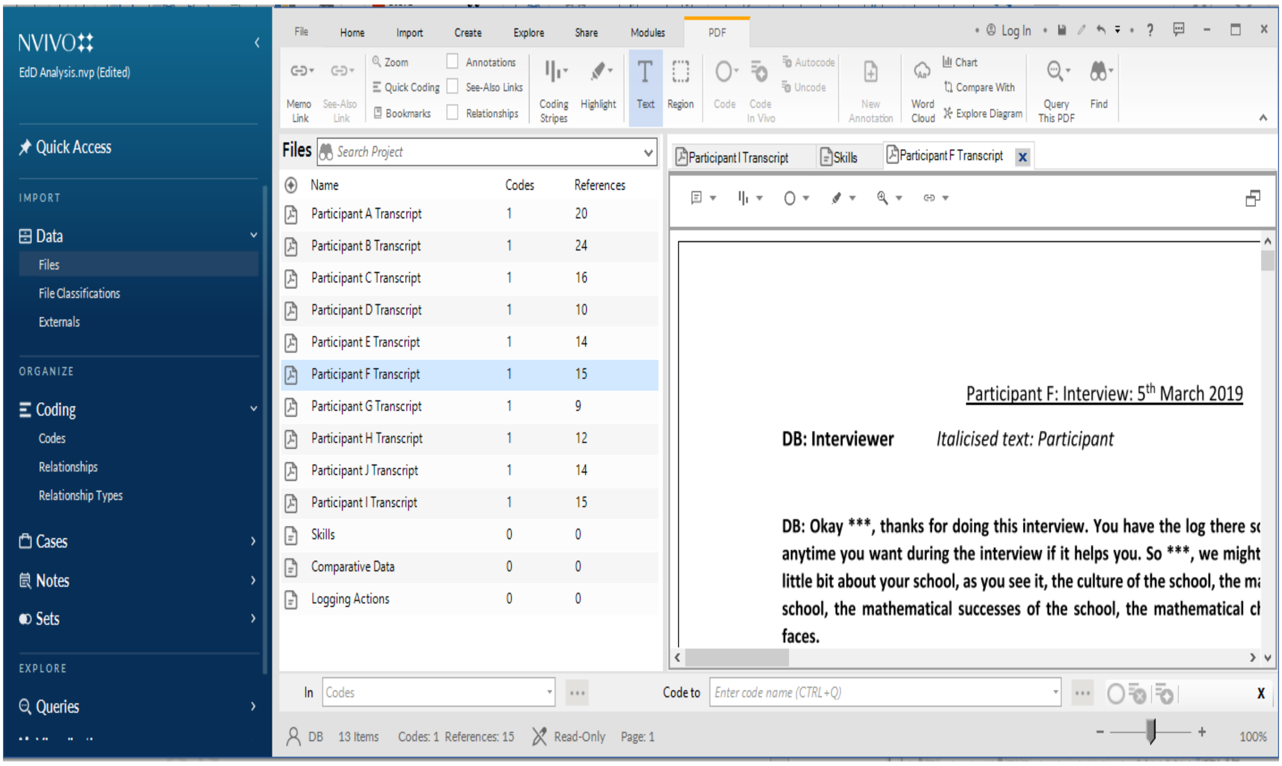


Figure 4.3 *NVivo 12* Screen Grab – Initial Coding

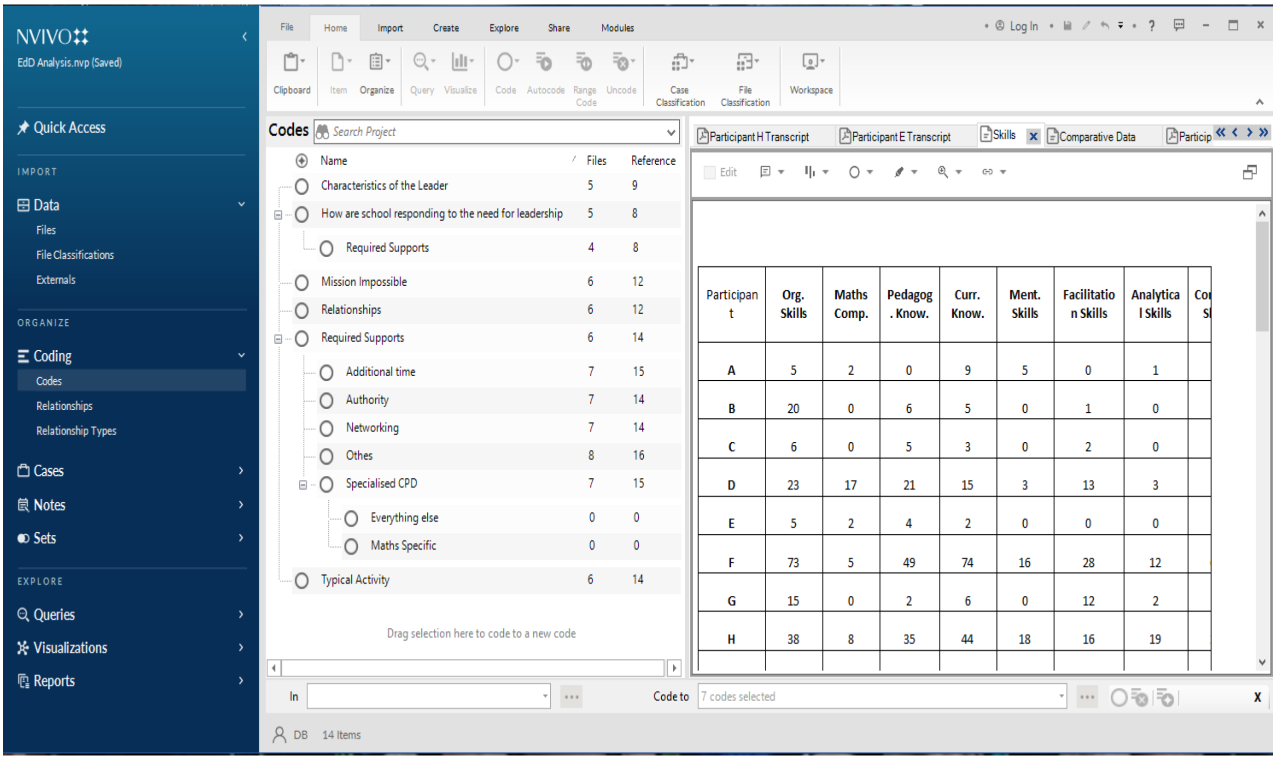
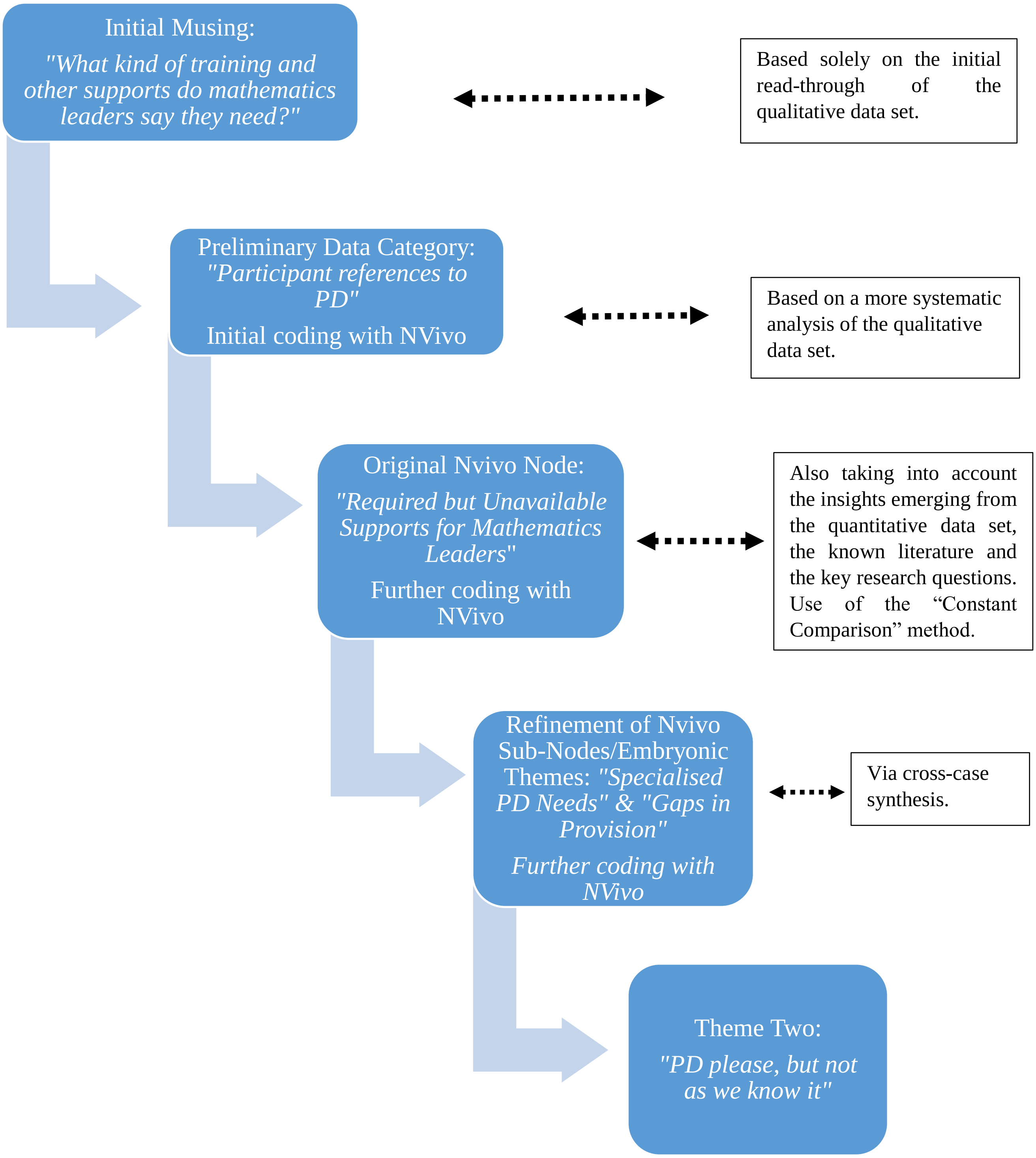


Figure 4.4 An Example of the Coding Process - From Initial Musing to Theme: Theme Two



4.3 Emerging Themes

The following section presents the project's five emerging themes, each to be examined in depth. The first theme is strategically positioned to readily facilitate the foregrounding of many of the key quantitative findings from the sample. This sets a useful context for the remaining, more qualitatively-focused motifs. In keeping with the recommendation of Creswell and Creswell (2018) to be receptive to "expected" codes (which ultimately emerge as themes), it is unsurprising that the contrasting volume and variety of mathematics leaders' workload surfaces as the key point of note from the data. This justifies its prominent inclusion as the first theme.

Remaining themes evaluate the expert nature of the mathematics leadership role itself, the self-expressed PD needs of such a distinct cohort, and, seeming inconsistencies between role conceptualisation and role enactment. The final theme assesses the very sustainability of this leadership role in light of the over-bearing teaching duties that most mathematics leaders also hold. Given their discursive and open-ended treatment, some of the themes headings are presented in question format. For ease of the reader, the themes to be examined are:

1. Different Leaders, Differing Activity Emphases
2. PD please, but not as we know it!
3. Mathematics Leadership and its Skill Set – Expert or Not?
4. The "Do as I say, not as I do" Paradox
5. Leading while Teaching – Mission Impossible?

4.4 Theme One: Different Leaders, Differing Activity Emphases

This initial theme is broken down into two distinct components. Firstly, the broad quantitative trends of the sample's collective mathematics leadership activity are identified and interrogated. These activity tendencies are supplemented with occasional qualitative insights. Comparisons between the activity volume and activity emphases of individual leaders (units), and between the various models of leadership identified in this research, add additional colour to this treatise.

The second part of this opening theme follows a similar pattern, but with a differing focus. Specific domains of mathematics leadership activity are examined. Here the activity patterns of the various categories of leader are appraised. Exploring the cohort's activity emphases strengthens the contextual basis required for evaluating the remaining themes in this analysis chapter.

The discussion begins with a synopsis of the general activity of the sample.

4.4.1 Activity Rates Across the Cohort

The activity logs recorded a total of 313 leadership actions by the ten leaders across the two logging windows in the 2018/19 academic year. This cumulative total spanned a range, at its extremes, of 95 actions by Participant F down to a low of 9 and 7 actions by Participants C and E respectively (see figure 4.5). Unsurprisingly, the four participants self-credited with the least number of actions during the period all held full-time, mainstream class teaching duties (Participants A, C, E and I). Conversely, the three most prolific mathematics leaders were either special education teachers or administrative principals (Participants B, F and H). Participant D somewhat bucks this trend – as a teaching principal with full-time classroom responsibilities, he engaged in more mathematics leadership acts (n=30) than one of the administrative principals (Participant G, n=20). His activity was also roughly on par with one of the special education teachers (Participant B, n=32) within the sample. It should be acknowledged that the disproportionately high number of actions recorded by Participants F and H (n= 95, n = 71 respectively) does somewhat distort the average figure for the cohort. Once both of these outliers are excluded, the average falls to a more representative 18 actions per remaining leader.

Figure 4.5 Number of Logged (and planned) Mathematics Leadership Acts – Per Participant

Participant	No. of Completed Leadership Acts	No. of Premeditated Leadership Acts
A	10	4
B	32	13
C	9	7
D	30	23
E	7	4
F	95	65
G	20	5
H	71	56
I	14	4
J	25	15
Total (n):	**313**	**196**
Average No. Per Leader	**31**	**20**

Across the ten leaders, there was a total of forty individual weeks available for logging – only three of these weeks had no activity entry (one week each for Participants A, C and G). It is difficult to attribute significance to this sub-cohort as it includes a mainstream class teacher, a teaching principal and an administrative principal. Extraneous events that were recorded in various logs, such as school closures for public holidays, discretionary school closures, sick leave, and other significant local school events, may somewhat explain these logging gaps.

4.4.1.1 Activity Trends across Key Leadership Models: Administrative Principals and Teaching Principals

The inter-model comparison between leaders reveals some interesting similarities and contrasts among the project's targeted leadership constructs. On average administrative principals engaged in over twice as many mathematics leadership acts as teaching principals (see figure 4.6a). Participant C, a teaching principal, was clear in his explanation of this divergence. In reflecting upon his teaching responsibilities during contact time, he expressed envy of the perceived additional, discretionary time that administrative peers have to lead, not only in Mathematics but across the curriculum:

> *"If you are the administrative principal, you probably think about it for the half hour or forty minutes at your desk, and then go and do it during the same school day."* (Participant C interview transcript)

Given the time imperative, it is unsurprising that teaching principals pre-planned well over seven out of every ten of their actions, whilst this proportion stood at just over a half for administrative principals. Understandably, spontaneous action was more suited to the more mobile administrative principal, and less so to their classroom-domiciled fellow leaders.

Figure 4.6a Number of Logged (and Planned) Leadership Acts – Per Leadership Model

	Admin. Principals	**Teaching Principals**	**Promoted Teacher-Leader**	**Volunteer Leaders**	**Collaborative Leaders**
Average No. of Actions	46	21	64	9	14
Average % of Actions Planned	52%	72%	55%	49%	29%

Figure 4.6b Number of Logged (and Planned) Leadership Acts – Additional Leader Categories

	Principals (overall)	Non-Principals (overall)	DEIS Leaders	Non-DEIS Leaders	Small-school Leaders	Large-school Leaders
Average No. of Actions	31	32	19	37	18	40
Average % of Actions Planned	64%	47%	53%	56%	68%	47%

There was remarkable similarity in the average number of mathematics leadership acts engaged in by principal (n=31) and non-principal leaders (n=32), as demonstrated by figure 4.6b. Given that all of the latter cohort had full-time teaching duties, this does indicate that teaching (of itself) may not be an inhibitor to more prolific mathematics leadership. This does raise the issue of when these acts of leadership are being carried out and this will be examined in a subsequent, more salient theme. It should also be considered, however, that within the non-principal cohort, two of the five leaders were special education teachers and as such were less susceptible to the time constrictions that other classroom-based leaders were subject to. Together, these two leaders (Participants B and F) accounted for a disproportionate four fifths of this sub-cohort's total activity, with the three remaining classroom-based participants (A, E and I) sharing the outstanding 31 actions over the logging period. This issue of the sustainability of classroom-based leadership of Mathematics will be examined in subsequent themes.

4.4.1.2 Activity Trends across Types of Schools

Comparisons between the activity levels of mathematics leaders serving different types of schools are equally insightful. Data from both qualitative and quantitative data sources indicate that non-DEIS mathematics leaders were on average twice as likely to engage in mathematics leadership acts than their DEIS counterparts during the logging period (see figure 4.6b). A similar proportion was roughly mirrored in favour of leaders from larger schools compared to those in smaller settings (an average of 40 actions versus an average of 18 actions respectively).

Again, it should be noted that the small-school leaders universally held full-time teaching duties in their respective schools.

Localised emphases are also evident within this analyses – for example, DEIS mathematics leaders proportionately devoted more time to planning than their non-DEIS counterparts. This can be somewhat explained by the additional planning requirements and organisational oversight that DEIS schools are subject to. These obligations arise from the additional teaching, learning and inclusion supports they receive. Non-DEIS leaders were on average three times more likely to enlist the assistance of outside experts to aid the teaching and learning of Mathematics. Leaders in small schools displayed a greater propensity to engage in mathematics-specific mentoring and advising of newly qualified teachers, whilst their counterpart leaders in larger schools offered more frequent support to relatively experienced colleagues.

4.4.1.3 The More Prolific Middle-Management Mathematics Leader

Teacher-leaders with an assigned, formalised responsibility for Mathematics were on average over four times more prolific in their self-recorded leadership actions during the logging period (n=64), when compared to leaders from a more collaborative, committee-type structure (n=14). It can be speculated that individual activity within such co-operative leadership structures is likely to be below that recorded by other leaders, given the greater collective yield that is likely to emerge through such shared leadership over time. Further analysis of the logged actions of the sample reveals that unpaid, voluntary leaders were on average seven times less active (n=9) than their remunerated, formally recognised counterparts (n=64).

It is important to acknowledge the effect that formal delegation of responsibility (and the accruing financial reward) is likely to have on the aforementioned comparisons. Significantly, post of responsibility holders are formally accountable to their boards of management for executing their role. Furthermore, many of their typical functions incorporate some aspect of "public performance" (addressing colleagues, mentoring, distributing equipment etc.…). Whilst this implies the obvious obligation to fulfil their duties, it perhaps also entails a subtler pressure to be seen to do so also. When asked to comment upon her colleagues' perception of the work she engages in as part of her post of responsibility, Participant F noted:

> *"I think they would say I do a lot of work for Mathematics in the school, that I... I suppose they would say to me that they think I would have a great love for maths because I always seem to be working for maths in the school. They would probably say I am always willing to help them and give them resources and encouragement…"* (Participant F interview transcript)

By way of contrast, two unpaid volunteer leaders demonstrated less urgency to be visible in their work, but instead adopted a more reactive approach, subject to the time and energy that they willingly chose to devote to their informal mathematics leadership position:

> *"And I'm happy to do it and I'm happy to help but I'm here to help, not to do the job."* (Participant A interview transcript)
>
> *"I do think it is really important, I think there is great potential and… I know my limits. I don't beat myself up that I can't do it better, but I would love to see it being done well in the school. I am just… almost responding to fires, and just putting them out and waiting for the next one, which… is good that there is somebody to do that, but it would be great if there was some body who was genuinely leading maths".* (Participant E interview transcript)

4.4.2 A Strong Tendency to Pre-plan Mathematics Leadership Activity

Close to two thirds of the overall cohort's total number of actions were planned in advance, with some mathematics leaders having a percentage of pre-planned actions running at over 75% (Participants C, D, H). Such high proportions, including the sample's average, may be explained by the supposition that the more pressing teaching duties of eight leaders deprived them of opportunities for more "spur of the moment" interventions, instead having to carefully choose and plan for a time when they and/or colleagues were available to engage. Figure 4.5 above confirms that four of the cohort had an excess of unplanned actions (Participants A, B, G, I).

4.4.3 Overall Trends in Activity Emphases

The more detailed break-down of the 313 aggregated acts of mathematics leadership is revealing. It indicates the areas of greatest and least activity across, and between the sample, including the various models of leadership therein. The twelve domains of mathematics leadership activity, as described in 3.6.2, are utilised as classifications for this analysis. A number of interesting patterns emerge from this analysis.

4.4.3.1 Most Prolific Activity Domains

Unsurprisingly, procuring, organising or distributing resources to teach Mathematics emerged as the most dominant duty, attracting 52 out of the 313 classifiable acts, a 17% share (see figure 4.7). It appeared in the top three most prolific duties for six of the ten leaders, and it was the sole activity domain in which all ten leaders recorded outputs across each week of logged action. Indeed, leaders A, B, E and I reported that 30%, 41%, 71% and 43% of their respective actions were concentrated in this domain (see figures 4.8a 4.8b below).

Standing at close to 12% each of the overall share of actions, both advising and mentoring new colleagues on mathematics-specific teaching, learning and planning issues and advising and mentoring existing colleagues on mathematics-specific teaching, learning and planning issues were the joint second most prolific activity domains. Given the researcher's somewhat arbitrary decision to separate these two very similar duties, one could legitimately claim that advising and mentoring justifiably accounted for close to one quarter of all the actions of the sample, thus propelling it ahead of resource management as the most prominent mathematics leadership domain. It is fair to speculate that the growth in (mathematics) mentoring/peer-to-peer advising will continue in the coming years as in-school induction programmes, such as *Droichead,* continue to take hold nationwide. Participant J is typical of this shift – both her activity log and her interview transcript recorded multiple instances of ad hoc (mathematics) support to colleagues that arose due to her official mentoring role, and her team-teaching responsibilities:

> *"I am in class team teaching with the junior infant class teacher everyday who is an NQT. I am also mentoring her. While team teaching I have the opportunity to model teaching practice and to observe the NQT teaching."* (Participant J, Activity Log; 3rd December, 2018)

In one sense, the contrasting nature of the two most prolific duties represents a broader transformation in what curricular leadership now constitutes – the traditional view of school middle management having a more logistical purpose is now giving way to a form of leadership that seeks to have a more tangible influence on the teaching and learning processes within the classrooms. It is also significant to note that, within this sample, there was no discernible concentration in who was receiving this mentoring and advising support. Recipients were as likely to be teachers with at least one year's experience as newly qualified recruits. Although somewhat of an outlier within the sample, Participant I actually goes so far as to suggest that existing, sometimes long-serving colleagues are even more willing to access such expertise. This may indicate a previously undocumented appetite among mid- to late-career teachers to enhance their mathematics teaching capacity, given the passing of time since acquiring their initial teaching qualification:

> *…I should probably say that the younger ones would probably find it harder to come up to me than the older ones.*
> **Researcher: Why do you think that is?**
> *I'd say they're more comfortable with me.*
> **Researcher: That's interesting isn't it?**
> *Yeah, they don't know me as well I'd say as well.*
> **Researcher: Yeah. There's a trust element too.**
> *They know that I'm not going to talk rubbish to them.*
> **Researcher: Okay...**
> *Whereas the other ones that I don't know aren't fully sure just yet, I would say.*
> (Participant I interview transcript)

Figure 4.7 Distribution of Leadership Actions by Domain

Activity Domain	No. of Logged Actions (n: 313)	% of Sample's Total Logged Actions
Plean Scoile	14	4%
School Vision	35	11%
SSE	35	11%
Resources	52	17%
CPD	18	6%
Status	24	7%
New Colleagues	37	12%
Existing Colleagues	37	12%
External Services	22	7%
Testing	9	3%
Monitoring	12	4%
Parents	18	6%

Figure 4.8a Activity Breakdown by Domain – Per Participant

Participant	Plean Scoile	School Vision	SSE	Resources	CPD	Status	New Colleagues	Existing Colleagues	External Services	Testing	Monitoring	Parents
A	0	0	0	3	0	2	0	5	0	0	0	0
B	3	4	0	13	0	1	1	5	4	1	0	0
C	0	1	0	1	1	1	0	0	0	3	0	2
D	3	5	7	2	0	3	2	3	0	0	1	4
E	0	1	0	5	0	0	1	0	0	0	0	0
F	1	9	12	13	2	11	8	10	11	4	4	10
G	1	2	0	2	5	2	3	3	1	0	0	1
H	6	13	16	5	7	4	7	6	3	1	3	0
I	0	0	0	6	1	0	3	3	1	0	0	0
J	0	0	0	2	2	0	12	2	2	0	4	1
Totals Per Domain (n: 313)	**14**	**35**	**35**	**52**	**18**	**24**	**37**	**37**	**22**	**9**	**12**	**18**

Figure 4.8b Activity Breakdown (% of Participant Total) by Domain

Participant	Plean Scoile	School Vision	SSE	Resources	CPD	Status	New Colleagues	Existing Colleagues	External Services	Testing	Monitoring	Parents
A	0%	0%	0%	30%	0%	20%	0%	50%	0%	0%	0%	0%
B	9%	12%	0%	41%	0%	3%	3%	16%	13%	3%	0%	0%
C	0%	11%	0%	11%	11%	11%	0%	0%	0%	34%	0%	22%
D	10%	17%	23%	7%	0%	10%	7%	10%	0%	0%	3%	13%
E	0%	14%	0%	72%	0%	0%	14%	0%	0%	0%	0%	0%
F	1%	9%	12%	14%	2%	12%	8%	11%	12%	4%	4%	11%
G	5%	10%	0%	10%	25%	10%	15%	15%	5%	0%	0%	5%
H	8%	18%	23%	7%	10%	6%	11%	8%	4%	1%	4%	0%
I	0%	0%	0%	43%	7%	0%	22%	21%	7%	0%	0%	0%
J (n: 313)	0%	0%	0%	8%	8%	0%	48%	8%	8%	0%	16%	4%

4.4.3.2 Least Prolific Activity Domains

On the opposite end of the scale, preparing materials for, and/or involvement in the administration of, student mathematics testing/other assessment had the fewest number of logged actions (n=9). Given the somewhat seasonal nature of formal testing in schools, and the fact that logging did not capture either the beginning or the end of the academic year, it is unsurprising that six of the ten leaders did not register even one action in this category. Monitoring the standards of mathematics teaching and learning within the school also featured minimally (n=12), again only four of the leaders registered any activity in the domain. The reasons for this may be more deep-seated than the mere lack of opportunity. Cultural sensitivities surrounding peer/head-teacher observation weigh heavily in the Irish context and given such complexity, this finding will be interrogated more comprehensively in another theme. Other less prevalent activity domains included liaison with parents, localised promotion of PD opportunities for the subject (both n=18) and engagement with external supporting agencies (n=22).

4.4.3.3 In Focus: The Evolving Planning Role of Leaders

One final observation reflects the changing nature of school administrative and planning priorities. The activity data suggests a supplanting of developing the school plan for Mathematics with a stronger focus on the numeracy aspect of the SSE process. Leaders were on average two and a half times more likely to be attending to the self-evaluation process (n=35) than curating and updating the school plan for Mathematics (n=14). This prioritisation is also evident in the interview transcripts:

> *"If they want advice, if they want suggestions, they can come, right…you roll over your school self –evaluation, then you have your school improvement plan. Right, that'll tend to be fairly active as we now have re-engaged with it, and like that we've been pushing problem solving for the last few years."* (Participant B interview transcript)

> *"I suppose the main thing I think is… we had a really good school SSE around maths – we came up with a really good plan. Now a lot of that still is happening, it got very well embedded, some of the parts of that, but obviously that needs someone to keep the motivation going, to remind new staff and old staff and staff coming back from career breaks that this is what we do in maths."* (Participant E interview transcript)

> *"And obviously the school SSE in later times has become one of the big parts of my post…"* (Participant F interview transcript)

Participant F, quoted above, makes for a revealing case - thirteen of the fourteen references to SSE in her interview were made by the participant herself, were distributed throughout the entire transcript, and, were raised without the prompting of the interviewer. Her references to the school plan, are considerably less frequent, and tend to be rooted in the past, prior to the SSE era. Elsewhere, but in a similar vein, Participant H immediately responded by citing the success of her school SSE process when asked to describe teaching and learning of Mathematics in her school. This was a recurring pattern among participants who evidenced a particular planning focus within their mathematics leadership.

4.4.4 Activity Emphases between Leadership Models

Given the five contrasting leadership constructs that permeate this project's methodology, it is prudent to exploit these differing models as additional lenses to further understand the cohort's mathematics leadership activity. This analysis is broken into two specific sub-sections. Voluntary leaders, promoted leaders and DEIS-school leaders are clustered together as one leg of this investigation, and this follows in sub-section 4.4.4.2. Firstly, it is worth scrutinising how teaching principals and administrative leaders compare in terms of how they allocated their leadership time and emphases.

4.4.4.1 In Focus: Contrasting Activity Emphases of Teaching and Administrative Principals

In considering the trends between the project's identified models of leadership, areas of activity did not differ to any noticeable degree between teaching principals and administrative principals. Indeed, the average proportion of activity devoted to resource management, enhancing the school-wide profile of Mathematics, mentoring and supporting new colleagues in matters pertaining to the subject, and, engaging with external services to support mathematics teaching and learning, were largely similar across both principal sub-cohorts (see figure 4.9a on the next page). Despite this, there were some deviations between both groups that are worth noting.

Teaching principals did, on average, spend a greater share of their time liaising with parents but this can be reconciled by the scheduling of parent-teacher meetings during the logging windows of one of the teaching principals. The two administrative principals in the sample (Participants G and H) made no reference whatsoever in their logs or interviews to specific, personal involvement in promotion of Mathematics among parents. It should be noted, however, that both of their schools continue to make commendable efforts to enhance parental participation in the mathematics teaching and learning process. By way of contrast, these two leaders devoted on average close to one third of their actions to tasks that fell under the school planning/administration umbrella, a likely typical competence for administrative principals. The comparable figure for this category of action stood at 20% in the case of teaching principals. Indeed, two of the three participants within this cohort engaged in no activity whatever relating to the school plan for Mathematics or numeracy-related school-self-evaluation work during the logging period (Participants C and J). This contrasts sharply with one administrative principal (Participant H) who devoted 23% of her output to simply coordinating SSE alone. One could speculate that the absence of teaching duties did free up administrative leaders to engage in more subject-specific administrative planning duties during the typical working day.

Figure 4.9a Activity Breakdown (% average) by Domain – Per Leadership Model

Domain	Admin. Principals (n=91 actions)	Teaching Principals (n=64 actions)	Promoted Teacher Leaders (n=127 actions)	Volunteer Leaders (n:17 actions)	Collaborative Leaders (n=14 actions)
Plean Scoile	6%	3%	5%	0%	0%
School Vision	14%	9%	11%	7%	0%
SSE	11%	8%	6%	0%	0%
Resources	9%	9%	27%	51%	42%
CPD	17%	6%	1%	0%	7%
Status	8%	7%	7%	10%	0%
New Colleagues	13%	19%	5%	7%	22%
Existing Colleagues	12%	6%	13%	25%	22%
External Services	4%	3%	13%	0%	7%
Testing	1%	11%	4%	0%	0%
Monitoring	2%	6%	2%	0%	0%
Parents	3%	13%	6%	0%	0%

4.4.4.2 In Focus: Contrasting Activity Emphases of Voluntary Leaders, Promoted Leaders and DEIS School Leaders

As a proportion of their overall actions, volunteer leaders devoted over 50% of their combined efforts towards managing physical resources, with a further third of their actions focused upon mentoring colleagues. This category of leader registered inactivity in seven of the twelve activity domains. Amongst these non-existent areas of inactivity were coordinating the ongoing

SSE processes in Numeracy, monitoring the standards of mathematics teaching and learning within the school, and, curating and or/redeveloping the school plan for Mathematics (see figure 4.9a).

This finding reinforces the more ad hoc, reactive commitment that voluntary, unpaid leaders are willing to give to the role. Similar trends are also found in the data provided by leaders who form part of mathematics leadership collectives; their actions were largely confined to resource management (43%), mentoring/advising colleagues (42%) and promotion of continuous development opportunities (7%).

Designated post-holding leaders showed much more diversity in their duties and were active across the entire range of activity domains. By further contrast, only a quarter of their typical work involved mathematics resource management, whilst a further quarter of their aggregated activity was focused upon internal school planning and evaluation processes. It would appear that leading school planning processes for Numeracy remains a competence that is generally assigned to middle and/or senior management, and is a duty that volunteer leaders appear to avoid or are not assigned to. This was confirmed by the interview transcripts of Participants B and F (both middle management, post holders) who were tasked with co-leading school planning processes. Participant A (a voluntary leader) indicated that his principal was reluctant to assign him cumbersome planning duties for fear that this might overwhelm the enthusiasm to be a practical support to colleagues, and so jeopardise his existing voluntary contribution.

Other small, inconspicuous differences in mathematics leadership emphases were found between DEIS and non-DEIS school leaders, and similarly between participants in large and small schools. As a revealing example, the proportion of actions devoted to SSE for Numeracy, curating the school plan for Mathematics, resource management in the subject area, mentoring/advising colleagues on Numeracy issues, and promoting continuous PD in Mathematics are virtually identical for leaders in small and large schools (see figure 4.9b on the next page). This trend of relative homogeneity echoes the general comparison between teaching and administrative principals earlier. It also consolidates the broader assertion that, barring the outliers flagged throughout this section, many of the participants (irrespective of leadership model) displayed a noticeable degree of commonality in the type of work they did as part of their mathematics leadership role. Divergences become more evident when issues of role conceptualisation and the challenges of real-time enactment are teased out in subsequent sections.

With this firmer understanding of the cohort's overall activity patterns, and the specific activity emphases within the various leadership models, it is now timely to consider the remaining themes. The complex issue of PD experiences and needs, as articulated by the participants, forms the cornerstone of the second theme.

Figure 4.9b Activity Breakdown (% average) by Domain – Additional Leader Categories

Domains	Principals (n=155 actions)	Non-Principals (n:158 actions)	DEIS Leaders (n:57 actions)	Non-DEIS Leaders (n:256 actions)	Small-School Leaders (n:71 actions)	Large-School Leaders (n:242 actions)
Plean Scoile	5%	2%	5%	3%	3%	4%
School Vision	11%	7%	14%	7%	10%	8%
SSE	9%	3%	8%	5%	6%	6%
Resources	9%	40%	29%	22%	24%	24%
CPD	11%	2%	8%	5%	5%	7%
Status	7%	7%	7%	8%	5%	9%
New Colleagues	16%	9%	12%	13%	17%	10%
Existing Colleagues	8%	20%	8%	16%	5%	20%
External Services	3%	6%	2%	6%	2%	7%
Testing	7%	1%	0%	6%	8%	1%
Monitoring	5%	1%	1%	4%	5%	1%
Parents	9%	2%	6%	5%	10%	3%

4.5 Theme Two: PD please, but not as we know it!

As this research focused upon the leadership of teaching, learning and promotion of Mathematics at the localised school level, it was inevitable that the self-expressed PD needs of the sample would loom large in the findings. A brief acknowledgement of the mathematics-specific PD history of the cohort is important to set a context. This background may go some way to rationalising the participant's idealised PD, and its differing emphases. This particular strand of the analysis will heavily contribute to the final policy-level recommendations of the dissertation.

It quickly became abundantly clear to the researcher that not one of the cohort had personal experience of mathematics-specific leadership PD. It was evident that their suggestions represented a strong hunger for provision that is not yet available to mathematics leaders in Ireland.

4.5.1 Shallow Previous Mathematics-related PD

Before examining the exigencies as expressed by the ten leaders, it is beneficial to audit the cohort's previous mathematics-related PD experiences, as ascertained by the questionnaire/profiler. Figure 4.10 below demonstrates a broad homogeneity in the nature of career PD undertaken - all but one of the participants had completed a mathematics-specific teacher summer course on at least one occasion. Half of the cohort had undertaken a minimum of one comparable evening course during term-time over the last five years. A further six of the ten had completed PDST training for mathematics leaders, typically (but not exclusively) around coordinating the SSE process in Numeracy.

Only four leaders (Participants A, D, F and H) indicated that, over the course of their careers, they had engaged in more than two different formats of the six categories of mathematics-specific PD offered in the questionnaire/profiler. These categories were as follows:

- Teacher summer course.
- In-term evening course.
- PDST training for mathematics coordinators.
- Further undergraduate studies.
- Further postgraduate studies.
- Some other unspecified form of relevant upskilling.

Participant A, significantly one of the voluntary leaders within the sample, was the sole partaker who has successfully completed accredited PD, singularly focused upon mathematics education. His Masters in Mathematics Education award represents a substantial deviation from the others, not only in terms of the commitment involved, but also the depth of investigation into the discipline at hand.

In summary, the cohort's mathematics-specific PD history could, at best, be described as patchy. It reveals an extensive experience of generalised teacher summer courses, a smattering of PDST-offered coordinating training, and a noticeable dearth of university-based theoretical upskilling in mathematical subject knowledge or pedagogical expertise.

Figure 4.10 Previous Mathematics-related PD per Participant

Participant	Teacher Summer Course	In-term Evening Course	PDST Training for Maths. Coordinators	Further Undergraduate Studies	Further Postgraduate Studies	Other
A	√	√			√	
B	√					
C	√		√			
D	√	√	√			
E	√					
F	√	√	√			
G	√		√			
H	√	√	√			
I			√			
J	√	√				

4.5.2 Idealised PD

Without equivocation, all participants unanimously agreed that ongoing, additional PD was unquestionably demanded by their leadership role. Equally, all but one leader expressed a strong willingness to participate in such upskilling were it to become available in the future. In an attempt to explore what this PD might entail, the researcher proposed a hypothetical scenario to participants where the local education centre had sought their opinion on what material should form part of an upcoming course specifically geared towards mathematics leaders. The scenario presumed a face-to-face method of delivery. Participant F immediately identified the lacuna in current provision for leaders:

> *"There probably is, you know there would be courses run by PDST which are mainly just curricular based, they don't really teach you how to lead maths. I would have engaged in a few in later years…"* (Participant F interview transcript)

This confirms the findings of the literature, as outlined in sub-section 2.6.2, where the dearth of leadership-focused mathematics PD was identified as a regrettable feature of the Irish context. Reflecting the experiences of Participant F, many of the leaders found it difficult to articulate a form of PD that went beyond their previous experiences of exclusively curricular and/or methodology-centred upskilling. It required a considerable amount of interviewer probing to encourage participants to engage in the intended "blue skies" thinking.

The overall mathematics-specific PD record of the sample is noteworthy in the context of the subsequent discussion. It is entirely plausible that such a relatively shallow PD history may have had a limiting effect upon the expectations that the participants possessed about the content and format of mathematics-specific PD for school leaders. Their important, if somewhat restricted, PD suggestions are outlined in the following sub-sections. Principally, the suggestions cluster around issues of personal mathematical competency, pedagogical knowledge, generalised leadership skills, and a collection of other secondary foci. This discussion of expressed need should also be seen in the context of this analysis' third theme (section 4.6) where the mathematical, pedagogical, organisational and generalised leadership skills-base of the cohort is interrogated. As a further complement to the discussion, other ancillary (mostly logistical) idealised supports proposed by the leaders will also be set out.

4.5.2.1 Idealised PD – Competency Focus

Issues of personal competency loomed large for all the leaders. Participant A proposed that a reprise of key subject-matter knowledge, to a 6th class standard, would be required as a preliminary module for any PD. A handful concurred with this suggestion. However, there seemed to be no desire among the cohort to engage in mathematical competency work that strayed into second-level content. This is somewhat surprising given that five of the cohort were teaching either 5th and/or 6th class at the time of the study. One might have expected that teachers at these grade levels would find it useful to possess a renewed foothold in the mathematics content that their pupils would soon be experiencing at second level. This may point to the practicality of the cohort in prioritising what is likely to derive a more immediate benefit, given the articulated time constraints under which they operate. This probable pragmatism is further underlined by the finding that Participants G, H and J, all principals but all without mainstream class teaching duties, did not prioritise issues of competency within their envisaged PD. One can presume that such issues simply do not arise in their daily work, thus insulating them from this imperative.

Unsurprisingly, classroom teachers, such as Participants A, C and D, were much more strident in their view that subject-matter knowledge be a core component for any upskilling offered to mathematics leaders. Participant C went further to suggest that specific input to better support colleagues with significant proficiency challenges might be useful. This was clearly based on his own experience of having to respond to competency queries from colleagues. Significantly, Participant B brought a very personal perspective to this competency dilemma. Irrespective of holding a mathematics leadership position, and the fact that some of her peers perceived this as conferring some degree of "expert status", she was unafraid to acknowledge gaps in her personal knowledge, and to openly express a willingness to address such deficiencies:

> *"What would I like covered? You see probably, again this is my own insecurities, I would probably like my own weaknesses in maths addressed first."* (Participant B interview transcript)

Clearly, when teachers are struggling with issues of competency, many see the local mathematics leader as a refuge for support and practical assistance. Consideration of Participant B's honest admission above does prompt a question – to whom does the leader turn to when they are in need of such support themselves? This further supports the case for bespoke PD.

4.5.2.2 Idealised PD – Methodology Focus

Reflecting their previous experiences of beneficial PD across the curriculum, many of the participants articulated a need for exposure to new and innovative teaching methodologies which could then be disseminated to colleagues back at school. Participant C clearly expressed this prerequisite:

> *"They (attendees) need something to bring back. They need something hands-on… you can be… as aspiring leaders say, "I want to be better at maths", but you need to give hands-on ideas, things that work"* (Participant C interview transcript)

This requirement is elaborated upon by another of the cohort:

> *"I feel I need to be going to staff with something concrete, you know. We always say that teachers like to come away from in-service with resources and I feel the same. If there is a course around leading maths, I would be thinking with a teacher hat on – what are the things that would help me in the teaching and learning of maths."* (Participant H interview transcript)

Specifically, participants detailed their desire for:

1. Additional ideas to better differentiate mathematics teaching.
2. Greater access to modern digital resources and concrete manipulatives to support a more interactive teaching and learning experience.
3. Enhanced exposure to more formative approaches to pupil-led assessment in Mathematics.

Additionally, there was also noticeable demand for input on new approaches to the teaching of multiplication and division tables, play-based methodologies that build on the *Aistear* curriculum framework (NCCA, 2009), and the more focused used of mathematics games as a viable methodology. Although each of these methodology-focused petitions are laudable, the researcher's urgings that participants should foreground the leadership aspect of their work when suggesting PD content did yield further, more pertinent suggestions.

4.5.2.3 Idealised PD – Leadership Focus

Participants were discerning, to varying degrees, about the actual nature of their desired, leadership-focused PD. Primarily, they wished for leadership upskilling which enabled them to practically assist, while simultaneously enhancing the enthusiasm of colleagues when teaching Mathematics. Participant A proposed this dual focus:

> *"People skills in terms of motivating people and what motivates people and how to, how to… to tap into people's interests and how to make them passionate about maths."*

(Participant A interview transcript)

He subsequently elaborated on what this passion entails:

> *"I mean (being) able to engage with the maths and enjoy the maths and make maths fun. And I believe that's from getting the teachers to do the maths themselves…"* (Participant A interview transcript)

The person-centric focus, as described above, has obvious parallels with the evolving affective leadership movement (see Guy et al., 2008), which seeks to understand and harness the positive human factors that propel feelings, thoughts and actions. When dealing with impressionable colleagues, a leader's efforts to emphasise the professional fulfilment of personal mathematical development, to model the sheer enjoyment of mathematics teaching, or, to simply express the gratification that comes from pupil achievement is the outworking of such an affective approach. Somewhat disappointingly, Participant A was the sole leader who communicated an understanding of this somewhat unexplored leadership dynamic. The remainder of the cohort retained a more transactional, and somewhat distant interpretation of their mathematics leadership role. As typified by Participant B, all leaders (save Participant A) focused on providing the required physical conditions, as they perceived them (concrete manipulatives, manuals, team-teaching support, recruitment of external experts, promotion of PD opportunities), as the mainstay of their leadership interventions.

Structured opportunities for leaders to build a familiarity with team-teaching approaches, and the array of skills that fall under the mentoring umbrella, were other pertinent suggestions generated by the sample. Although somewhat outlying in her opinions, Participant J prioritised the building of generalised leadership skills over any mathematics-specific content. Her thesis proposed that competency is a given amongst mathematics leaders, and therefore it is the capacity to productively lead that is the key aptitude. She explained her decoupling philosophy in succinct terms:

> *"So I think it is about leadership skills, as opposed to maths skills. We are all qualified primary school teachers so we are all qualified to teach maths, do you know what I mean? So we all should have familiarity with the maths curriculum… em… so I think what is important in leading any curricular area in school is actually leadership skills."* (Participant J interview transcript)

Expanding upon this idea of a distinct leadership skillset, Participant C also hinted at a need for mathematics leaders to become more empathetic, and display greater emotional intelligence, when interacting with colleagues, irrespective of their experience or mathematical prowess:

> *"You see… here's the difficulty – I lead maths in my school, right? But every teacher in my school is as equally qualified as I am. They may not have my experience but they are equally qualified. Okay? So you can't necessarily talk down to someone who is as qualified as you… it would be unfair and unreasonable and they may have skills in other areas that you would not necessarily have."* (Participant C interview transcript)

4.5.2.4 Idealised PD – Analytical Nous

Building capacity to critically interrogate the large volume of whole-school performance data, (be they standardised test scores, report cards, teacher-filled checklists, pupil portfolios) were suggested as a necessary PD focus by many leaders. It was Participant I's assertion that only through quality analysis of such triangulated data sources that schools will fully recognise the direction that their planning and teaching processes need to move in. This is particularly interesting in light of the analytical burden that the SSE process has foisted upon schools (DES Inspectorate, 2016), and the high stakes decisions that are often premised upon the in-house analytical skills of the teaching staff, or perhaps of just one individual therein.

4.5.2.5 Idealised PD – Specialised Interventions

Another participant ventured that PD for mathematic leaders needs to put school improvement on a more sustainable footing, less reliant on outside experts. Building on personal experience, Participant A illustrated how his experience of upskilling in the "*Lesson Study*" approach resulted in considerable benefit, not only for himself personally, but also his colleagues. Training mathematics leaders in other, equally specialised interventions, such as "*Maths Recovery*", "*Mata sa Rang*", "*Maths For Fun*", "*Ready, Set, Go Maths*", could ensure that individuals are sufficiently skilled (and credible) to promote innovative mathematics teaching and learning within their own schools. Although universally available to mathematics leaders in Ireland, and heavily promoted within the education community, neither qualitative nor quantitative data bases contained one single participant reference to any of these training opportunities.

4.5.2.6 Idealised PD – School Development Planning

Given their focus on the more administrative burden upon schools, it was unsurprising that a clear majority of the principals within the cohort insisted that meaningful PD should also offer advanced guidance in school development planning that would support ambitious intentions for the teaching and learning of Mathematics. One leader predicted that this need for additional planning capacity would be significantly increased by the forthcoming introduction of a new mathematics curriculum, and the whole-school planning implications this would entail. Displaying an acute awareness of the broader curricular provision of primary schools, Participant D identified a need for planning support that allowed for more natural integration of Mathematics within the emerging STEM (Science, Information Technology, Engineering and Mathematics) configuration. This is likely to be another huge area of demand from school leaders going forward.

4.5.2.7 Idealised PD – The Networking Dividend

Lastly, an incidental spin-off benefit from specialised PD that brings mathematics leaders together is the networking legacy that this creates. A tangible synergy is undoubtedly created when a community of mathematics leaders work alongside each other, sharing experiences and co-operatively grappling with the common challenges of their role. No such structure currently exists as starkly demonstrated by Participant D's observation:

> *"I don't know any maths leaders... Like I have never sat in a room with someone and discussed maths leadership, you know!"* (Participant D interview transcript)

Citing her experience of PD that was aimed at music leaders within primary schools, Participant F notes the value of learning from experienced peers who had led curricular areas in their own schools. In her interview, she developed this idea by noting the mentoring potential that such learning communities might give rise to:

> *"I would have liked maybe an external mentor, maybe someone in another school, that was already a maths leader or someone that could have knowledge of maths leadership that could point me in the right direction."* (Participant F interview transcript)

When asked to describe her ideal leadership mentor, Participant F continued:

> *"Someone who has already done it, in another school or someone with expertise or a qualification in maths leadership. Maybe someone who has a qualification in mathematics education who is a teacher. I would have liked it from someone who was*

> *currently actively teaching in school, who is actually doing it…"* (Participant F interview transcript)

Given the proliferation of mentoring structures at all levels within the Irish school system, whether for induction of NQT's or the initiation of freshly-appointed school leaders, it is entirely possible that similar arrangements could be also applied to support curriculum leadership grades within primary schools.

4.5.3 Other Ancillary Supports: Dedicated Release Time and Finance

Unsurprisingly, the entire cohort cited time pressures as an obstacle to satisfactorily meeting the various demands of their mathematics leadership role. Therefore, their clamour for additional time (particularly release time for teaching leaders) was inevitable. Given the centrality of this issue to the very sustainability of local curriculum leadership, the issue of when leaders lead, and to what extent per day/week, will be scrutinised in a distinct, separate theme (see section 4.8 "Leading while Teaching – Mission Impossible?"). Suffice to say, this theme will depict a cohort of time-poor mathematics leaders, who struggle to juggle competing demands, whether from behind the teacher's table or the principal's desk. Participant D, a teaching principal, was a typical case in point:

> *"Time! Time to… you know… a couple of days out of the classroom to have a look at some practical stuff that is going on. To maybe do an online course or two… I mean the chances of me doing a maths CPD course this year are slim, you know I'd love to have the opportunity to have a couple of days training with the PDST or whoever else is delivering it…"* (Participant D interview transcript)

Requests by the leaders for additional financial support to further mathematics teaching and learning in their schools were also littered throughout the interview transcripts. Purchasing of additional teaching manipulatives, of licences to use specialised mathematics software, and, of professional development opportunities (via payment of fees and/or substitute cover for such days) were noted as tangible manifestations of such commitment. Participant J, a teaching principal of a developing school, commented upon her self-perceived duty to ensure that budgets be ring-fenced to support the core curricular areas.

From the other perspective, Participant B made a point of complimenting her own school principal for financially supporting her various mathematics initiatives, and further opined that this vital support makes a crucial difference to her work. This demonstration of collegiate support touches upon a broader point, exemplified by four of the five teaching leaders specifically when referencing the positive influence that practical, and personal support from their respective principals had upon their work. Participants A and E both further developed this point to speculate that greater collective buy-in from the entire in-school management team could significantly enhance the impact of their voluntary curricular leadership. This suggestion, and its possibilities, will form a central part of a later theme (see section 4.8) which critiques the sustainability of single-person leadership structures, as operated by nine of the ten participants.

Despite initial and understandable reluctance, the eventual PD suggestions made by this cohort represent a crucial component of this study. They demonstrate the unquestioned value of stake-holder consultation when designing meaningful PD programmes. As referenced in this present discussion, consideration of the expert-nature of mathematics leadership is an important complement to any discussion of the cohort's PD needs. This focus on the specialist nature of the role, and the skills base that underpin it, will form the corner-stone of the next theme.

4.6 Theme Three: Mathematics Leadership and its Skill Set – Expert or Not?

Although the predominant stance of the literature affirming the expert-nature of mathematics leadership has already been explored in Chapter Two (specifically section 2.5), the researcher felt it important to test this assertion through the participants' opinions and experiences. Indeed, it can be suggested that this strand of the analysis represents the core raison d'être of the research itself. If Irish policy makers can better "experience" the role through the eyes of local mathematics leaders, and get a sense of the professional demands it entails, it may buttress a more compelling case to acknowledge, and adequately resource this crucial leadership role.

Three distinct data sources informed this particular analysis:

1. The self-assessment of participants' personal comfort with general mathematics competency and knowledge of mathematics pedagogy.
2. Interview responses to the "expert" label being ascribed to their work by the researcher.
3. Investigation of the range of skills utilised by the leaders during the two logging windows.

Given the mixed-methods orientation of this research, the complementary exploitation of all three data sources provided added confidence in what emerged.

4.6.1 Self-Assessed Mathematics Competency and Pedagogical Knowledge

Participants were asked to evaluate their own level of personal competency of primary school Mathematics, via the questionnaire/profiler instrument, and to use a continuum ranging from 1 to 4 in order to quantify this rating. 1 represented "*not competent*" and 4 denoted "*highly competent*". All but one of the participants self-awarded a "*highly competent*" rating – the outlying participant self-graded as "*somewhat competent*". This preponderance of high ratings is not itself indicative of an expert cohort. As asserted by Participant J, one would legitimately expect that all fully qualified teachers (not just mathematics leaders) are sufficiently competent to teach Mathematics to a 6th class standard, and that this upper primary standard should be reconceptualised as a baseline competence rather than a ceiling in order to practice.

Given the sometimes erratic connection between personal mathematical competency and pedagogical proficiency (see Greaney et al., 1999), the researcher also requested that participants self-asses their "personal knowledge of the field of mathematics pedagogy". As before, a continuum ranging from 1 ("*poor knowledge*") to 4 ("*a high level of knowledge*") was exploited. Seven of the cohort self-rated at the highest level of knowledge, with a further two participants self-plotting as "*knowledgeable*". One leader self-assessed at a 2 rating, which equated to "some knowledge". This same participant had previously admitted to gaps in her own personal mathematics competency. Whilst these largely positive overall ratings were useful in providing insight into the self-perceptions of the participants, they were insufficient to confidently ascribe expert status to this cohort.

At this juncture, a caveat must be acknowledged – the self-evaluations offered by the participants were entirely subjective, and were based on a personal interpretation of what each classification entailed. The researcher did not offer any benchmarks or indicators of mastery that might guide the participant in their responses. Therefore, as an example, it must be appreciated that what one leader considered as "*poor knowledge*" may in fact be ranked as "*knowledgeable*" by another. What is noteworthy though is that seven of the ten leaders self-ascribed the highest available ranking of both personal and pedagogical mathematics competency. This consistency is significant and does support the already established, obvious connection between mastery of both disciplines. Furthermore in this regard, it is also striking that the lowest self-rankings noted for both disciplines were awarded by the same participant.

A further point worth considering is an inherent conflict that emerges in the data here. Despite largely professing a very high level of pedagogical knowledge, sub-section 4.5.2.2 makes it clear that many participants retained a strong appetite for additional, methodology-focused PD. One could view this anomaly in a benign light by interpreting this demand as an enthusiasm to maintain, or possibly even further enhance an existing high level of pedagogical content knowledge.

4.6.2 Participant Reaction to the "Expert" Label

As part of the protocol for the semi-structured interviews, participants were asked whether or not they believed that one needed to be a "mathematics expert" in order to be an effective mathematics leader, and by extension, if they could be considered as an specialist in the discipline. Interestingly, not one participant unconditionally accepted the personal label of mathematics expert. Participant F alone observed that as she held no mathematics-specific qualification, this disqualified her from such standing. It is also quite likely that modesty may have prevented some leaders from answering in the affirmative, in particular the inference that they might be self-identifying as being superior to colleagues in some way. Participant A gave voice to this self-effacement:

> *"Now you don't want to be the "I'm the oracle" scenario either."* (Participant A interview transcript)

Interestingly, some of the participants did concede that fellow teachers on staff do perceive them as an authority (Participants A, C, D and F being cases in point), however all were keen to distance themselves from such ascribed eminence. When rationalising their rejection of the specialist characterisation, there was a certain commonality in the responses with a base-line competency and proficiency being the preferred perception of their expertise:

> *"I don't think you need to be an expert but I do think you need to have a good level and a good understanding of the mathematical content of the curriculum at the very least."* (Participant A interview transcript)

> *"Because I think that if you are confident and competent, that will communicate itself to people as well. So the door is more open… Well, expert is too high. I think there is a competency level."* (Participant B interview transcript)

"So I think if you are proficient enough in maths and you understand the concepts that you are trying to teach well, not just answering the questions in the book, but being able to understand why they work the way they work." (Participant C interview transcript)

"I don't think they have to be an expert but they need a high level of maths competency." (Participant F interview transcript)

Unlike the vast majority of the sample, Participant E suggested that the required level of competency is an evolving dynamic, responsive to particular school demands, and more generally, is a proficiency that can develop over time:

DB: Does that maths leader need to be able to prove their competency to a superior level?

I don't think so, no. I think so long as they are willing… we'll say something that comes up which is a bit of a new challenge, that they are willing to go off and research it, find out and build their competency as they go, I don't think they need to have it all coming in to the job.

(Participant E interview transcript)

In a somewhat similar vein, Participant H, an administrative principal, drew upon an interesting analogy to explain her position:

"They don't have to be experts... you know the director of the orchestra doesn't have to play every instrument but they need to be interested in it and in upskilling to enhance their own skill set." (Participant H interview transcript)

Participant J turned the competency question on its head and suggested that teachers who may have struggled with competency in the past may have a better empathy with mathematics learners who also find it particularly challenging:

"No, they don't need to be an expert… in my experience teachers who weren't particularly good at maths in school are actually very well able to teach it because they have to think a think a little bit more about it." (Participant J interview transcript)

She went on to challenge the widely held misconception that a high level of teacher mathematical competency is a guaranteed indicator of effective classroom performance:

"Whereas for some people you know, it may have come very easily… maths and you know whereas then when you are trying to teach or explain why two and one makes three and trying to explain that to the children, sometimes a teacher who struggled with maths might be able to do that better. So you don't necessarily have to be an expert at all." (Participant J interview transcript)

Whilst the cohort held largely similar views on the competency and methodological requirements (bar the aforementioned Participant J), the researcher chose to extend the line of questioning to ask participants to describe the ideal mathematics leader. Although uncomfortable with the expert tag, perhaps participant responses to this query might shed light on the more specialist aspects of their leadership work.

4.6.3 Participant Characterisation of the Ideal Mathematics Leader

Participants characterised their ideal mathematics leader within the following constructs:

1. *Affinity towards Mathematics:* Once aspects of mathematical competency and methodological knowledge are set aside, the characterisation of the model mathematics leader elicited significant engagement from the sample. Unsurprisingly a personal interest and positive disposition towards the discipline itself emerged as a prominent prerequisite:

   "It's hard to be good at something you don't like because you have to put the time into it. It doesn't seem like time when it is something you are interested in." (Participant C interview transcript)

   All bar one of the participants gave a strong impression of having a particular affinity for the subject. This subject-specific attraction was a particular factor in the case of the voluntary leaders, and was clearly articulated by Participants A and I on more than one occasion.
2. *Organisational Ability:* An aptitude in logistical work was referenced by over half of the participants. This is unsurprising given the relatively high proportion of the leaders' logged actions that corresponded to the procurement, storing and distribution of manipulatives to support the teaching and learning of Mathematics (17% - see figure 4.7). As schools often rise and fall on their organisational routines, this aspect of curricular leadership should not be under-estimated. The associated need for administrative competence, be it the curation of school planning/policy documents or fulfilling other additional bureaucratic requirements, was also identified as a key characteristic of the ideal mathematics leader.
3. *Broad Teaching Experience:* Others asserted that an aspiring mathematics leader ideally should have experience of teaching at the various grade levels in primary school, thus affording them an overview of the curricular progression and pedagogical

emphases from year band to year band. Acknowledging his mostly senior primary experience, Participant D addressed the challenge this presents:

"There would be issues there about just how much of a whole staff approach it is to maths in a vertical school when you have staff whose experience is mostly on the junior scale of things and then you have other staff whose experience is mostly on the senior scale of things…" (Participant H interview transcript

Participant F expanded this point further when she stressed that a mathematics leader needs a certain degree of "classroom credibility" in order to influence the teaching approaches of colleagues. Although now a special education teacher, she noted that her recent classroom experience (of two decades) afforded her a degree of empathy with the challenges faced by colleagues, combined with a sense of realism of what was practicable when implementing new initiatives. All three teaching principals in the sample noted that much of their natural authority with colleagues derived from the fact that they taught Mathematics on a daily basis, and as such had a vested interest in ensuring that changes in pedagogical approaches were well-thought out, not frivolous flights of fancy. Clearly this has implications for non-teaching, administrative leaders who may potentially run the risk of alienating colleagues when making unreasonable demands that they will not have to personally implement. Within the sample, Participant H (an administrative principal) was quick to reference her experiences of filling in for absent teachers as a medium she deliberately exploited to familiarise herself with the reality of mathematics teaching and learning in her school. This insight clearly informed her thinking around Mathematics, and her arising leadership emphases.

4. *Familiarity with the SSE cycle:* Reflecting the enhanced current concentration on SSE, and an easing of external oversight, participants were eager to emphasise the more analytical and strategic demands of the role. Assessing the school's teaching and learning performance, from a variety of perspectives and with sometimes incompatible data sources, is a significant leadership challenge. Exploiting this information to craft a context-specific improvement plan also demands competent management. Participant D articulated this new, and more complex leadership landscape:

"You need to be able to synthesise information from so many different sources, whether its circulars, whether stuff from the PDST… there is an onus on you to try to keep up to date, and that's a tricky thing in itself because you're been stretched in so many different directions." (Participant D interview transcript)

5. *Analytical and Emotional Intelligence:* Participants F and I made explicit reference to the need for analytical nous in order to "get behind" standardised testing data, and to craft achievable, yet locally appropriate targets for improvement. This also pre-supposes an ability to lead colleagues in the formulation of a coherent strategy and the accompanying leadership skillset to ensure that the plan is implemented appropriately. This has implications for the leader's interpersonal dexterity, as highlighted by Participant J who gave this competence pre-eminence above any mathematics-specific capability. This assertion is also reflective of the some 56% of her leadership actions that this leader devoted to mentoring, which of itself is a very relationship-centric form of leadership intervention. Participant G, with a comparable activity profile to the aforementioned Leader J, also targeted the interpersonal dimension of her leadership role. Similarly, Participant F prioritised facilitative skills, particularly when dealing with her large staff who had infrequent opportunities to come together to discuss curricular and pedagogical issues.
6. *An Interest in the broader STEM Configuration:* Other participants noted the desirability of mathematics leaders having a heightened interest in disciplines that form part of the STEM configuration. It is likely that this is a tacit acknowledgement of the stated intention of Ireland's curriculum advisory agency that mathematics teaching become a more integrated and life-applicable discipline (NCCA, 2017). Unsurprisingly, additional expertise in information technology was explicitly referenced by some interviewees. A supplementary involvement with Mathematics outside of the school setting was referenced by Participants A and D. It is revealing to note that both of these leaders share considerable experience of teaching mathematics competency classes to student teachers in the same Dublin higher education institute.

4.6.4 Skillset Exploited by the Leaders

Whilst the emerging picture of the sample's ideal mathematics leader is quite evident, it was important to corroborate this profile by examining the broad range of skills and dispositions that the ten leaders drew upon during the logging windows. This data provided a more objective and credible source upon which the suggested dispositions of the model leader could be authenticated. As outlined in sub-section 3.6.2, participants were asked to indicate the expertise that they drew upon for each and every recorded act of mathematics leadership. Eight distinct aptitudes were offered per intervention: *organisational skills*; *mathematical competency*:

pedagogical knowledge; curricular knowledge; mentoring skills; facilitation skills; analytical skills, and finally *consultation skills*.

Figure 4.11 provides an overview of this logging data. Organisational skills accounted for a dominant one quarter of the skills utilised, followed closely by curricular knowledge at 21%. Whilst the pre-eminence of organisational skills is unsurprising, especially given the priority this competency was afforded by participants during their interviews, the focus on curricular knowledge was not similarly anticipated. In the first instance, it was not explicitly referenced by any interviewee as a key competence, nor did it appear in the literature as a prerequisite to lead. There has been a considerable rolling out of curriculum supports to all teachers in recent years – such curricular information could not be considered as privileged or inaccessible. It is likely that curriculum knowledge was most heavily accessed by leaders in schools where use of textbooks was being actively reduced. This possibly triggered consultations about curricular guidelines among teaching staff. As a case in point, Participant D's relatively frequent drawing upon his own extensive curricular knowledge is complemented by his clearly asserted intention to lessen textbook-dependence amongst his teachers going forward.

Affirming the sample's view that mathematical competency is well-established across the profession, and therefore not an area of acute need for teachers generally, only 5% of the skills utilised fell into this category. Pedagogical knowledge, given its more specialised nature, accounted for a much larger 16% of the exploited skills base. The poor showing of analytical skills (5%) may be explained somewhat by the seasonal nature of the logging. Were the charting to have happened closer to the beginning or end of the school year, both traditional standardised testing windows, one would anticipate a greater amount of analytical activity by mathematics leaders. Alternatively, one could also speculate that this dearth of analytical activity may reveal deficits in leaders' willingness or capacity to engage in high level assessment practices, such as assessment for learning (as outlined in Wiliam, 2009) or in-depth error analysis (see Herholdt and Sapire, 2014). Both the aforementioned analytical skills and mentoring skills were the only competencies to register no recorded entries (for four of the ten participants). Organisational skill was the only aptitude of the eight that featured in the exploited skillset of all ten leaders. Proportionately it spanned a high of 61% of the skill base utilised by Participant B, to a corresponding low of 10% for Participant J. On average, it accounted for a third of each leader's recorded skills base.

Figure 4.11 Itemised Skills Breakdown (With % Totals) – Per Participant

Participant	Org. Skills	Maths Comp.	Pedag. Know.	Curr. Know.	Ment. Skills	Facilitat. Skills	Analyt. Skills	Consult. Skills
A	5 (21%)	2 (8%)	0 (0%)	9 (38%)	5 (21%)	0 (0%)	1 (4%	2 (8%)
B	20 (61%)	0 (0%)	6 (18%)	5 (15%)	0 (0%)	1 (3%)	0 (0%)	1 (3%)
C	6 (38%)	0 (0%)	5 (31%)	3 (19%)	0 (0%)	2 (12%)	0 (0%)	0 (0%)
D	23 (23%)	17 (18%)	21 (21%)	15 (15%)	3 (3%)	13 (13%)	3 (3%)	4 (4%)
E	5 (36%)	2 (14%)	4 (29%)	2 (14%)	0 (0%)	0 (0%)	0 (0%)	1 (7%)
F	73 (23%)	5 (2%)	49 (15%)	74 (23%)	16 (5%)	28 (9%)	12 (4%)	61 (19%)
G	15 (41%)	0 (0%)	2 (5%)	6 (16%)	0 (0%)	12 (33%)	2 (5%)	0 (0%)
H	38 (19%)	8 (4%)	35 (17%)	44 (22%)	18 (9%)	16 (8%)	19 (9%)	24 (12%)
I	8 (57%)	2 (14%)	0 (0%)	0 (0%)	3 (22%)	0 (0%)	0 (0%)	1 (7%)
J	5 (10%)	2 (4%)	11 (22%)	14 (29%)	14 (29%)	0 (0%)	1 (3%)	2 (6%)
Total number of times each skill was utilised by sample (% of total)	198 (25%)	38 (5%)	133 (16%)	172 (21%)	59 (7%)	72 (9%)	38 (5%)	96 (12%)

4.6.5 The Mathematics Leader - A Complex Construct

The expressed opinions of the leaders paint a complex picture of the model mathematics leader. This intricacy is added to by the contrasting skills and knowledge base that different leaders drew upon during the project, alongside an obvious unease with ascribing expert status to the seemingly specialised work they do. Whilst organisational proficiency, mathematical competency (to a certain standard), pedagogical knowledge and curricular familiarity emerged as uncontested characteristics, others were more context-dependent.

The data indicates three key knowledge bases that were particularly influenced by the local situations of the individual leaders. Firstly, the full gamut of interpersonal skills (consultative and facilitative primarily) loomed large for leaders who took a more practical role in advising and mentoring colleagues. Secondly, planning and strategic competencies were more important to leaders who focused on fulfilling the centrally-mandated school planning and SSE requirements. Finally, an interest in information technology and other mathematics-related disciplines was prominent in contexts where curricular integration and STEM-promotion was a priority for school staff.

Irrespective of local emphases, it is irrefutable that mathematics leaders do call on a significant skills and knowledge base when executing their duties. Whilst this analysis chapter has already demonstrated the vast range of these duties, some areas of activity appear more sensitive than others. These particular activity domains will be identified and explored in the subsequent section. With a clear understanding of the cohort's skill and knowledge base firmly established, the reader is now in a better position to critically assess the capacity of the leaders to face these challenging responsibilities.

4.7 Theme Four: The "Do as I say, not as I do" Paradox

As outlined in sub-section 3.6.1, the participant questionnaire/profiler was one of the key research instruments of the project's methodology. Along with ascertaining relevant professional data, it sought the cohort's opinions on the priority they attached to the various duties within their mathematics leadership role. It was intended that these prioritisations would in turn help establish a rationale for the activity patterns of the participants, as revealed by their activity logs. One could reasonably expect that highly valued duties would feature prominently in the logging data, and vice versa. Whilst this was true for some of the leaders, and indeed for a proportion of the specified duties themselves, the overall comparison of priorities and actual actions did reveal a number of noteworthy contradictions. Before identifying and teasing out these incongruities, it is important to evaluate the leaders' self-declared hierarchisation of duties.

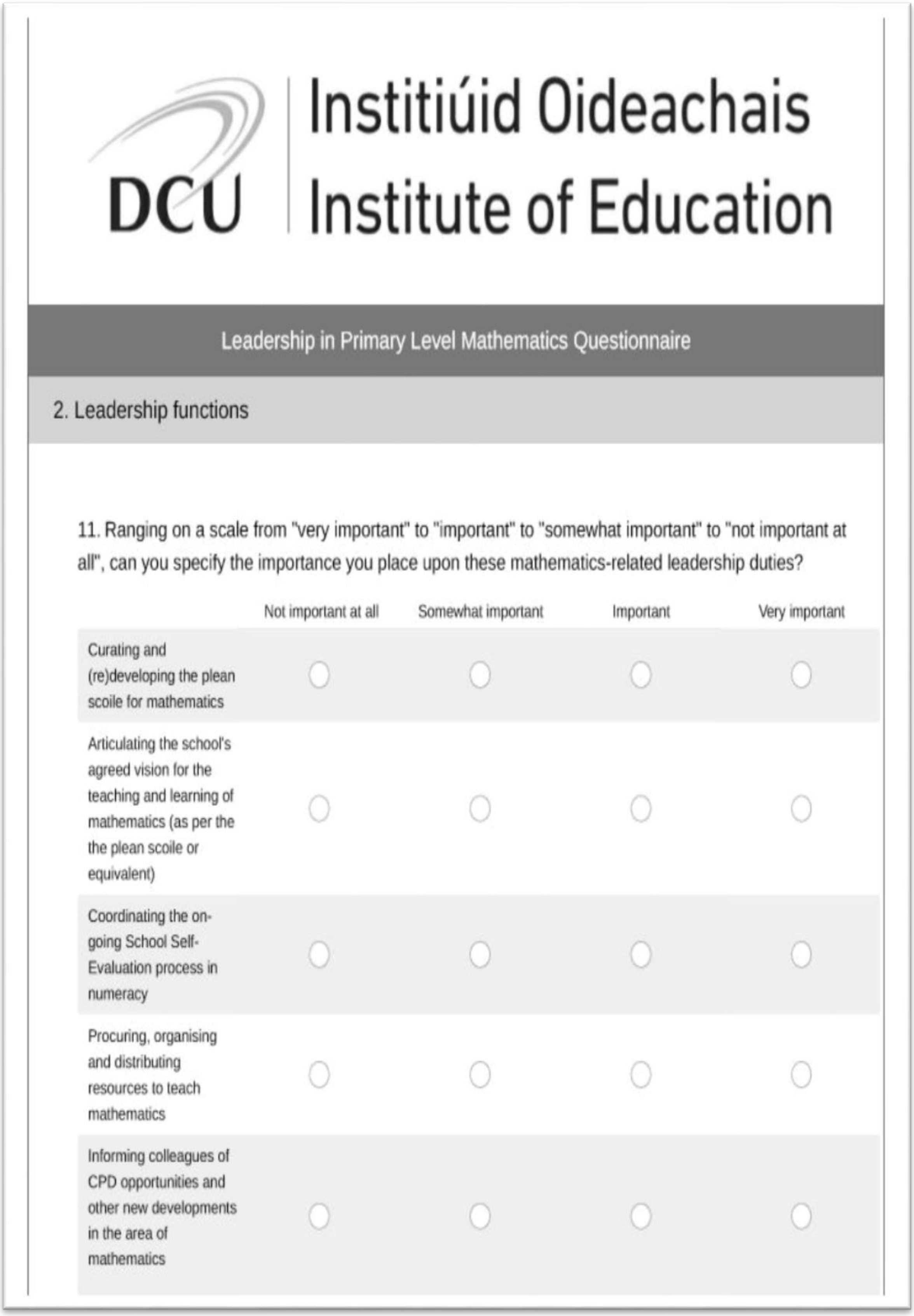
4.7.1 Self-Declared Prioritisations

The questionnaire/profiler offered participants four graded prioritisations for each of the dozen specified activity domains. Ranging from "*not important at all*", through "*somewhat important*", to "*important*" and peaking with "*very important*", leaders were asked to choose their personal ranking per duty (see figure 4.12 for screen grab of questionnaire/profiler). Given the ordinal nature of these responses, the researcher must acknowledge his inability to determine the actual difference between the four response options. Ordinal scales have no fixed measurement unit, and therefore, the distinction between each is impossible to gauge. Goos and Meintrup (2015) further advise, in dealing with such data, that typical arithmetic operations are worthless. However, from a frequency perspective, it remains instructive to examine the specific activity domains which drew a proportionately high or proportionately low number of "*very important*" and "*not important at all*" rankings from the sample.

Of the twelve domains, articulating the school's vision for Mathematics (n=8), the promotion of Mathematics by school leaders within the broader school community (n=8), mentoring new colleagues (n=7), and, the monitoring of mathematics teaching and learning standards (n=7) all drew the highest number of "*very important rankings*". In light of this prioritisation, it was unsurprising that none of the quartet attracted a single "*not important at all*" ranking. At the opposing end of the scale, the promotion of mathematics-based PD among colleagues, and the coordination of the SSE process for Numeracy (n=2) both struggled to attract "*very important*" rankings, with the promotion of PD failing to garner any (see figure 4.13).

Although the confines of the research prevent a participant-by-participant analysis of personal prioritisations, some ranking patterns bear mention. Of the full set of gradings awarded, only one participant (and on only one occasion) granted a "*not important at all*" classification. This ranking was attached to the coordination of the SSE process for Numeracy. Coincidentally, the "*very important*" ranking was the most frequently allotted of the four options (n=53), whilst participants were twice as likely to award an "*important*" rather than a "*somewhat important*" rating (n=44 and n=22 respectively). Participants C and G jointly bestowed the highest number of top rankings (n=7), with Participants F and I being the most frugal in this regard (n=4).

Figure 4.12 Participant Questionnaire/Proflier Screen Grab



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Leadership in Primary Level Mathematics Questionnaire

2. Leadership functions

11. Ranging on a scale from "very important" to "important" to "somewhat important" to "not important at all", can you specify the importance you place upon these mathematics-related leadership duties?

	Not important at all	Somewhat important	Important	Very important
Curating and (re)developing the plean scoile for mathematics	○	○	○	○
Articulating the school's agreed vision for the teaching and learning of mathematics (as per the the plean scoile or equivalent)	○	○	○	○
Coordinating the on-going School Self-Evaluation process in numeracy	○	○	○	○
Procuring, organising and distributing resources to teach mathematics	○	○	○	○
Informing colleagues of CPD opportunities and other new developments in the area of mathematics	○	○	○	○

Figure 4.13 Participant Priorities by Domain – Per Participant

Participant	Plean Scoile	School Vision	SSE	Resources	CPD	Status	New Colleagues	Existing Colleagues	External Services	Testing	Monitoring	Parents
A	3	4	3	4	3	4	4	3	4	2	3	3
B	3	4	4	2	2	3	4	2	3	4	4	3
C	3	4	1	4	3	4	4	4	3	4	4	2
D	4	4	2	3	2	4	4	2	2	4	3	2
E	4	4	2	3	4	4	3	3	2	4	4	4
F	3	3	3	3	4	4	3	3	3	4	4	4
G	3	4	2	4	3	3	4	4	4	2	4	4
H	2	4	4	2	3	3	3	4	4	3	4	2
I	3	3	3	2	4	4	4	3	4	2	3	4
J	4	4	3	4	3	3	4	3	3	3	4	3

(Legend - 1: Not Important at all, 2: Somewhat important, 3: Important, 4: Very Important)

4.7.2 Variations in Prioritisation among Leadership Models

Of the four aforementioned activity domains which attracted the highest number of "*very important*" rankings (articulating the school's vision for Mathematics, the promotion of Mathematics by school leaders within the broader school community, mentoring new colleagues, and the monitoring of mathematics teaching and learning standards), all drew at least one such ranking from participants in four of the five leadership models examined in this study. In fact, this superior ranking for both mentoring of new colleagues and the monitoring of mathematics standards was present across all five models. On the opposing end of the scale, the co-ordination of SSE for Numeracy attracted only one "*very important*" ranking each from the principal and promoted middle-management sub-cohorts.

Administrative principals universally afforded the maximum prioritisation to promoting the school's vision for mathematics, the mentoring of existing colleagues, liaison with supporting external agencies and the monitoring of school-wide mathematics standards. Teaching principals were equally emphatic in their ranking of promoting the school vision for mathematics, but were less definite in their ranking of the remaining three domains. In fact, their apathy towards leading their school's SSE process for Numeracy is striking. Similarly, volunteer leaders also tended to deprioritise leading the school's SSE process, and were more likely to give "*important*" or "*very important*" rankings to the co-ordination of standardised testing for numeracy, and the strategic involvement of parents in the school's mathematics teaching and learning programme. The sole collaborative leader within the sample (Participant I) tended to award similar or identical rankings to these volunteer coordinators in respect of many domains. The two formally-appointed teacher leaders (Participants B and F) expressed largely similar prioritisations – they universally awarded the highest available ranking to the co-ordination of standardised testing and the monitoring of mathematics standards within their school community. One suspects that this prioritisation may well have reflected their formally assigned duties, which formed part of their daily work. On the other hand, they similarly described their prioritisation of promoting mathematics PD among colleagues as only "*somewhat important*".

4.7.3 Documented Activity and Leadership Priorities

It is important to foreground the consideration that the cohort's stated prioritisations were sampled prior to the launch of the activity-logging process. The researcher did not expect complete alignment between both data sets, and for the most part, this expectation was borne out. The intention was to simply examine if stated priority was reflected in participant activity, and in which domains was this association most and least pronounced.

As outlined in sub-section 4.4.5.1, management of physical mathematics resources, mentoring of both new and existing colleagues, articulating the school vision for mathematics teaching and learning, and, spearheading the SSE process in Numeracy were the five most dominant domains as per the activity logs. However, only two of these leadership spheres (school vision and mentoring of new colleagues) achieved a "*very important*" ranking from at least half of the sample's questionnaires/profilers. Despite accounting for 11% of the cohort's logged activity, coordination of the SSE process for Numeracy attracted a paltry two "*very important*" and four "*important*" rankings. Some consistency between stated precedence and actual priority was provided by the promotion of PD which accounted for a mere 6% of the participants' combined output, whist commensurately failing to attract a single "very important" ranking, but with five "important" rankings.

Curation of the school's mathematics resources is further typical of the discernible disconnect between both data sets. This domain accounted for a significant 17% of the cohort's documented activity, yet it was ranked as "*very important*" by less than half of participants. The conclusion, even if counter-intuitive, is obvious – leaders assigned more attention to activities which they themselves, prior to the research, had declared as being less significant. A similar, somewhat contradictory trend is also visible elsewhere in the data - the monitoring of mathematics teaching and learning standards drew a "*very important*" ranking from all but three of the participants, yet it accounted for a meagre 4% of the cohort's activity. Given the key position of managing the school's mathematics equipment stock, and the monitoring of local mathematics teaching and learning standards, as the most and least prolific activity domains respectively, alongside their somewhat incongruous standing within the cohort's prioritisations, both domains warrant further scrutiny. This examination is chiefly informed by the semi-structured interviews, and the specific views of the participants when prompted about both domains, and the inherent paradoxes offered by their questionnaire/profiler and activity log data.

4.7.4 In Focus: The "Resource Management" Paradox

Despite its relatively modest prioritisation among participant questionnaires/profilers (wherein it only accumulated four "*very important*" rankings), many of the leaders were quick to cite that taking charge of the school's mathematics equipment was their gateway into a broader form of mathematics leadership. Participant A is a case in point of "cutting his leadership teeth" in this way. His interview implied a swift realisation by his school principal that this volunteer leader would ultimately be more useful to his school were he to concentrate his attention on pedagogical leadership, rather than sourcing, cataloguing and assigning concrete materials to classrooms. His initial logistical role was subsequently re-assigned to another colleague. Given his additional expertise in mathematics methodology, and his teaching experience at third level, it is little wonder that Participant A's energies were re-directed. This re-emphasis may perhaps reveal a more widely held view that resource management is ultimately a less skilled, and more menial aspect of mathematics leadership.

Notwithstanding its heavy time demand, and its sometimes physical nature, Participant A's experience may just illustrate how such work can deflect mathematics leaders from the instructional impact that is primarily expected of them. By its nature, resource management can draw multiple interventions by mathematics leaders, often in the same day. However, the sometimes random, scatter-gun distribution of materials, or re-organisation of a resource store room, can often be considered to have little tangible benefit. This contrasts sharply with a more palpable dividend from supporting a colleague with a pedagogical challenge, or updating the school plan for Mathematics in advance of a whole-school inspection, to cite but two examples from the activity logs. Specifically, this mentoring benefit is vividly described by Participants C, D and J, as prominent examples, when they discuss the professional growth of new staff members following consistent, classroom-based guidance from their respective principals. By contrast, it was much more difficult to find specific instances of leaders acknowledging a critical impact arising from any of the multitude of occasions when they acquired, organised or distributed a piece of mathematics equipment, however important such actions may be on a local level.

The other volunteer leader within the cohort (Participant E), upon reviewing her activity log data, expressed surprise at the dominance of resource management within her work profile:

> *"But yes, I was surprised how much maths there was… that I was doing, but also I was surprised by how it was consistently almost always around resources that it was…"* (Participant E interview transcript)

One can infer that Participant E's frequent activity within the domain of resource management led to a degree of automation in her work, where dealing with resource requests almost became a second nature, inseparable from her typical daily duties. This may go some way to explain the de-prioritisation of managing the school's stock of mathematics-teaching materials, subliminal as this may be, among others in the sample.

When considering the preponderance of resource-based actions in the activity logs, it is also important to consider that some leaders clearly held a broader interpretation of "*procuring, organising or distributing resources to teach Mathematics*" than initially envisaged by the researcher. It is likely that this re-interpretation may have only arisen during the logging phase, when participants truly reflected upon the nature and impact of their work. Participant D described in detail how he would demonstrate the use of manipulatives to colleagues. Given the pedagogical impact of such presentations, this could be considered an exercising of instructional leadership:

> *"In addition to modelling lessons, I would do some run-throughs of different resources, whether they were problem-solving strategies, whether they were some interactive resources, you know… visnos.com, or fraction walls – you know just practical hints and practical stuff that she could bring back into the classroom…"* (Participant D interview transcript)

Interestingly, the two other teaching principals within the sample also indicated their subtle use of resource sharing and demonstration as a way of influencing the pedagogical approaches of less experienced colleagues, especially NQTs. Participant F (a teaching leader) also suggested that when feeding back to NQTs (as part of the *Droichead* induction process), she would lay particular emphasis upon the exploitation of suitable concrete manipulatives. Participant H revealed a similar strategy when guiding less experienced colleagues. It is therefore understandable, when couched in the somewhat restrictive terms of the questionnaire/profiler, that resource management drew a generally muted level of enthusiasm from leaders. The interviews revealed its broader influence, and a corresponding recognition of its value among leaders as shown above.

Within the cohort, Participant B is an outlier – describing herself as "more of a provider", she asserted the absolute importance of her management of the school's mathematical resources. This management was confined to purchasing, storing and maintaining the schools mathematics equipment in working condition. In her view, facilitating teacher access to effective manipulatives was one of the key factors in the high standards of mathematics teaching and learning evident in her school. There was no sense in her interview that such work should be de-prioritised, or that it could be considered in any way inferior to the other activity domains. In fact, she actively championed the retention of resource management within the foundation responsibilities of all mathematics leaders.

In looking to the future, Participant F identifies the changing nature of mathematics resource management within schools:

> *"my post has evolved, it would originally have been very much that organisational… fetching resources from the maths room, bringing them to the particular teacher, but now we have a good set-up in our school where we have quite a nice layout for our*

> *maths equipment… they go get it themselves either before contact or after contact time, and they have it ready so I am not as… needed…"* (Participant D interview transcript)

It is highly likely that other mathematics leaders have witnessed similar changes. Given this evolution of activity emphases, and the relative lack of priority attached to resource management by the project's representative sample, one wonders will logistical responsibility for the school's mathematics equipment feature within the remit of mathematics leaders a decade from now.

4.7.5 In Focus: The "Monitoring of Standards" Paradox

As outlined in sub-section 4.4.5.2, the "*monitoring the standards of mathematics teaching and learning within the school"* domain of activity featured sporadically within the overall activity records – six of the ten participating leaders did not register a single act for this sphere of mathematics leadership. In fact, this evaluative duty accounted for a minimal 4% of the combined 313 recorded leadership acts. The juxtaposition between these recorded figures, and the stated prioritisation that the same domain received within the questionnaires/profilers, could not be starker. Seven of the ten leaders awarded it the maximum ranking of "*very important*", whilst the remaining three allotted an "*important*" classification. Obvious questions emerge – why are the leaders not following through, in their actions, upon their stated priorities? Furthermore, are there specific sensitivities associated with monitoring the mathematics standards with the school that are contributing to this inconsistency between priority and action? As a research approach, the value of using semi-structured interviews which mined this discrepancy between expressed priority and actual action became very apparent at this juncture.

During his interview, Participant A offered an obvious explanation – as a class teacher, with full-time teaching duties, he was simply not in a position to observe the mathematics teaching of colleagues, given its real-time nature. Despite his personal commitment to monitoring the teaching and learning standards of Mathematics in his large urban school, a system of release that would free him up to visit colleagues did not exist. He accepted that his school is not unique in this regard. Other teaching leaders, most notably Participants C, D and I concurred. This situation was a particular frustration for Participant D, a teaching principal, who bemoaned the dearth of substitute teachers who could potentially free him from his teaching role on occasion. It appears that his enthusiasm to visit classrooms, observe colleagues and feedback constructively is likely to go unharnessed. Other leaders, through circumstance, found themselves in situations that increased their exposure to colleagues' teaching. Uniquely within the sample, Participant J was a case in point – the developing status of her school has allowed this teaching principal to team-teach with newly qualified colleagues. The dividend for both parties was obvious:

> *"…it has to be a two-way thing and I suppose something like modelling a lesson or observing somebody and trying to help them improve their teaching, they observe you, you observe them… I have just found that doing the team teaching with a NQT this year has worked really, really well."* (Participant J interview transcript)

Participant A also noted that personal confidence is important before one can enter to observe into a colleague's classroom. He identified two key prerequisites that the would-be visitor must hold:

> *"I would… say (as) the evaluator of the lesson… feel more confident depending on two things, my level of experience, the years I have taught for… and then the second is do I have further expertise in this area."* (Participant A interview transcript)

Speaking as the only participant to hold a formal, additional qualification in mathematics education, this may be an easier threshold for him to cross. However, it does bear consideration in light of the sample's relatively poor levels of recognised, formal expertise in mathematics teaching and learning. Does it follow that leaders who do not meet the dual criteria of experience and expertise should not be considered suitable for commenting upon the mathematics teaching of equally qualified colleagues?

The theme of personal credibility to observe colleagues is again visible in Participant B's transcript where her self-confessed challenge with personal mathematics competency has resulted in a more facilitative, and less interventionist form of mathematics leadership. Despite her considerable service in the school, there is a sense of self-inferiority when compared to colleagues who display a more obvious mathematical flair. Although she assigned a "*very important*" ranking to this domain, Participant B's self-perceived mathematics ability has prevented her from acting upon this prioritisation. In contrast, Participant I was the least experienced teacher within the sample – however, his relative inexperience was in no way inhibitive to his repeated and strongly asserted willingness to visit classrooms, when circumstances allow.

Issues of cultural sensitivity within schools also came to the fore in many of the interviews. At the urging of the researcher, most of the participants took a two-fold interpretation of what monitoring school-wide mathematics standards entailed. Firstly, the desktop auditing of the school's standardised test performance in Mathematics was accepted unanimously by the cohort. The five principals within the sample appeared quite at ease with this duty, as did the leaders with assigned, formal middle-management responsibilities. The second application of the monitoring role, visiting classrooms to observe mathematics teaching and then offering feedback afterwards, drew more discussion from interviewees. Participant H, an experienced administrative principal, addressed the historical perspective:

> *"I do think it is a cultural issue and a hangover issue of years of our union dictating what happens in Irish classrooms and schools to be honest. I think the idea of me observing any experienced teacher here would be……it would not happen."* (Participant H interview transcript)

When asked if purposeful observing of teachers, even for non-evaluative purposes, was worth the fight, she replied tersely:

> *"I wouldn't go looking for it… I think I'm like any other principal in the country until we are obliged to do it, we won't."* (Participant H interview transcript)

Again, when questioned about the feasibility of such visits, mathematics leaders within small, rural school settings also shared this pessimistic perspective:

> *"Not on a cultural level in a small school like this."* (Participant C interview transcript)

Participant F sounds a similarly wary tone in her response to the proposal:

> *"Teachers are not very confident doing a lesson in front of somebody else, they feel they are being evaluated all the time and they don't like being evaluated…"* (Participant F interview transcript)

Such a prevailing culture within many of our schools has led to a situation where the school principal (in this case of Participant H, and supported by the experiences of two other sampled principals) has a somewhat restricted view of teaching and learning processes in their own school. This situation persists, despite the principal holding ultimate responsibility for standards of classroom delivery. Fleeting, ad hoc visits to classrooms, engaging with whole-staff input at staff meetings, and monitoring of teacher planning documents form the sum total of many leaders' evidence of teaching and learning standards among colleagues. Participant B noted that her sole opportunity to incidentally see others teach Mathematics is during team-teaching interventions – any deliberate and scheduled observation of the teacher would simply not be countenanced within her school. Participant F identifies similar resistance to pre-announced observations of mathematics teaching, for fear of any evaluative overtones.

In fact, other than those who held a specific mentoring role through the *Droichead* induction programme, no other school leader held any experience whatever of visiting classrooms with the intended focus of observing or developing methodological proficiency. Participant A saw potential for this approach, but some way off in the future, whilst Participant D suggested that classroom visits should only occur at the end of a long, collaborative process between school leader and colleague:

> *"You dropping in unannounced… could de-stabilise that teachers own confidence in their ability… those visits come at the end or during a longer process, where we actually as a staff… we are comfortable in formatively assessing each other… to share successes, to share failures and to talk about where their maths teaching is…"* (Participant D interview transcript)

Notwithstanding the time and methodological expertise required by such a consultative process, the challenge of generating and maintaining sufficient personal and professional trust among colleagues also looms large in the background. Such a scenario, positive as it may sound for teaching and learning standards, appears a long way off, based on the near-universal experience of the cohort.

The final theme of this chapter will now be introduced. It questions the very sustainability of mathematics leadership constructs as they stand in our primary schools today.

4.8 Theme Five: Leading while Teaching – Mission Impossible?

This theme will explore the chief frustration that all leaders reported in their role, via their discretionary activity log comments and interviews. Primarily, their discontentment centred on inadequate time to comprehensively execute the duties within their mathematics leadership remit. Based on the data, it is difficult to avoid the conclusion that leading from the principal's office, the special education room and the classroom are very different, yet demanding experiences (with differing priorities and duties – as confirmed in sub-sections 4.4.2 and 4.7.2).

However, of these models, leading from the classroom does appear to present very particular challenges. Teaching principals are a particular case within this sub-cohort of teaching leaders. Relevant participants were asked about the viability of leading from the classroom and although not universally downbeat, the reality of their aggregated responses does merit consideration. To again underline the mixed-methods orientation of this research, the use of quantitative logging data (identifying when leaders were undertaking their leadership work and for how long) added crucial insight to the qualitative sources noted above. Given its consistent re-appearance as a key motif during the interviews, it is prudent to take account of the sample's views on the time poverty that they experienced in their leadership role.

4.8.1 A Lack of Time to Lead

The lack of time to lead, as expressed by all ten leaders, is one of the consistent threads of the entire study. Participant A, consumed with a challenging class at the time of the study, reflected upon his own pressures to juggle core and voluntary commitments:

> *"I have a duty of responsibility to my class… and it takes a lot of time and energy to make sure that everything runs smoothly in here. And I don't have the additional time that I probably had in previous years."* (Participant A interview transcript)

For this voluntary leader, there was only one solution to serve both of these masters:

> *"I would love to have the time to do that (collate mathematics teaching resources), like I would love to be released from my class for a week to go and do that."* (Participant A interview transcript)

Participants C, E, G, H and I all expressed similar frustration at the lack of ring-fenced time to devote to their mathematics leadership role – interestingly, this broad sub-cohort contained voluntary leaders alongside administrative and teaching principals. Many expressed frustration that more immediate concerns, sometimes teaching-based but often more bureaucratic in nature, monopolised their available time. This resulted in a largely reactive mind-set, which often failed to grapple with the more demanding, and long-lasting initiatives needed to positively impact upon whole-school mathematics teaching and learning. Participant H, on a more optimistic note, opined that having staff together for longer periods of uninterrupted time (e.g. a start-of-term planning day) provided a context for her more far-reaching leadership interventions in Mathematics. However, she did lament the rarity of such occasions. Real-time comments from the participants' logs further vivified this palpable exasperation at the insufficiency of dedicated leadership periods:

> *"Too busy a day - not even an "incidental" to log."* (Participant B, Activity Log; 3rd December, 2018)

> *"Very busy coming into December - too many other demands in fulfilling DP role to engage in pre-planned maths input."* (Participant B, Activity Log; 7th December, 2018)

> *"Amount in the job stops me from having enough time."* (Participant G, Activity Log; 28th November, 2018)

> *"I had planned to contact the PDST today but I never got around to this as something else came up. Even though it was an admin day, there never seems to be enough time."* (Participant J, Activity Log; 4th December, 2018)

Whilst many leaders failed to suppress their irritation at this situation, and the personal stress it induced, Participant B displayed a more accepting disposition. Undoubtedly informed by her extensive classroom and senior-management experience, she was more stoical about prioritising her precious time:

> *"You do what you can! And as I said the goalposts will shift depending... If something is an emergency, if the heating breaks down, what the hell are we going to do? Maths is definitely going to go on the back burner for that."* (Participant B interview transcript)

4.8.2 Leading from the Classroom

Before sampling the views of teaching leaders about the sustainability of leading Mathematics from the mainstream classroom, particularly teaching principals, considering the opinions of leaders without such duties is instructive. Participant F was unequivocal:

> *"It's obviously a lot easier for me, as part of special education, to maybe find the time or the location to engage in my work as maths post-holder. I suppose, as well as that, I'm obviously in and out, frequenting classrooms, especially with team teaching, which is a big part… of our special education team at the moment. So, it would be a lot easier for me. I obviously have a whole-school eye on what is going on as well."* (Participant F interview transcript)

Given her dual experience of working as a class teacher and laterally as a member of the special education team, Participant F's opinion came with much credibility. Participant B, of a similar career profile, concurred, and even speculated that leading Mathematics adequately may be an impossibility for any leader, irrespective of their teaching and/or managerial role. Participant A, a class teacher, pulled no punches when asked if leading from the classroom was feasible:

> *"I really don't think it is… I don't think you can do it as effectively as I would like to do it from the class."* (Participant F interview transcript)

Another teaching leader (Participant I) expressed his frustration in virtually identical terms. He also cited his desire for "*time to look, and help, and see, and do*" as opposed to the all-too-hurried nature of his current mode of leadership. Participant E, similarly with mainstream teaching duties, immediately identified the limitations of her dual mandate:

> *"If you are always in your own classroom, you can't maybe see where the gaps are then when you are suggesting implementation. You can't really see… you are working off trust."* (Participant E interview transcript)

Participant F, upon revisiting her time as a class teacher, similarly recalled:

> *"I was probably only aware of my own class results and once the general curve for the school was fine… I wasn't worrying about individual classes… but I would be honest and say I feel that I am far more effective now leading it than I was in the mainstream."* (Participant F interview transcript)

4.8.3 In Focus: Teaching Leaders and their Time Frustrations

Although the insufficient time to fulfil the range of duties attached to their mathematics role was an unmistakable source of frustration to all sampled leaders, this exasperation was most strongly articulated by the teaching principals. Amongst these three leaders within this sub-cohort, their small staff allocation has resulted in an onerous, individual leadership burden. All expressed a high personal interest in their mathematics leadership, however it was clearly only one of a number of leadership hats they wore, alongside their core teaching responsibilities in challenging multi-grade settings.

Participant C chronicled these competing responsibilities, and his resultant time poverty:

> *"most teaching principals are… 2.30 to 3.00 getting kids off the premises, making sure everything is safe, making sure the place is locked up… tidied up. And then, probably 3.00… checking what e-mails and post that was important for the day that they haven't got to yet... they are doing the basic day-to-day stuff. And I suppose… the thinking part behind leading happens mostly at weekends or in the car."* (Participant C interview transcript)

Participant D, despite excelling in undergraduate studies in Mathematics and making a sincere declaration of the subject being his favourite to teach, noted that the time constraints upon him had taken their toll upon his enthusiasm to lead:

> *"If I had a very strong mathematically-minded teacher join the staff, I wouldn't hesitate to offload it."* (Participant D interview transcript)

This change in attitude is all the more striking in light of this leader's earlier admission that he deliberately chose Mathematics as one of his earliest leadership priorities upon appointment. He noted that his expertise and passion for the subject would help generate a positive, early impression among his new staff.

The multiplicity of leadership duties, further complicated by teaching responsibilities, can lead to a somewhat unorthodox working style, which belies the time and effort involved:

> *"You mightn't plan it out but you'll go "that's what I'll do". You'll come in at 8 in the morning, it'll take you five minutes to grab the few bits, so what looks like a snatched moment in a log, because you did it in five or ten minutes in the morning, but if you hadn't it thought through in the head for the hour the night before… a lot of it is unseen an unsee-able."* (Participant C interview transcript)

This revelation is an apt stimulus to evaluate when the larger group of participants actually carried out their mathematics leadership duties.

4.8.4 When do Leaders Lead?

To underscore the impossibility of the role of the mathematics leader, as asserted by many of the cohort, the activity-log data provides further illumination. Essentially, they depicted a method of leadership that was sustained by reactive, hurried responses during teaching time. These responses were supplemented by frequent encroachments upon mandated break times or the leisure time of leaders before and/or after contact time. For the purpose of this discussion, all pupil-facing engagement (excluding breaks) is considered as contact time. As a proportion of the sample's 313 logged leadership actions, close to 22% occurred before the official start of lessons, with a further 26% happening after the pupils had gone home for the day. Figure 4.14 further demonstrates that 11% of duties spilled into recess or other break times. A meagre 7% of activity took place during staff meetings or other whole-staff gatherings.

Within these headline findings, there is considerable variation among the sample – 50% of Participant A's actions took place prior to contact, with fellow leaders E and G registering nil activity before the start of any logging day. Participants B and J showed the highest proportion of leadership activity during contact time (63% and 68% respectively), although this was offset by the relatively low level of leadership activity during the teaching day by Participants E and I (14% and 7% respectively). Unsurprisingly, the two administrative principals within the sample (Participants G and H) were at their most active during the teaching time of colleagues, and interestingly, the three teaching principals (Participants C, D and J) were similarly most prolific during contact time. Given the dual mandate of the latter trio, this is somewhat unexpected. As all three indicated their strong preference to pre-plan the vast bulk of their leadership interventions, it may also suggest that many of these intrusions were initiated by colleagues, which then forced a response from the leader. As a whole, principals were most likely to utilise staff meetings as a platform to complete a proportion of their mathematics leadership work.

To emphasise the fleeting and rushed nature of the work, 67% of the pool of logged actions were allocated fifteen minutes or less (see figure 4.15). A quarter of all interventions lasted, on average, less than five minutes. Of the 33% of actions that entailed a time commitment of thirty minutes or more, they primarily consisted of presentations at staff meetings, mentoring meetings with newly qualified colleagues, or tabulation and analysis of whole-school standardised test performance.

A deeper examination of the time demand, on a per activity-domain basis, reveals that three quarters of all actions focused on the management of the school mathematics resources were fifteen minutes or less in duration (see figure 4.16). Mentoring of both new and existing colleagues similarly attracted a preponderance of brief, fifteen-minute or less interactions (81% and 83%) respectively. Liaisons with external agencies were correspondingly short-lived with close to half of all such actions lasting less than five minutes. Unsurprisingly, given its information-only nature, virtually all actions (94%) associated with the promotion of PD opportunities among colleagues were also under five minutes in extent. Actions contributing to the curation of the school plan for mathematics tended to be more long-lasting, with 71% of such interventions lasting for at least half an hour. Given its similar planning focus, it is unsurprising that 69% of actions linked to the coordination of the school's SSE intervention were at least thirty minutes in duration. The similarity between both rates is obvious, and it does suggest that the paper-based, planning aspects of the mathematics leadership role tend to be the most time-consuming than colleague-facing responsibilities.

Figure 4.14 (Proportionate) Distribution of Leadership Interventions Per Participant

Participant	Adjusted No. of Actions*	Actions Before Contact	Actions After Contact Time	Actions During Contact Time	Actions During Break Times	Actions During Staff Meetings
A	10	5 (50%)	0 (0%)	2 (20%)	3 (30%)	0 (0%)
B	32	2 (6%)	9 (28%)	20 (63%)	0 (0%)	1 (3%)
C	9	1 (11%)	3 (33%)	4 (45%)	1 (11%)	0 (0%)
D	35	3 (8%)	7 (20%)	9 (26%)	8 (23%)	8 (23%)
E	7	0 (0%)	3 (43%)	1 (14%)	1 (14%)	2 (29%)
F	115	33 (29%)	26 (22%)	40 (35%)	14 (12%)	2 (2%)
G	20	0 (0%)	3 (15%)	12 (60%)	0 (0%)	5 (25%)
H	74	16 (22%)	24 (32%)	30 (41%)	0 (0%)	4 (5%)
I	14	6 (43%)	4 (29%)	1 (7%)	3 (21%)	0 (0%)
J	25	1 (4%)	3 (12%)	17 (68%)	4 (16%)	0 (0%)
Totals:	341	67 (20%)	82 (24%)	136 (40%)	34 (10%)	22 (6%)

*****adjusted to reflect the fact that occasionally some actions prolonged across two or more time blocks

4.15 Duration of Leadership Interventions – Per Participant

Participant	**Less Than Five Mins.** **(% of Participant Total)**	**Five – Fifteen Mins.** **(% of Participant Total)**	**Around Thirty Mins.** **(% of Participant Total)**	**Around One Hour** **(% of Participant Total)**	**More Than One Hour** **(% of Participant Total)**
A (n: 10 actions)	30%	50%	10%	10%	0%
B (n: 32 actions)	28%	47%	12%	13%	0%
C (n: 9 actions)	11%	56%	0%	0%	33%
D (n: 30 actions)	4%	23%	20%	10%	43%
E (n: 7 actions)	43%	29%	14%	14%	0%
F (n: 95 actions)	38%	49%	9%	4%	0%
G (n: 20 actions)	15%	80%	5%	0%	0%
H (n: 71 actions)	1%	25%	45%	27%	2%
I (n: 14 actions)	22%	64%	14%	0%	0%
J (n: 25 actions)	68%	32%	0%	0%	0%
% of sample's aggregated actions	25% (n:77)	42% (n:131)	18% (n:56)	10% (n:32)	5% (n:17)

4.16 Duration of Leadership Interventions – Per Domain

Domain	Less Than Five Mins. (% of Domain Total)	Five – Fifteen Mins. (% of Domain Total)	Around Thirty Mins. (% of Domain Total)	Around One Hour (% of Domain Total)	More Than One Hour (% of Domain Total)
Plean Scoile (n: 10 actions)	0%	29%	21%	36%	14%
School Vision (n: 32 actions)	11%	51%	23%	9%	6%
SSE (n: 9 actions)	6%	25%	37%	23%	9%
Resources (n: 30 actions)	37%	38%	17%	8%	0%
CPD (n: 7 actions)	50%	44%	0%	6%	0%
Status (n: 95 actions)	20%	50%	13%	4%	13%
New Colleagues (n: 20 actions)	32%	49%	11%	5%	3%
Existing Colleagues (n:71 actions)	29%	54%	11%	3%	3%
External Services (n: 14 actions)	46%	27%	9%	18%	0%
Testing (n: 25 actions)	11%	56%	22%	11%	0%
Monitoring (n: 12 actions)	34%	34%	16%	8%	8%
Parents (n: 18 actions)	28%	22%	17%	11%	22%

Notwithstanding the revelations above, there is no discernibly significant activity pattern, either in time allocated or when activity occurred, between the project's pre-defined models of leadership. Contradictions abound within the models themselves – an example being the huge variation in the working schedules among the two post-holding leaders within the sample. The three teaching principals within the sample also generate contradictory findings, in terms of their activity profiles and when they get their work done. The aggregated logging data does though clearly point to transitory and short-lived interventions, shoehorned into the teaching day, often spilling into the leisure time of the leaders. Furthermore, what is abundantly clear from the interview transcripts is an overwhelming assertion that time availability, localised factors and personal working preferences chiefly dictated when leaders fulfilled their duties.

4.8.5 Time Constraints and Participant Self-Efficacy

When asked in the activity log to rate the effectiveness of each of their 313 logged actions, exactly two thirds of all interventions were classified as being "*effective"* by participants. The remaining third of acts overwhelmingly fell into the "somewhat effective" classification. Whilst encouraging, this does not tell the complete story of partaker self-efficacy and satisfaction in their mathematics leadership role. The questionnaire/profiler also probed this domain in more generalised terms. When asked whether or not the leaders felt "*equipped and supported*" to satisfactorily carry out their duties, an overwhelming eight of the ten replied in the negative. When probed for a justification of this, time constraints and other variations of this theme (teaching duties, administrative burden, initiative overload and other external responsibilities) were the almost automatic and dominant response. This discontentment was again evident when participants were directly asked: "*How would you rate your overall effectiveness in your role of leading Mathematics*?" On a five-point scale, six of the cohort selected the "*effective*" mid-point ranking, whilst one indicated a "*somewhat effective*" selection, and a further participant self-assessed as "*ineffective*". Only a pair of participants self-awarded a "*very effective ranking*". As before, follow up questioning revealed a tangible frustration borne out of inadequate time to complete the role in a manner envisaged by the leader.

The isolation of the role, an inadvertent product of the aforementioned time pressure, also came to the fore in one of Participant C's contributions*:*

> *"And you probably make a lot of decisions on your own, which isn't necessarily the healthiest thing in the world, there should be more staff meetings at times, but in a bigger school, you could probably have cluster meetings and organised meetings, maybe you'd have to do more of that… but you'd be fresh to do it. I don't find I'm fresh to do it at 3.00 – the last thing I want is a staff meeting after teaching thirty kids for six hours…"* (Participant C interview transcript)

Participant D also painted a similar picture of the solitary mathematics leadership role of the teaching principal, where the competing curricular and organisational demands of school principalship rest disproportionately on one time-poor individual.

Participants C, E and G also flagged the isolation that singular leadership constructs can experience – without a team backing them up, often sharing the practical tasks of leadership, the position can become untenable for the individual. The researcher sees a connection between the aforementioned time poverty experienced by many of the participants, and this professional seclusion experienced by some mathematics leaders. Collaborative leadership structures may be the response that simultaneously addresses both challenges. It stands to reason that with greater involvement by more school staff in the administration of a particular curricular area, a synergy is created that may multiply productivity whilst not over-burdening any one individual. Participant I, part of an existing shared leadership arrangement, is proof positive of this collective dividend. When commenting about his mathematics leadership partner, he recalled their experience of organising a large, school-wide promotional event:

> *"I'd say he has helped a lot with me. Like when we were doing the maths week, when we were organising the maths week, he was the one that was helping me. As in, I was the one that was organising it, but he was the one that was helping me, I think that's where it's gone."* (Participant I interview transcript)

The workings of such collaborative leadership structures will be examined in greater detail in the recommendations section of this dissertation.

4.9 Conclusion

This chapter aimed to fulfil one fundamental function - the presentation of the primary, key findings of this mixed-methods study. Through the foregrounding of significant results, the reader's attention was drawn to what the collective experiences and opinions of the participant cohort has revealed about mathematics leadership in Irish primary schools. The researcher elected to organise these findings into a thematic format which facilitated a more coherent, cross-participant view of the phenomenon under scrutiny.

Nuanced themes of contrasting activity emphases, common PD needs, the expert nature of mathematics leadership, contradictions between stated priorities and actual recorded activity, and, the structural obstacles to meaningful curricular leadership all emerged during this analysis. Notwithstanding the finer detail, a reinforcement of the complexity of mathematics leadership, in all its forms and in all manner of leadership models examined, is the ultimate finding of this study. The chapter's aforementioned themes can further be classified as individual "calls to action" and they heavily influence the project's recommendations in Chapter Six.

If, as Creswell (2009) posits, data analysis truly is the process of sense-making, the researcher acknowledges that his findings must be measured against our existing knowledge base as set out by the literature. Chapter Five will present this juxtaposition, in the expectation that this exercise will lend additional credibility and insight to the study's findings, and its subsequent conclusions.

Chapter Five: The Data and the Literature

5.1 Introduction

Chapter Two of this dissertation has already set an important context for the project's focused examination of mathematics leadership in Irish primary schools. The resultant synthesis of relevant national and international literature revealed a neglected domain of inquiry, acutely in need of investigation from the broader Irish perspective, and specifically, from the primary-level standpoint. The review clearly foregrounded the curricular, pedagogical and organisational dimensions of the leadership role. Although uncontested, these identified domains are somewhat lacking in specific, practical detail of how mathematics leaders are prioritising and then fulfilling such competing obligations. Most patently, the variety of leadership constructs profiled in the literature were clearly evident in the contrasting models of leadership exploited in the study's methodology. Further context for the study, and its ensuing methodology, was provided by a reprise of the literature's dominant position on the varied and demanding skillset required to lead Mathematics, and the most typically accessed supports that allow such leaders to carry out their important work.

This short chapter intends to draw parallels between the project's own emerging findings and the accepted, supported understandings of mathematics leadership as articulated in the aforementioned literature review. The current chapter's positioning between the findings and recommendations sections is significant: a robust comparison between findings and literature will ultimately result in a more credible, tested set of recommendations.

For ease of consistency, this juxtaposition will loosely exploit the analysis' five themes as a convenient structure. Accordingly, the nature of the work engaged in by mathematics leaders, as articulated in the literature, and as found in the study itself, represents an important starting point for this comparison.

5.2 The Work of Mathematics Leaders

The literature and this study's findings are largely consistent in their cataloguing of the sheer range of duties that can fall within the remit of the typical mathematics leader. Prominent in the writer's review of available research, Sexton and Downton (2014) had clearly indicated this miscellany of responsibility under the mathematics leadership umbrella. Specifically, they noted the monitoring of standardised test performance, the liaison with external support agencies, the management of concrete materials to support the teaching and learning process and, the coordination of whole-school numeracy planning, as core obligations.

All four of these facets of leadership were evident in the data output of this project's cohort, although some to a greater degree than others. Managing concrete resources described 17% of the cohort's actions; leading whole-school planning and SSE processes for Numeracy accounted for a combined 15% of output; engagement with external supporting agencies drew 7% of leadership acts, whilst involvement in leading the standardised testing process for Numeracy signified a mere 3% of cohort activity. This combined quartet represented a weighty 42% of the over three hundred leadership acts captured across the ten activity logs. It should be noted that a certain degree of interconnectivity existed between some of the highlighted domains – liaising with external, supporting agencies was typically a complementary activity to leading school planning and self-evaluation processes.

Interestingly, all four aforementioned domains of responsibility are typically classified by the literature as more managerial functions of mathematics leadership. Considered as logistically facilitative of the teaching and learning process (see Hallinger and Heck, 2010; Bush and Glover, 2014), they are equally portrayed as demanding, overly-bureaucratic, time-consuming functions which detract from directing the teaching and learning process (see Fitzgerald, 2009). Much of the interview data supported this finding, with interviewees openly lamenting the laborious requirements of paperwork (and other related form-filling). Principal leaders, who held primary responsibility for filing various numeracy-related applications and returns on behalf of the school, were especially strident in this regard. Participant H was a case in point of this frustration, by expressing a palpable sense of inevitable leader-misdirection and time wastage, a sentiment that was equally evident in the literature. The calls of many of the project's participants to temper the clerical dimension of their role is a suggestion resoundingly supported by many researchers in the field (Bates, 2006; Eacott and Holmes, 2010) to name two. This proposal will be expanded upon in the subsequent conclusions and recommendations chapter.

It can also be suggested that this facilitative focus is somewhat in keeping with the servant leadership approach, as outlined in sub-section 2.3.2. Deprioritisation of personal prestige and self-fulfilment in order to enable colleagues complete their important (classroom) work, core tenets of the servant approach (Cerit, 2009), are discernible patterns within the approach of many of the cohort. In some cases, the profiled leaders (such a Participant B) found professional satisfaction in providing the logistical supports needed by teaching colleagues, however others strongly expressed a resentment of this under-utilisation, as they saw it. Given his superior level of specialised PD experience in mathematics, it is unsurprising that Participant A is most strident in this frustration. Participant D also hints at a professional malcontentment about the banal nature of the supports that he must typically offer to colleagues. Whilst servant leadership is evident in the work of many in the sample, it appears that some are uncomfortable with the practical implications of this.

Given the aforementioned preponderance of administrative work, it is unsurprising that other more instructionally-focused duties (as identified by Sexton and Downton, 2014; Jorgensen, 2016) were either minimally present in the activity records of the study's ten leaders, or were completely absent. Instances of participants delivering PD to colleagues, facilitating enhancement of teachers' pedagogical content knowledge, providing practical assistance to teachers in their personal mathematics planning, or, modelling effective pedagogical practice for colleagues, were largely missing from most logs, and the vast bulk of interview transcripts. Participants A and I were the only two interviewees to specifically confirm their fleeting experience in addressing collegiate pedagogical content knowledge. Uniquely, Participant J described her experiences of directly modelling mathematics teaching approaches to a less experienced colleague. Equally exceptional, Participant H was the sole contributor to show any direct understanding of the planning approaches for Mathematics of her colleagues, and her own leadership role in assisting this lesson preparation. The researcher was unable to find any reference, either direct or implied, to participants delivering any form of organised collective PD in Mathematics to colleagues across the project's three data sets.

Sub-section 2.3.2 offered a reprise of four different leadership approaches that dominate the contemporary, mainstream literature. The fleeting presence of instructional leadership practices within the combined activity of the sample has already been identified, as have specific examples of a servant-leadership orientation. A transformational mind-set was evident in the fact that a respective 11% and 8% of the cohort's aggregated activity was dedicated to communicating the school's vision for the teaching and learning of mathematics, and, the general promotion of mathematics in the broader school community. Consistent with such an approach, Bass (1998) does urge the transformational leader to take every opportunity to communicate the organisation's vision, and to do so in a positive manner that promotes buy-in and builds the intrinsic motivation of staff. However, this assumption of precedence among the sample is somewhat tempered by the non-recognition of most participants of vision-enhancing/promotional work when asked to pinpoint professional, local priorities during their interviews. Once again, contradictions of priority and action come to the fore.

It is further interesting to note that either direct or indirect evidence of distributed leadership approaches, as outlined by Spillane (2005b), were largely absent from the data. Participant after participant noted the intolerable time pressure they toiled under, and the lack of additional assistance to meet their mathematics leadership duties. Whilst the mathematics leadership role was ostensibly "delegated" to all of the sample's non-principal participants, four of the affected five leaders enacted their role in an isolated and unsupported manner. Participant B even wondered aloud why she had been considered suitable for the role by her principal given her lack of previous connection or interest in the subject. The experience of the four delegates was a far cry from Woods' (2004) vision of a genuinely distributed philosophy "where people work together in such a way that they pool their initiative and expertise" (p.441). The one exception to this prevailing culture was Participant I who, predictably, was part of a shared leadership construct. His experience embodied the urging of Harris and lambert (2003) to "(engage) expertise wherever it exists" (p.4). He and his co-leaders divided up their leadership duties to best fit with their individual skillset, and to take account of the professional circumstances of each other at any given time. His more satisfying, unhurried experience of mathematics leadership stood in stark contrast to the testimony of his fellow participants.

Whilst the various duties captured in the logs and interview transcripts do correspond with the breadth of responsibilities chronicled in the literature, this study's results showed a rather unequal distribution of emphases between these obligations. Once organisational duties were stripped out from the leadership workload, the curricular and pedagogical aspects of the role had a fleeting presence in the output of most of the sample. Participants B and I were manifest examples of this inequity, with 41% and 43% of their respective logged activity solely confined to the curation of mathematics equipment. In the case of Participant E, this proportion soared to a staggering 71%, although admittedly based on a relatively low number of completed leadership acts. Whilst there are valid reasons explaining this imbalance, it does lead to a rather lop-sided and logistically-loaded interpretation of what mathematics leadership involves for Irish schools. The literature has also captured this discrepancy – amongst these, Fink and Resnick attempt to rationalise it by suggesting that "(leaders) gravitate towards doing what they know how to do" (2001, p.599). Although this project neither confirms nor contradicts this explanation, it does point to the fact that enhanced leadership PD may be needed to help leaders to diversify their workload. This PD focus forms the cornerstone of this chapter's next section.

5.3 PD and the Mathematics Leader

The literature is united, and unequivocal, in its assertion that mathematics leaders require specialised PD and training opportunities in order to satisfactorily execute the range of varying responsibilities that fall under the role. Jorgensen (2016) is quite typical of this prevailing viewpoint. With the notable exception of Participant J, the entire sample supported this demand for bespoke PD, tailored uniquely for mathematics leadership. Given this relative unanimity, it is perhaps more beneficial to contrast both what the literature and the sample suggest as the most appropriate content and experiences that should form part of this leadership preparation.

Predominantly, the literature advocates specialist PD in both the mathematics competency and mathematics pedagogy domains for the numeracy leader. Given the distinct nature of this duo, both require separate discussion below.

The challenge of addressing deficiencies in leaders' own mathematical content knowledge is readily acknowledged in the international literature, and indeed it is seen as a key component of any leadership-forming intervention. Profiled models of delivery include face-to-face tutor/group arrangements, on-line communities, and mentor/mentee structures (see Akiba et al., 2015; Jorgensen, 2016; Webel et al., 2017). Such variety of provision is unfortunately not a feature of the Irish context, and whilst many of the participants articulated a strong desire to enhance their own mathematical content knowledge, none could point to a single experience of formal, organised PD that addressed this need. At best, snatched moments between colleagues who might informally, but superficially address a competency issue, habitually attempted to fill this obvious void. Participant A accurately portrayed the experience of many in the cohort when describing his leadership interactions:

> *"…often times that would be at the photocopier or in the staffroom getting a cup of tea or it will be maybe just someone might knock into the room kind of thing… "can I just borrow you for a second?" kind of thing."* (Participant A interview transcript)

The literature is silent on the issue of personal embarrassment, or fear of ridicule, were mathematics leaders to be considered as particularly needing of competency-enhancement themselves. Neither does this issue emerge in this piece of research. However, the openness of the sample to self-assess their own content knowledge (and suggest how it might be improved) indicates that this may not be a significant impediment to leaders engaging in useful professional upskilling.

Sub-section 2.6.2 of the literature review described the growing offering of pedagogy-focused mathematics PD for primary school teachers in Ireland. Whilst a strong methodological focus is hugely necessary to support innovative classroom teaching (and to keep mathematics leaders abreast of emerging approaches), the current near-exclusive emphasis upon classroom teaching within the PD suite, to the exclusion of other domains, is undeniable. This is considered as short-sighted and foolhardy by the international research (see Bush and Glover, 2014). Through their responses, the profiled leaders confirmed that this pedagogical over-concentration is also a severely limiting feature of the teacher/leader PD landscape in Ireland. One by one, each of them articulated a craving for a form of leadership formation and ongoing training that addresses their need to lead people, as much as the subject itself. Echoing the recommendations of the literature (see Olson, 2004; Vale et al., 2010; Bush and Glover, 2014; Yow and Lotter, 2016), participants articulated a desire to grow their "soft", inter-personal capacities, thus allowing them to work alongside colleagues in implementing an agreed and innovative culture of mathematics teaching and learning. Other technical skills, such as the analysis and strategic use of data, negotiating the intricacies of school development planning, and managing a culture of institutional change, were common themes shared by the synthesis of the literature, and the exhortations of many participants. Unsurprisingly, the principal leaders in the cohort echoed the urgings of Fullan et al. (2005) to be cautious when leading change, and to ensure that mathematics curricular transformation and development in schools is fortified by whole-school consensus and a clear, communicable rationale for its implementation.

Throughout the interview transcripts, there was a palpable sense of the professional detachment and segregation that many of the mathematics leaders felt. This has broader implications for how school leaders self-perceive – whether as isolated actors struggling to keep up with an unenviable workload, disconnected from local colleagues and peers in other schools, or, as team players who share the leadership load in a personally satisfying and professionally sustainable manner. Clearly the difference between both scenarios, at opposing ends of the continuum, has huge repercussions for the personal and professional wellbeing of the leader, their role effectiveness within the school community, and, the image of mathematics and of leadership that they communicate to colleagues. Of the ten participants sampled in this research, only two described their leadership work as "*highly rewarding*", whilst a further three could only offer a "*somewhat rewarding*" response. This air of despondency is further emphasised through the admission by eight of the ten leaders that they felt unsupported in the execution of their role. Such role-overload, and its arising professional dissatisfaction, among mid-ranking curricular leaders has already been captured in the review of the literature (see Fink and Resnick, 2001). This malaise also remains a recurring theme of more contemporary research examining general school leadership, even in the Irish context (see Stynes and McNamara, 2019). The sheer breadth of duties captured in this study's activity logs, moving from the curricular to the organisational and on to the pedagogical (often within the same day), has exposed the true expanse of the role. During many of the participant interviews, this awesome diversity was accepted as an unavoidable aspect of the role. Participant upon participant described their dexterity in juggling multiple duties, yet with a perceptible insinuation that very few leadership acts received the full attention they merited. It appears that the platitude of "Jack of all trades", first mooted in sub-section 2.2.3, remains a valid description of how mathematics leaders operate, and of how they self-perceive.

Whilst the isolation found in this study may be a symptom of localised factors, often unrelated to Mathematics or indeed any specific curricular area, such remoteness from other mathematics leaders was bluntly recognised by Participant D. His stark observation, that he did not personally know any other fellow teacher/principal who self-identified as a mathematics leader, was a powerful expression. In essence, he felt alone in his role, without a comparable peer to turn to for advice and support. Vale et al.'s "communities of practice" (2010, p.52), where specialist leaders gather to address areas of shared concern - ultimately supporting one another, would appear as the perfect antidote to this professional remoteness. It is quite likely that communal accessing of PD is a convenient, yet highly effective way of introducing mathematics leaders to each other. Although no participant in this study went as far as to make a suggestion comparable to Fink and Resnick's "monthly principals'/leaders' conferences" (2001, p.601), other jurisdictions do provide an example for mathematics leaders in Ireland to organise, and pool their collective expertise. This call to assemble and to collaborate, will form a key plank of the recommendations found in the next chapter. For now, the juxtaposition of the literature and this dissertation's emerging findings will shift its focus to consider the specialist nature of mathematics leadership, and whether any common ground exists between both perspectives, generalist and specialist, on this key consideration.

5.4 The Specialist Nature of Mathematics Leadership

Leithwood et al.'s refrain that effective educational leadership requires an individual "in a particular position or with special expertise" (2007, p.57) provides a concise, yet insightful summation of the prevailing view of the literature. Notwithstanding the numerous compilations of generalised leadership traits, offered by Hart (1992), Gronn (1999) and Leithwood et al. (2008), to cite but three relevant examples, the research reveals a very specific skillset that is exclusive to effective mathematics leadership. On an abstract level, the project's participants largely supported this specialist agenda. Although their initial impulse was to express self-deprecation and therefore reject the expert label as a personal description, considered analysis of their varied catalogue of work, and the professional demands it made upon them, revealed a set of unique and highly specialised practitioners at work. This challenges the previously cited proposition of Field (2002), Halverson et al. (2007) and Katterfeld (2014) who collectively proffer that curricular leadership is generic in nature, and has no subject-specific demand that exceeds common professional expertise.

Bryman (2004) and Eacott and Holmes (2010) indicate that an awareness of the local mathematical culture within one's school is an obvious, if under-estimated, leadership essential. This was a recurring theme in many of the interviews, typified by Participants G and H (both administrative principals) who held a very strong sense of their schools' respective approaches to mathematics teaching and learning. This awareness was heightened by a clear cognisance of how successfully or otherwise this whole-school philosophy was been realised at the micro, classroom level. Their consciousness was further supplemented by a firmly-held sensitivity to the possible factors that were influencing their school's current attainment levels in the subject. Interestingly, teaching leaders appeared to be at a distinct disadvantage in this regard. Leaders, such as Participants A, C, D and E, universally bemoaned the impossibility of being relieved from their own classrooms to professionally "visit" and liaise with colleagues

> *"But when I am not out of the classroom, I simply can't visit other classrooms… I'd love to have the opportunities to have them but... you know… just the constraints of time at the moment are…"* (Participant D interview transcript)

As displayed in the above quotation, participants identified this lack of opportunity as the primary hindrance to forming a more rounded view of mathematics provision in their schools. This has broader implications relating to dedicated release time for non-administrative leaders, and this too will form a cornerstone of the dissertation's subsequent recommendations.

Jorgensen (2016), in his profiling of Australian mathematics leaders, notes that a receptiveness to, and practical desire to engage in focused PD, is a hallmark of the emerging leader. This was an almost universal aspiration of the cohort, with one notable exception. Notwithstanding this outlier, the second part of Jorgensen's thesis suggests that such expert leaders typically hold a long and varied track record of PD in the discipline. Whilst sub-section 4.5.1 outlines the relative infrequence of mathematics leadership-specific upskilling engaged in by the participants in recent years, this paucity should also be considered in light of the haphazard and overly-generic PD offering for Irish leaders over the last twenty years. Once again, an obvious consideration for the dissertation's recommendations becomes apparent.

The literature is less consistent on the vexed issue of whether or not mathematics leaders simultaneously require expert-level knowledge of both mathematical subject-matter and of mathematical pedagogies. It is inconsistent as to whether or not such knowledge should be superior in depth to that of colleagues, in order to best lead the subject. At one end of the spectrum Fink and Resnick propose that "(mathematics leaders) don't have to be content specialists" (2011, p.600), whilst others such as Vale et al. (2010) and Yow and Lotter (2016) counter with a compelling argument that mathematics leaders require an enhanced, perceptible knowledge, specialist in nature, to set them apart from those whom they lead.

Interestingly, this schism is also reflected within the sample. Participant B suggests the greater suitability of a colleague with a primary degree in Mathematics to lead (rather than herself, an eminently more experienced practitioner), whereas Participants B and C, for example, immediately reject the "mathematical expert" tag when it is proffered as a leadership prerequisite, during their interviews. However, their denunciation of this label comes with a caveat. Most participants noted that a mathematics leader should display a comfort with senior primary-level Mathematics and that this ease should also be evident in a familiarity with a broad range of methodological approaches to address any likely classroom scenario. This conditionality was strongly reinforced by the vast majority of participant self-ratings. When asked to self-classify their personal content and pedagogical knowledge of primary school Mathematics, nine out of the ten leaders chose the highest or second-highest available ranking.

It would appear that while the "expert" term is unattractive, for fear of immodesty possibly, a knowledge base beyond the typical is a de-facto condition to lead Mathematics in Irish primary schools. Again, this challenges Katterfeld's (2014) nonplussed reception towards specialised curricular leadership, and its implication of a unique, identifiable skillset underpinning each curricular discipline. This enhanced, diversified knowledge base (demonstrated by the participants) strongly resonates with the domains of MKT, as proposed by Loewenberg Ball et al. (2008), and as detailed in sub-section 2.5.3. Indeed, once leadership acts of a more organisational/logistical nature were disregarded, the activity profiles of most of the cohort clearly revealed instances of the application of common content knowledge, specialised content knowledge, and, knowledge of content and curriculum. This trio encapsulate the very core of MKT theory. Harkening back to the previous section in this chapter (5.3), it bears consideration as to how this diversified, and complex knowledge base could be developed by leaders through PD. Again, the subsequent conclusions and recommendations will draw from these consistent, literature-supported findings.

Yow and Lotter (2016) envisaged a tri-fold alliance of content mastery, pedagogical know-how and generalised leadership capacity as core aptitudes in the arsenal of the effective mathematics leader. The analysis of the participants' questionnaires/profilers, activity logs and interview transcripts largely reinforced this axis. When asked to classify the skills and competencies that underpinned each of the leadership acts captured in the log, all three categories were evident among the some 806 classifications provided by the cohort. Although mathematical competency significantly lagged behind the remaining domains, it still featured in one out of every twenty classifications. This lag may be explained by the more basic, elementary nature of primary school Mathematics, which presumably made an unremarkable, sometimes unnoticed demand upon the leaders. On this basis, competency is likely to become a more significant demand for mathematics leaders at senior primary and at second level, where the mathematical sophistication required elevates sharply.

Unsurprisingly, pedagogical knowledge accounted for 16% of the 806 categorisations, whilst the more generalised leadership classification attracted an amalgamated 28% of all responses (see figure 4.11). This consistency between the literature and this study's findings is reassuring

– the role of mathematics leader is clearly specialist in nature, and is characterised by its multi-dimensionality and arising complexity. Foremost among the challenges presented by the role is the necessity to avoid the logistical overload that is largely typical of contemporary curricular leadership, and to diplomatically expand both the discrete and overt monitoring of mathematics standards at local level. These two thorny issues, logistical overkill and standards control, will form the core of the next section.

5.5 Contradictions of Priority and Action

Section 5.2 has already depicted the disproportionate quantity of mathematics leadership engagement that is associated with logistical and administrative functions - the literature and the study's findings fully concur in highlighting this imbalance. Actions specifically linked to either physically organising the school's mathematics equipment stock, or completing mandatory planning documents on behalf of the school, were the most frequently occurring activities, and were also among the most time-consuming individual acts for the profiled leaders. Katterfeld's (2013) advice to simply avoid role overload, and to prioritise the formulation and enactment of local academic vision (over bureaucratic concerns), although desirable, would seem to be quite remote from the reality on the ground.

A related consideration arising from the interviews was the participants' near universal enthusiasm to decrease the amount of time devoted to such work, and to re-direct more of their energies to specifically influence the teaching and learning of Mathematics in their schools. Participant F was a case in point of this desire – she noted the positive evolution of her responsibilities as her school successfully established alternative, non-leader dependent structures to manage her school's vast mathematics equipment stock. Participant D, although holding the same intention (but based in a much smaller school), described with dissatisfaction his need to frequently arrange mathematics resources not only for his own class teaching, but for colleagues too. This scenario was clearly depriving an already time-poor teaching principal of opportunities to bring a more instructional focus to his leadership work.

This then begs the question as to why this clearly recognisable imbalance endures, despite the expressed willingness of the cohort to shift their activity focus. Among the leaders within this study, the reasons were obvious, but nonetheless compelling. Participants E and J were very cognisant that there was simply no one else on staff willing to step into the role (despite the school having a very large amount of mathematics resources), hence their volunteerism. Implied in this is a desire to not see hard-earned school funds, spent on manipulatives, go to waste. Participant E described multiple scenarios where locating a mathematics teaching resource for a neighbouring teacher represented an urgent need, and as a senior colleague, she felt compelled to act. Other participants noted the dis-organisation of school mathematics equipment as a very obvious eye-sore to the school community, and a poor reflection upon the subject's status in the school – this demanded a response.

Both administrative and teaching principals strongly communicated a realisation that owing to their formal leadership role, they felt an obvious responsibility to personally respond to paperwork and mandated planning requirements, given the teaching burden that other colleagues had to also carry. Participant H exemplified this generosity in her transcript. In other cases, non-principal leaders hinted at a perceived lack of personal authority to directly intervene in the teaching and learning agenda of their colleagues. Participants A and J, both voluntary numeracy coordinators in their first decade of teaching service, expressed an unease about possibly over-stepping the mark when advising long-serving colleagues. Organising mathematics equipment and meeting other logistical needs was a tolerable, and low risk form of leadership for them. Unsurprisingly, the more time-poor leaders within the sample indicated that management of the school's mathematics resources was a tangible, and visible indication to the school community of their work. Hence it was important that they responded as an exercise in accountability, if for no other reason.

The literature offers further, plausible explanations as to why mathematics leaders perpetuate the imbalance in activity. Fink and Resnick (2001) note the human tendency to resort to what is habit, and ultimately what is easier to carry out. Although time-consuming, resource management could not be described as overly demanding of an evolved leadership skillset. By way of contrast, the intellectual burden that more instructionally-focused mathematics leadership entails is significant. Loewenberg Ball et al.'s (2008) aforementioned multi-faceted model of MKT is noteworthy in its sheer depth and complexity. Familiarity with, if not mastery of the various domains within this model is a reasonable prerequisite for mathematics leadership. This is borne out in the experience of Participant A, whose further post-graduate study in mathematics pedagogy marked him out as an obvious mathematics leadership asset to his principal and his school colleagues.

Other possibilities may further explain the documented disparity between participant priority and action; undoubtedly for many leaders, leading change is easier in theory than in practice. The literature captures this dynamic too - Bryman (2004), among many others, notes the sheer complexity of managing periodic change in an already pressurised school context. In an era of enhanced SSE and a newly published mathematics curriculum, spearheading change is an inevitable and on-going requisite of mathematics leadership in an Irish context too. Leading Mathematics clearly entails leading people, and this also adds a considerable and sometimes intimidating burden upon the leader's shoulders. Key thinkers in the educational leadership space (Goleman, 1998; Fullan, 2002; Caruso, 2003; Clarke and Mahdi, 2011), whilst imploring the need for emotional intelligence when leading, are cognisant of the load this creates. It is little wonder that mathematics leaders, many of whom are unpaid for their work (and often holding other onerous school-wide duties) may shy away from these contentious, often controversial aspects of idealised mathematics leadership.

One of these more potentially controversial aspects of leadership that emerged during this study was the monitoring of mathematics teaching and learning standards at a local level in schools. Specifically, any formal arrangements to observe (and comment upon) the mathematics teaching practices of teachers was particularly problematic. Once again, Katterfeld is characteristically enthusiastic in her recommendation of what mathematics leaders ought to be doing in this regard – "(placing) a strong emphasis upon the systematic supervision of instruction by colleagues, at close quarters" (2013, p.338). Notwithstanding this exhortation, such activity accounted for just over 3% of overall activity output for this study's sample (see figures 4.7 and 4.8a), with six of the cohort's ten leaders failing to register a single act whatever in this domain. When participants were asked to reconcile these poor application levels with earlier, contradictory expressions of the importance of supervising teaching and learning standards, responses were somewhat reflective of the literature. Many explanations were localised within discourse about the traditional autonomy and piecemeal accountability experienced by Irish primary school teachers in their classrooms (see Coolahan, 2003; O'Donovan, 2013). Chiefly, principals cited the absence of time and opportunity to visit colleagues' classrooms, alongside a lack of mathematical/pedagogical self-confidence to stand in judgement of a colleague. Perhaps most damning of all, these head teachers also noted a personal reticence to go against the prevailing local school culture which placed little or no priority upon peer observation:

> *"I do think it is a cultural issue and a hangover issue of years of our union dictating what happens in Irish classrooms and schools to be honest. I think the idea of me observing any experienced teacher here would be……it would not happen."* (Participant H interview transcript)

The international literature, reflecting its predominant and more evolved North American, Australian and British perspectives, presumes a broader acceptance of peer observation. Consequently, it actively chronicles multiple case studies of such professional collaborations between teaching colleagues, and between school principals and teams of teachers (see Fink and Resnick, 2001; Supovitz and Poglinco; 2001; Bruce and Ross, 2008; Balka et al., 2010; Katterfeld, 2013; Sexton and Downton, 2014; Grootenboer et al., 2015). A mixture of evaluative and non-evaluative frameworks are evident in this selection, each with encouraging outcomes for both the observed teacher and the observing colleague/superior. There is little or no evidence in the cited research of the understandable teacher misgivings that one might expect to accompany such monitoring initiatives. One can only presume that such practices are part and parcel of the local educational culture, and therefore are simply accepted as a common and valued practice. Furthermore, the near-exclusive focus of the U.S. literature (and the PD that follows from it) appears to be geared towards improving the knowledge base and general competence of the mathematics leaders themselves prior to entering their colleagues' classrooms, thus facilitating constructive post-observation feedback. Understandably, the research also demonstrates that such cultures take time and resources to embed. There will be no overnight transformation in the Irish system. The hugely limited suite of PD available to mathematics leaders in Ireland, as confirmed in the literature review and through the experiences of the sample themselves, is but a poor comparison to what neighbouring jurisdictions are making available to its leadership strata. It would appear that Jorgensen's (2016) comments reinforcing the need for dedicated, in-house mathematics leadership as a response to the poor availability of bespoke PD from external providers may be the only safety valve available to hard-pressed Irish primary schools. Until such deficits in provision are addressed, it is highly likely that despite noble intentions to engage in classroom visits and other forms of standards monitoring, such experiences will be the exception rather than the norm in Ireland.

The concluding and perhaps pivotal comparison between the literature and the analysis from this study centres upon the critical sustainability of mathematics leadership structures, typically single-person entities, within Irish primary schools. This important juxtaposition follows.

5.6 The Sustainability of Middle and Principal Leadership of Mathematics

The findings of this study clearly presented the participating mathematics leaders as a conscientious, task-oriented cohort, hugely dedicated to their work but commensurately hamstrung by external factors which exercise an overbearing, inhibiting influence. This section will explore some of these key inhibitors, and will contrast the study's associated findings with how they dovetail with the established principles taken from the literature.

Sub-section 4.8.1 strongly depicted the time pressures that the eight teaching leaders in the cohort universally reported. The comments of Participants A, B, G and J all showed a constant battle to find an equilibrium of priority between official, daily teaching duties, additional administrative demands, and their (sometimes voluntary) mathematics leadership role. Many logging comments revealed this unsolvable dilemma:

> *"Too busy a day - not even an "incidental" to log."* (Participant B, Activity Log; 3rd December, 2018)

> *"Very busy coming into December - too many other demands in fulfilling DP role to engage in pre-planned maths input."* (Participant B, Activity Log; 7th December, 2018)

> *"Amount in the job stops me from having enough time."* (Participant G, Activity Log; 28th November, 2018)

When both teaching and leading functions came into direct conflict, core teaching responsibilities understandably predominated. The five non-principal leaders within the sample shared this common frustration, and openly bemoaned the unenviable position this put them in, on an almost daily basis. Such an impossible situation resonates with Siskin's (1993) depiction of some (middle and senior) leaders as neither proper administrator nor fully committed teacher, but rather an unsatisfactory hybrid of the two, yet carrying the full burden of both. Although dating back over twenty years ago, Zinn's (1997, p.11) "overwhelmed" teacher-leader remains very evident today unfortunately. Participant C gave voice to this fatigue when considering his opportunities for specifically targeting mathematics leadership work:

> *"It's just not practical, and you can't think about it much between 8 and 9 in the morning because you are trying to get ready for the school day, and you can't think about it much between half 2 and 4.00 because you are trying to wrap that school day up and prepare for the next one, and the days fly –before you know it… it is Thursday*

> *evening, and you're kind of going "what the hell did I achieve in the week?"* (Participant C interview transcript)

This reported time poverty finds specific support in the literature, and has even been specifically noted as a distinguishing feature of the Irish primary system by the OECD when they highlighted "the absence of time for performance of (leadership) duties and (the) absence of structured meeting times during the school week" (2007, p.65). Literature from Britain dating back over two decades ago shows, even at that time, a realisation that a reduced teaching load was a reasonable accommodation to mathematics leaders straddling both the teaching and leadership positions (see Brown, 1998). This is now a commonplace arrangement in British, Australian and North American schools – surely this study's sample must enviously view this facilitation of the dual mandate that these teacher-leaders hold. It is lamentable that the specific advantages that teacher-leaders hold, such as collegiate credibility and an intimate familiarity with the "core business of teaching and learning" (Robinson, 2007, p.21) should be squandered in Irish schools due to the absence of this formally ring-fenced release time.

The literature, specifically Seashore Louis et al., (2010), raise sincere concerns about the practicality, and sheer sustainability of principal-only subject-specific leadership. These doubts are in the main underpinned by an acknowledgement of the enormity of the principal's role, and the multiplicity of competing administrative and leadership exigencies it makes. In essence, the research queries how one person can co-prioritise so many competing demands. This specific motif did not emerge among the two administrative principals within the sample. Whilst both comfortably held the reins of mathematics leadership in their respective schools, their mandated authority allowed them to delegate more menial tasks, and to keep a broader enabling, whole-school focus in whatever they personally carried out (see Coelli and Green, 2012). This resonates somewhat with Ng et al.'s (2015) depiction of the principal as conductor of the orchestra – facilitating others to play their part, rather than being an on-the-ground operative him/herself.

With an average of 26 mathematics leadership actions per participant during the combined logging periods, it is interesting to note that the mean number of acts for the two non-teaching principals was recorded at 46 for the same duration. This rate reveals an industrious style of leadership that appears to belie the more pessimistic stance of the literature. Interestingly, both leaders gave the impression that they simply fell into the role, without any particular fondness for the subject, in order to plug a gap in the management structures of their respective schools.

Both, however, readily acknowledged the need to respond to such leadership challenges in a more organised and sustainable manner, that did not rely so much upon their personal input.

Notwithstanding their own situations, both loosely concurred with Gronn's (1999, 2003) distaste for the over-concentration of leadership authority in the hands of one individual. First identified in sub-section 2.4.1, Leithwood et al.'s "total leadership" approach (2008, p.34), a variation of distributed headship, strongly resonates in this regard. However, so too does the authors' warning to ensure that the arising co-leadership duties are truly equal, patently meaningful and directly geared towards a common, negotiated goal. Borrowing from Spillane's "leader plus" distributive dynamic (2005b, p.144), it is crucial to recognise that the wider principal fraternity may need to display a more radical shift in mind-set – no longer is it sustainable to merely prescribe and then delegate duties to subordinates (thus reinforcing a traditional, and now outmoded leadership hierarchy). Rather they must self-perceive as first among equals in a community of co-leaders for Mathematics (or whatever curricular area). They must empower each member with an important, authority-laden role to execute. Notwithstanding the benefits of this approach, practical obstacles arise in the transcripts – Participant D, for example, expressed a clear willingness to meaningfully share his mathematics leadership position, but added that a lack of interest and/or availability among colleagues in stepping up to the challenge has thwarted his noble intention. It does demonstrate that willingness for such co-leadership must come from both sides, and that it does need to be practically facilitated to get off the ground.

The inadequacies of the PD opportunities for mathematics leaders in Ireland have previously been explored in considerable detail in this and other chapters. However, this unsatisfactory provision is also a relevant consideration in any discussion about the viability of subject-specific leadership in primary schools. Whilst a plethora of U.S. and British research articles and other publications ponder the evolving role of mathematics coordinators, and provide increasingly complex guidance to such leaders (see NCSM, 2008; Balka et al., 2010), Irish mathematics leaders can only watch and attempt to respond in an ad hoc and localised manner to the demands of their role. Official recognition and centralised support remain an aspiration, unlikely to be granted in the short term. Unsurprisingly, this glaring chasm will re-emerge for further discussion in the subsequent recommendations of this research.

A final threat to the viability of mathematics leadership is the isolation of the role. The admission by participant D that he personally knew of no other mathematics leaders is as troubling, as it is honest. Sub-section 4.5.2.7 builds on these declared sentiments and describes a strong appetite among many of the profiled leaders for networking opportunities that would connect them with mathematics coordinators in different schools. However, a more deep-seated need of these leaders was an enhanced localised support that would allow them to share their leadership burden with their own colleagues. Participants A and H both outlined the positive personal and professional benefit that accrued from a collaboration with colleagues on a mathematics-specific leadership initiative. This contrasts sharply with the more solitary experience of many participants who expressed a basic need for logistical support from co-teachers, greater affirmation from both peers and superiors, and enhanced co-operation from other members of the school's in-house management team.

Whilst leader isolation is not a particularly new phenomenon in the international and domestic research (Kelchtermans et al., 2011; Beausaert et al., 2016; Bauer and Silver, 2018; Stynes and McNamara, 2019), it is disappointing that the literature is somewhat silent in chronicling this professional seclusion in the case of mathematics leaders specifically. Maybe it is an area that has not warranted examination up to now. Perhaps it can be somewhat explained by the suite of logistical and professional supports (including PD opportunities and dedicated release time) that British, Australian and North American leaders take for granted. Representative bodies such as The National Council of Supervisors of Mathematics, National Council of Teachers of Mathematics (both from the U.S.A.), The National Centre for Excellence in the Teaching of Mathematics (U.K.) and The Australian Association of Mathematics Teachers (Australia) all play a key advocacy and networking role for mathematics leaders in their respective jurisdictions. Such organisation, and its strategic pooling of expertise, provides a lesson to mathematics leaders in Ireland and this example will be expanded upon in the researcher's subsequent recommendations. Participant F's vision may indeed be an admirable aim for Irish leaders in the years ahead:

> *"an informal network if you ever wanted to get involved, where… you know, online you would… put up any ideas you had and share resources, share ideas."* (Participant F interview transcript)

5.7 Conclusion

In the bulk of instances highlighted in this chapter, the similarities between the stance of literature and the study's findings is reassuring, even though many points of agreement relate to the more pressurised and unsupported aspects of the role. Undoubtedly, we can confidently confirm the sheer complexity and multi-dimensionality of the position. Furthermore, the time and skills-demand it makes, the acute need for specialised PD to sustain the position, and the over-concentration upon the administrative aspects of the role, all surface again and again as uncontested truths. These are important learnings in attempting to grapple with the researcher's overarching research question – how is mathematics leadership being enacted in our primary schools. In truth, these realisations represent the lived experiences of those who enact the role every day, including the study's cohort. However uncomfortable they may be for schools, their boards of management, or the responsible state bodies, such truths cannot be excluded in any comprehensive appraisal of the sustainability of the mathematics leadership position.

Other, more vexed issues remain in need of further clarification: how best can the education system support teaching leaders, as a specific grouping, and their unique circumstances? What supports might best assist leaders to reconcile key priorities, such as peer observation, (however challenging for colleagues) with actions on the ground? What model of professional networking and collaboration might best suit all leaders of Mathematics in diverse and geographically-disparate Irish primary schools? The next chapter responds to these critical prompts.

Optimism is offered through the innovation (and promise) that shared leadership constructs are displaying. This chapter did highlight their important, albeit fringe existence within the profiled cohort of leaders. Such models have the potential to supersede the traditional image of mathematics leaders as heroic, if ultimately overwhelmed and isolated actors.

On multiple occasions in this chapter, the discussion signposted emerging conclusions and recommendations that logically followed the researcher's findings and analysis. The subsequent, final chapter of this dissertation teases out these rationalised judgements and commendations in more substantial detail.

Chapter Six: Conclusions and Recommendations

6.1 Introduction

From its outset this study aimed to examine the enactment of localised mathematics leadership within the Irish primary school system. Prompted by a persuasive combination of the career experiences of the researcher, who undertook this role in three different school settings, and the somewhat patchy treatment of mathematics leadership as a distinctive, and deserving discipline in the national and international literature, it was deemed a topic in need of deepened consideration. Fundamentally, the research is an attempt to place the topic of mathematics leadership on the agenda of national policy makers.

In particular, the research enterprise profiled ten unique individuals who actively carried out this important work on a daily basis. Each leader was purposely distinctive in terms of their context, their professional background and their general experience – this guaranteed a degree of representativeness that would ultimately lend credibility to any emerging findings. Crucially, it was also intended to chronicle each leader's specific experiences of, and opinions towards, their curriculum management role. In many ways, this latter aim represents the very raison d'être of the research – to demonstrate to the educational community (and beyond) the true nature of the mathematics leadership role, the physical and intellectual demands it makes upon the individual, and, the expansive skillset that its successful execution demands. Moreover, the research aimed to address four key sub-questions:

- How do primary schools practically respond to the need for mathematics leadership?
- How do individual mathematics leaders conceptualise and enact their role?
- What is the nature of this mathematics leadership work and its associated challenges?
- Which supports do mathematics leaders presently exploit as part of their duties, and what additional, currently unavailable supports would make their role more impactful and professionally sustainable?

To answer these probing questions, the research employed a mixed-methods approach. The accompanying combination of research instruments from both the quantitative and qualitative traditions illustrated the researcher's pragmatic orientation to help make sense of the phenomenon at hand from a multiplicity of contexts and viewpoints (see Greene, 2008). This clearly responded to the variety within the sample, and the very real challenge of accurately capturing different leaders, in varying contexts, often doing very diverse duties as part of their work. The sequential nature of the ensuing data-enquiry process played a key facilitative role in a fluid and responsive analysis process, ultimately building towards the generation of cross-case themes. Furthermore, a mixed-methods approach allowed the flexibility to incorporate findings (sometimes consistent, occasionally contradictory and infrequently outlying) from differing research tools within a coherent overall structure.

Through the analysis and presentation of subsequent findings from this small, yet representative sample, it was envisaged that a clearly defined set of conclusions and recommendations would emerge. Crucially, Chapters Four and Five have set out and interrogated the headline thematic findings, and have contextualise them in the existing literature base. This has paved the way for the current chapter where a set of key conclusions (each with a pair of accompanying recommendations) are identified and scrutinised. Each conclusion carries echoes of one or more of the sub-queries which underpinned the overarching research question.

As acknowledged in section 3.9, the researcher is undeniably an insider in the field of mathematics leadership. A recognition of this predisposition is as important at this juncture as it was during the data analysis phase of the project. It is incumbent upon the researcher to leave aside personal inclinations, and to impartially generate a set of conclusions and recommendations that have clear objective grounds within the data. To display this neutrality, the researcher will utilise specific findings from the data (including log and interview contributions) to support each of the suppositions offered. The limitations of this study also require re-acknowledgement in this context. Recognition of the small number of participants, and the irrefutable incongruity of case-study research and broad generalisability, should guard the reader against unchecked acceptance of the hypotheses and commendations set forth in this chapter.

As the research process has proceeded, particularly the data-analysis and reporting phases, additional and related topics in need of additional investigation have clearly emerged. Therefore, as a complement to this final chapter, three such areas are acknowledged and briefly discussed in section 6.6.

Although the five cross-case themes which emerged in the data-analysis process do not directly map upon each of the conclusions, their subtle presence is very much manifest in this discussion. Nowhere is this more evident than in the first conclusion/recommendation (drawing as it does across all five cross-case themes) which rejects the notion of an archetypal mathematics leader, and pinpoints the importance of context in shaping the conceptualisation, and enactment of the role by the individual leader.

For ease of the reader, figure 6.1 provides a tabular overview of the complete set of conclusions and accompanying recommendations.

Figure 6.1 Overview of Conclusions and Recommendations

Conclusion	Accompanying Recommendations
1. Different leaders conceptualise and enact their role in different ways.	• Each school, irrespective of size, needs a formally appointed mathematics leader/leadership structure. • The DES must prepare a mathematics-specific leadership framework to accompany its more generalised SSE quality framework for school leadership and management.
2. There is a considerable demand for tailored PD and professional networking opportunities to meet the specific needs of mathematics leaders.	• A broadly-based preparation and in-service support programme should be devised and made mandatory for all aspiring and serving mathematics leaders. • Teacher unions, principal-representative bodies and other supporting agencies should facilitate the creation of mathematics-specific leadership cells.
3. There is an over-concentration by mathematics leaders upon the more logistical/managerial aspects of their role. This, in particular, is to the detriment of proactive monitoring of local mathematics teaching and learning standards, which appears to present very specific challenges in its enactment.	• Mathematics leaders must re-evaluate the core aspects of their work and be primarily accountable to their principal. Leaders should be enabled to delegate the more clerical and logistical domains that traditionally fall within their remit. • Formal status for mathematics leaders within their school will build the individual's capacity, and credibility among colleagues, when leading developments in mathematics teaching and learning.
4. Most mathematics leaders are time-poor, and typically feel ill-equipped and practically unsupported in their role. Teaching leaders are particularly susceptible to role overload. The sustainability of single-person mathematics leadership constructs requires urgent consideration.	• Collaborative leadership structures, along the In-School Management Team model, provide a more sustainable form of mathematics coordination in schools. Schools, once adequately resourced by the DES, should explore the capacity of such structures. • Dedicated release time must be made available to school leaders who, either individually or collectively, lead Mathematics in their school

6.2 Conclusion One:

Different leaders conceptualise and enact their role in different ways.

This study clearly demonstrates that mathematics leadership is a real phenomenon in Irish primary schools. It also shows that local leaders are responding to an acute need within individual schools for the coordination of its mathematics teaching and learning agenda – the over 300 logged actions generated by the sample across the two logging windows are proof positive of this fact. Furthermore, the data strongly supports the supposition that the different models of leadership (administrative principal, teaching principal, promoted middle-management leader, volunteer and those who form part of a broader committee structure) do give rise to differing patterns of role enactment.

Sub-sections 4.4.1.1 and 4.4.1.3 of Chapter Four outlined the more prolific output of administrative principals as opposed to teaching leaders, and similarly of middle-management leaders when contrasted with their voluntary, unpaid counterparts. Interestingly, volunteer leaders exclusively concentrated their activity on mentoring and management of the school's equipment stock, thus underlining their more reactive, ad hoc approach to their optional role. Formally recognised (and remunerated) leaders were more even-handed in how they spread their activity across the study's twelve activity categories. Teaching leaders were more likely to liaise with parents in the course of their leadership role, and to also prioritise other duties which had a more obvious connection to the classroom teaching of the subject. These "part-time leaders" were also noticeably more inclined to involve themselves in the practical management of the school's mathematics teaching resources.

Principal leaders, on the other hand, dedicated a much greater proportion of their time to planning considerations, namely curating the school plan for Mathematics, and spearheading the school's self-evaluation process for Numeracy. The geographical and/or socio-economic context of the different schools from which the sample was drawn, particularly whether DEIS or non-DEIS, also appeared to exert some degree of influence on activity. Sub-section 4.4.1.2 demonstrated the less prolific output of DEIS leaders generally, the comparative reluctance of these same leaders to utilise outside expertise in realising their role, and their above-average concentration on whole-school planning.

Similarly, the interview transcripts of the ten participants were laced with countless examples of leaders enacting and rationalising their role. Albeit in very different contexts, they were typically grappling with comparable challenges. All ten strongly asserted the absolute need for their role – the volunteer leaders described a frustration that their school's formal management team were not sufficiently resourced to respond to the numeracy challenge within their school. The realisation of this fact prompted them to respond. Their overriding refrain was that Mathematics is simply too important, as a core subject and a key life skill, to leave without direction and coordination. Other participants revealed how they had requested that Mathematics be added to their already heavy middle-management duties, rather than see the status of the subject fade among their colleagues. One of the teacher-leaders in the sample exemplified this affirmative mind-set:

> "*I think we were doing up the maths plan, and there really wasn't anyone to head it up, so I said "look, I'll take a little bit of time out of my post and do the maths plan."* (Participant E interview transcript)

Principal leaders, heavily burdened and time poor, also demonstrated a similar commitment to the subject by ensuring that it received priority within their already packed agenda of weekly work. Participant D, a principal, noted how prioritising Mathematics allowed him to get "a foothold in the school", thus demonstrating his intention to re-concentrate his staff upon core curricular areas.

The interviews also shed further light on what the leaders perceived as their key role - several expressed a more facilitative focus that aimed to provide the logistical and resource support to allow colleagues teach Mathematics to the best of their ability. Others asserted a mentoring mind-set that prioritised the provision of mathematical and pedagogical assistance to fellow teachers. Some envisaged a role that targeted in-school planning and administrative requirements. A small number primarily sought to harness the potential of the broader school community to support mathematics teaching and learning, whilst others co-prioritised all four aforementioned foci. Undoubtedly, each of these emphases demands a very specific and broad skillset. Sub-section 4.6.4 revealed the variety and the extent of this requirement, ranging as it does from logistical skills, to mathematical competence, through to interpersonal and leadership aptitudes. Whilst modesty most probably prevented any participant from unconditionally accepting the "expert" label offered by the researcher when describing their own work, their subsequent interviews continually contradicted their initial diffidence. Reminiscent of Burke's (1994) true professional, transcript after transcript indicated a specialised coterie immersed in complex and demanding work, grappling with uncertainty, yet drawing on a diverse set of foundation disciplines to guide them in their role.

The accumulated data base, complete with its numerous inconsistencies and contradictions, dispels the notion of the archetypal mathematics leader, who works in a very standardised and prescribed manner. This should not be considered as problematic – the sheer adaptability and responsiveness of the sample to their own schools (and their own unique needs) can actually be interpreted as one of the cohort's chief strengths. It does, however, underline the need for localised mathematics coordination which gives rise to the research's opening recommendation – **each school, irrespective of size, needs a formally appointed mathematics leader/leadership structure [Recommendation 1]**.

A specialist role requires recognition and status. Given the key standing of Mathematics within the teaching and learning programme of all primary schools, it is a significant statement of priority when an individual is formally appointed to spearhead the subject. Many schools, suffering from a lack of sanctioned promotional positions, are meeting this imperative through voluntary effort, or perhaps are unable to put any compensatory arrangements in place whatsoever. When one considers the volume of work engaged in by the study's sample, and the highly probable positive impact it has in their schools, it is troubling to recognise that some schools may not have a comparable individual acting as a catalyst for improvement. Worse still, such a scenario may exist through no fault of the school itself. The DES should ensure that all primary schools are granted approval to expand their formal leadership structure, and that engaged teachers are rewarded adequately for the increased workload. Where schools do have discretion in appointing an in-school management team, it is important that coordinating of Numeracy not be overlooked in favour of other non-core subjects. Centralised direction should be given to all schools in this regard. In smaller schools (which could have as few as two full-time teachers on staff), to enhance to the viability of the position, an individual could be delegated responsibility for a range of related curricular areas that fall under the STEM umbrella, including mathematics and science provision. This could have the secondary benefit of strengthening the cross-curricular integration of mathematics teaching and learning as part of the school's broader curricular programme.

When boards of management are evaluating candidates for such leadership and management positions, they too should seek individuals who have a demonstrated interest and aptitude in mathematics teaching and learning. A track record of relevant PD should also be considered as a prerequisite in such appointment processes. It is imperative that suitability for mathematics leadership, specifically, be the most heavily weighted criteria, rather than traditional emphases such as length of service and other non-relevant experience.

An associated recommendation centres on the need to provide guidance to such leaders in their work – **the DES must prepare a mathematics-specific leadership framework to accompany its more generalised SSE quality framework for school leadership and management [Recommendation 2].** This study has demonstrated the capacity of ten mathematics leaders to prioritise and to respond, in unique ways, to the distinctive challenges of mathematics teaching and learning in their own schools. The leadership discretion they enjoyed was, in most cases, crucial to their responsiveness and local credibility. Whilst they clearly did not require a "*How To…"* guidebook to enact the basic aspects of their role, they would have benefitted from having access to a set of rationalised and research-based principles and/or indicators of best practice. Such a document, describing as it does high quality mathematics teaching and learning, and effective coordination of the subject, would be a vital stimulus for self-reflection and planning. In light of this study's findings, perhaps a series of provocative, self-directed questions might be a more user-friendly format. For example, one of this study's twelve activity domains was: *Monitoring the standards of mathematics teaching and learning within the school* – a possible thread of self-reflection that the researcher is proposing might include:

- Why monitor standards?
- What does monitoring standards mean to me? To colleagues? To pupils? To parents? To my principal?
- What am I looking for when monitoring standards? Have colleagues been consulted? What other official guidelines are useful?
- How best can I monitor teaching?
- How best can I monitor learning?
- How can the teacher/pupil voice be best accessed?
- Will this be perceived as a threat by others? Why? How could I provide assurance?
- Are there cultural sensitivities in the school that need to be considered?
- Will this monitoring be evaluative?
- Who will I report my findings too? How will this be done?
- How will my findings feed in to school self-improvement?

Sub-section 2.6.3. of this study's earlier literature review shows that Irish officials need only look to the North American system to sample a myriad of similar guiding documents (see NCSM, 2008; Balka et al., 2010) They should also take encouragement from their own recent "Looking at our Schools: A Quality Framework for Primary Schools" publication (DES Inspectorate, 2016) which, although non-subject-specific, did begin a welcome re-orientation towards self-sustainability in school leadership, and a noticeable shift from externally imposed evaluation. This provides the template for what is required, not just by Mathematics, but other key curricular disciplines. In the absence of DES-designed charters, it may well fall to the academic community to fill the void. The U.S. examples cited above should provide encouragement – one of these framework documents emanated from the membership of the voluntary professional body of school supervisors, the other from university-based academics. Given the relatively small size of the Irish educational community, perhaps a collaboration of state and other voluntary actors is best. With the imprimatur of the DES (and the official weight that this carries at school level), a practitioner and academic-led charter for mathematics leaders would represent a truly historic departure in the Irish context.

6.3 Conclusion Two:

There is a considerable demand for tailored PD and professional networking opportunities to meet the specific needs of mathematics leaders.

Given the Irish context as depicted in the existing research (sub-section 2.2.4), it is unsurprising that the PD history of the cohort was lacking any noteworthy mathematics leadership-specific dimension. This is not a reflection of any degree of inertia on behalf of the participants, but rather it highlights the failure of support services to provide the suite of required pre- and in-service training. Indeed, mathematics leaders in Ireland should not consider themselves unique in their frustration about this lamentable situation - the literature demonstrates that similar limitations are a feature of many international education systems (see Jita, 2010; Lamb, 2010; Akiba et al., 2015). Multiple interview transcripts in this study captured a palpable appetite to engage in a broad-based mathematics-leadership preparation programme had it been readily available. This enthusiasm is coupled with a frustration in the typical methodology-only focus of the vast majority of the cohort's PD history in Mathematics. There is an exasperated recognition by the participants that there appears to be no indication that this situation is set to change any time soon.

Support for the imperative to offer customised leadership preparation also comes from section 4.6 of this dissertation's analysis. It clearly outlined the broad, intellectually-challenging knowledge and skills base that the leaders called upon in performing their mathematics leadership duties. Self-identification of these competencies (organisational skills, mathematical competency, pedagogical knowledge, curricular knowledge, mentoring skills, facilitation skills, analytical skills, and consultation skills) formed a corner-stone of the participants' logged activity. Upon reviewing their own logged data, many expressed surprise at the variability of the exploited skills, and the frequency of their utilisation. Several of these specific skills are not naturally occurring, and therefore require nurturing and professional training at both the formation and in-service phases. It is unrealistic to expect aspiring and serving mathematics leaders to simply pre-possess this comprehensive array of aptitudes – only through custom-designed focused PD could such an aspiration be realised.

The professional isolation of mathematics leaders from colleagues holding a similar role in other schools is also a concern. Whilst there is an obvious social remoteness arising from this seclusion, it also nullifies any degree of professional synergy that comes from the interaction between skilled practitioners bringing their experience to bear, irrespective of their context or other local factors. Encouragingly, the tangible willingness of a number of participants to reach out to colleagues in other schools demonstrates that were such opportunities available, they would be readily seized upon.

This multi-faceted conclusion gives rise to two distinct, yet inter-related recommendations – the first addresses what support services should consider as core content for mathematics-leadership PD. The second proposes networking structures that would facilitate enhanced professional collaboration and learning among mathematics leaders.

A broadly-based preparation and in-service support programme should be devised and made mandatory for all aspiring and serving mathematics leaders [Recommendation 3]. Reflecting the demonstrated complexity of the role, it is unsurprising that an expansive programme of PD for mathematics leaders is recommended by this research. The initial Mathematics input requires a two-fold focus – methodology and personal competency. The experiences of the cohort reveal that methodology-based training is relatively well catered for in the primary education system at this time – not so for competency-enhancing opportunities. It is a natural assumption that mathematics leaders would display a mastery of the discipline itself. Whilst the majority of participants indicated a general comfort with mathematical subject knowledge, most appreciated that this familiarity required periodic topping-up, especially among those without daily mainstream teaching duties. For example, Participant H (an administrative principal) admitted her reliance on her interactions with NQTs in order to keep her mathematical knowledge fresh:

> *"I feel I am getting a sense of what is out there in terms of the latest pedagogy or methodology or resources for teachers and that's why I play a big part here in the mentoring of NQT's and maths would be one of the areas that I would work with in that regard".* (Participant H interview transcript)

Such enhanced subject-matter competency would help fortify the platform upon which specialist methodological knowledge might then be subsequently extended. The researcher envisages that both of the aforementioned mathematical capacities are indeed inter-changeable and as such, could be worked upon simultaneously in a PD setting. It might also be prudent to broaden the content of any Mathematics input into early second-level material – given the growing need to strengthen transition from primary to post-primary. This bridging would be of significant benefit at the senior primary grade levels. Building the leader's curriculum awareness, from pre-school provision, through primary and cumulating at early second level, could also form part of the theoretical dimension of any such training programme.

In light of the multi-faceted mathematical input that is recommended by this research for any bespoke leadership preparation/in-service training, it would perhaps be prudent for those creating the content to consider the MKT framework (see Loewenberg Ball et al., 2008). Sub-section 2.5.3 of this research outlines the construct's deep subject-matter component, its pedagogical knowledge base, its broad curricular awareness, and its specialised understanding of the mathematical teaching and learning process - all of which contribute to "mathematically informing" the leader. Although North American in its origins and its theoretical underpinning, it is entirely possible to modify this framework to better suit the Irish context.

This study has clearly shown that leading Mathematics entails leading others - pupils, parents, colleagues and other supportive agents. This behoves the leader to cultivate a range of interpersonal skills, an accompanying emotional intelligence, and, an overall collaborative approach when attempting to fulfil their duties. Such personal development is demanding and typically requires specific external input, guided personal reflection and organised opportunities to build self-awareness in the workplace. The capacity to juggle time, financial and other resource pressures should not be presumed. Therefore, each should be addressed as part of any broad-based leadership training. Crucially, curricular leadership also requires expertise in leading change, as discussed in sub-section 2.2.3, and highlighted specifically in Fullan, 2002; Hargreaves, 2008; Taliadorou and Pashiardis, 2015; Brown et al., 2017. With an evolving educational landscape in Ireland, it is clear that managing change (and the emotional baggage it often brings) is indeed a pivotal competency that will be sorely tested in the years ahead.

All relevant education stakeholders in Ireland must be involved in the design, delivery and promotion of such specialised training. The PDST, the Inspectorate, CSL, IPPN, INTO, higher education institutes and other relevant academics would form a formidable platform to make good on this suggestion. Given their foothold in primary and second level schools, their national profile for delivering quality PD, and their dedicated (although separate) numeracy and leadership development team structures, the PDST would best spearhead the project. As a practical support, they could utilise the regional education centre infrastructure to offer preparatory/in-service programmes to all mathematics leaders across the country. An online component could also be developed to facilitate greater access and participation in remote locations (as successfully demonstrated in Jorgensen, 2016). Coincidentally, the two leaders in this study who taught in relatively rural locations, Participants C and D, expressed a strong desire for greater professional connectivity, most likely on account of their geographical contexts. Prior to finalising the content, it would be worthwhile to further consult with schools, in particular with those individuals who already hold the mathematics leadership position. This ultimate “seal of approval” would provide added credibility to what might emerge. Due regard should also be paid to more evolved British, Australian and North American systems and how they have fared in designing and delivering evidence-based preparatory courses for mathematics leaders.

Completion of such PD should be established as an assumed precondition for any teacher seeking to apply for a promotional position which entails a mathematics leadership dimension. Certification for such provision could be sought through the higher education sector, the prestige of which will entice further teacher interest. Those already serving in a mathematics leadership positions should be given a maximum three-year derogation in order to attain the required qualification, after which time they must relinquish the position if they fail to upskill satisfactorily. The DES, specifically through its school leader-supporting agencies, should provide incentives to higher education institutes to consider the integration of similar, curriculum leadership-focused modules within their traditional diploma and masters-level school leadership programmes.

A secondary recommendation springs from the collective strength that sometimes derives from communal PD, or other incidental contact and networking (as demonstrated by Vale et al., 2010 in a diverse Australian school system) – **Teacher unions, principal-representative bodies and other supporting agencies should facilitate the creation of mathematics-specific leadership cells [Recommendation 4].** The professional isolation expressed by the participants, sometimes from their own colleagues but more patently from other mathematics leaders, was stark and somewhat alarming. All PD (even the type envisaged by the researcher), irrespective of its benefit, must be finite in nature and needs to aim for participant self-sufficiency. This puts the onus on mathematics leaders themselves to form small, self-reliant communities that enable peer discourse, offer collegiate support and promote professional growth and development.

In Ireland, there is no evidence (including this research) to suggest that such structures have organically formed. Therefore, given their broad membership among all strata in the primary teaching population, and their education and school-leader committee structures, the INTO should act as a catalyst in establishing such cells. They too could possibly help provide expert facilitators, seed funding and other logistical support at the crucial formative stage. Principal representative bodies, namely the IPPN, could also bring their considerable influence to bear in this regard. Local, neighbouring schools could cluster together in pods of five or so in order to form local mathematics committees – their largely common teaching contexts would provide an important sense of familiarity and togetherness. The aforementioned PDST, through their nationwide *Meitheal* programme, currently exploit a similar small-group, localised model which enables experienced principals to frequently meet and support each other. Although focused on general school leadership, its core concept could easily transfer to a gathering focused on subject-specific headship. Visiting advisors, from the inspectorate, the CSL or indeed the institutes of higher education, could offer their expertise to various cells on an organised, rotational basis. Each of these agencies offer a different perspective on leading mathematics: official policy, leadership skills and pedagogical developments. This dissertation's recommendation to organise and self-sustain is earnestly offered in the realisation that the past record of the Irish education system to support subject-specific school leadership is at best patchy, and at worst non-existent. Perhaps, as is the case in so many facets of their work, it is up to mathematics leaders to act on their own initiative, but perhaps in a more collective, organised manner than heretofore.

6.4 Conclusion Three:

There is an over-concentration by mathematics leaders upon the more logistical/managerial aspects of their role. This, in particular, is to the detriment of proactive monitoring of local mathematics teaching and learning standards, which appears to present very specific challenges in its enactment.

Given its strong presence in the literature (as demonstrated by Fink and Resnick, 2001; Fitzgerald, 2009; Jita, 2010, among many others), it was unsurprising that a preponderance of the cohort devoted a considerable chunk of their time to the managerial dimension of their position. Curation of the school's stock of manipulatives to teach mathematics accounted for 17% of all activity recorded by the cohort; spearheading the formulation of some or all of the school's planning documentation for the teaching and learning of Mathematics drew 15% of all leadership acts; simply advertising PD opportunities offered by external services was responsible for 6% of actions, and, liaising with these same outside agencies contributed a further 7% of all participant engagement. This managerial-heavy imbalance becomes all the more obvious when one considers that other distinct activity domains, principally monitoring the teaching and learning standards for Mathematics, leading the formal assessment procedures for the subject, and, harnessing parental input to benefit the school's teaching and learning agenda for Literacy, cumulatively accounted for only 13% of the 313 captured leadership actions. Furthermore, instances of participants offering organised mathematics-focused PD to colleagues were non-existent in all ten activity logs and their accompanying interview transcripts. With the exception of mentoring support to both new and existing colleagues, which accounted for a combined 24% of self-logged actions, the tendency of the sample to revert to an administrative and/or a logistical mode in their work, is as striking as it is predictable.

The provided reasons for this managerial preponderance were varied – some leaders saw such work as non-threatening to colleagues, and therefore an opportunity to work unnoticed in the background, unburdened by the more inter-personal dilemmas of the role. Others saw it as a good way of easing into a leadership role, and a very tangible means to prove their worth to their superiors. A number of leaders simply rationalised their organisational focus as a logical response to a need that presented itself in their school context (such as an untidy store room or an ill-equipped junior colleague). Interestingly, a further subset of participants genuinely considered such logistical support as the most crucial function in their largely facilitative understanding of mathematics leadership.

The literature's assertion (as most clearly articulated by Fink and Resnick, 2001) that such work is comparatively attractive because of its familiarity, and its low cognitive demand, was never directly confirmed by any participant. It was clear, however, that a number of leaders felt that such work did enable them to ensure greater visibility among colleagues, and therefore offer noticeable public accountability for their designated role. Picking up on this motif, one of the teacher-leaders provided a clear rationale for her strong and deliberate mathematical "presence" in her school:

> *"I think (colleagues) would say I do a lot of work for Mathematics in the school… they would say to me that they think I would have a great love for maths because I always seem to be working for maths in the school."* (Participant F interview transcript)

It remains problematic that some leaders hinted that prioritisation of the more discrete, but often critical domains of their work (such as assisting a struggling colleague, meeting with small groups of parents, or analysing whole-school standardised testing data, to offer three examples) might be in some way a source for negative feedback from colleagues. Their chief fear being that colleagues might falsely presume a dereliction of duty. This concern was most discernible in the transcripts of Participants B and F, both of whom were remunerated mathematics leaders coincidentally.

One of these lagging activity domains was the monitoring of school standards in the teaching and learning of Mathematics – in fact, it was only logged on twelve occasions by the cohort, representing a paltry 4% of all recorded actions. The intrigue of this finding is added to by the contrarian views that the cohort had largely espoused in the pre-logging questionnaires/profilers - when asked to evaluate the importance of this very activity domain, seven of the ten leaders awarded it the maximum ranking of "*very important*", whilst the remaining three allotted an "*important*" classification. Yet, this strongly expressed prioritisation is imperceptible in the logging data, only for it to subsequently re-emerge in the follow-up interviews. It can be clearly inferred that leaders felt more secure in speaking about such monitoring of standards, rather than in its enactment – implementing this philosophy was clearly fraught with hesitancy.

The transcripts strongly suggested that powerful school cultures often inhibited leaders from fully committing to this duty, in particular visiting the classrooms of colleagues – long-held institutional distrust of any form of peer observation; a suspicion of evaluative motivations behind such visits, despite promises to the contrary, and most strikingly, a feeling of inadequacy (whether mathematical or otherwise) by the leaders themselves to provide constructive feedback to colleagues following a classroom visit. It was noticeable how many leaders simply felt that they personally lacked the mathematical and/or professional credibility to initiate professional dialogue with colleagues about their mathematics teaching, despite their extensive teaching experience and particular competence in mathematics methodologies. Personal modesty, a reluctance to stand out from peers and a self-perceived deficit in formal authority also emerged as other key obstacles to active monitoring of teaching and learning standards. In summary, the barriers to such peer collaboration were numerous and varied, and for many leaders, they presented an insurmountable challenge at that time.

The arising recommendations are obvious – firstly, **mathematics leaders must re-evaluate the core aspects of their work and be primarily accountable to their principal. Leaders should be enabled to delegate the more clerical and logistical domains that traditionally fall within their remit [Recommendation 5].** Each school context is unique and the mathematics leadership focus varies from site to site. Notwithstanding this local influence, duties which require the highest degree of specialist mathematical knowledge (and which carry the greatest impact upon the teaching and learning of the subject) should be ring-fenced as the leader's core work. Leadership frameworks, as discussed in section 6.2, have the potential to greatly assist with this prioritisation. Such a process should be co-led by the school principal, the wider In-School Management Team and the mathematics leader him/herself. School plans, curriculum statements, other international leadership frameworks, and most crucially, the mathematics needs of the teaching staff should be considered within this negotiation. Following this process, the school community should also be made aware of this precedence, and their role in its implementation. At the end of a school term or some other agreed time frame, the school mathematics leaders should submit a formal account of their completed work to the principal teacher, which is then presented to the board of management for their acceptance. Domains of emphases and de-emphases should be identified and rationalised, and success criteria should be foregrounded. Priority areas for additional, future attention must be clearly set out.

This establishment of fundamental duties is only worthwhile if sustainable arrangements are concurrently put in place to alleviate the low-order, often time-consuming tasks that traditionally preoccupy mathematics leaders (as evidenced on multiple occasions in this study). Possible solutions might include the direct involvement of non-teaching school staff in such work, or the support of small teams of teachers who might offer logistical back-up on a roster basis throughout the school year. Strategic use of student teachers and other long-stay work experience visitors would also be of benefit. Indeed, the utilisation of additional, mandatory after-school ("Croke Park") hours across the entire school staff could also lighten the burden in times of extra logistical demand. Notwithstanding their usefulness, many of these solutions are largely reactive and temporary in nature, merely allowing the mathematics leaders keep his/her head above water on a day-by-day basis. Consistent, multi-annual funding which could be used by the mathematics leader to "buy in" logistical support on a planned, strategic basis offers the best prospect for true role realisation for the over-burdened mathematics leader. A per pupil annual financial contribution by the DES to each school's curriculum leadership plan, a "School Leadership Allowance", might be the most efficient means of allowing schools to target support where it is needed. Curriculum leaders, in concert with their principal, could present a budget proposal based on their subject's needs as they see them at the outset of the school year. Alongside the logistical needs for the year ahead, this budgetary tender could also include suggestions for PD, resource acquisition, procurement of ICT aids, suggestions for specialised external assistance, and, suggestions for subject-specific professional collaborations. Funds could then be drawn from this leadership allowance on the basis of the various proposals.

Crucially, this re-prioritisation requires that the local mathematics leader be vested with the authority to delegate, and to make the necessary organisational changes to help recalibrate their role. This leads to a secondary recommendation - **formal status for mathematics leaders within their school will build the individual's capacity, and credibility among colleagues, when leading developments in mathematics teaching and learning [Recommendation 6]**.

Official recognition of the leadership position in schools has two significant benefits – firstly, it acts as a personal reinforcement to the work of the leader. Although teacher unions in Ireland have continually berated the meagre monetary reward for those holding middle and senior management positions (INTO, 2020), the allowance is recognition (although insufficient) of the additional responsibility that such promotions entail. Given the centrality of Numeracy in the teaching and learning programme of all schools, and the government's stated emphasis upon STEM-related outcomes in their medium-term education strategy (DES, 2017d), it is imperative that all schools are sanctioned to formally appoint a numeracy coordinator.

It is untenable, and patently unfair, that the leadership structures of many schools are only surviving due to the volunteerism of so many teachers, typically over-burdened and unrewarded - a phenomenon laid bare in this study. The sentiments of Participants A, E and I (all voluntary leaders, and all working in difficult conditions), indicated a simmering frustration that their efforts were often unrecognised, and unsupported by the wider school community. Whilst all three freely volunteered, and sought no reward for their efforts, the researcher senses that formal acknowledgement of their burgeoning role and some expression of solidarity from the school hierarchy would have been appreciated.

A second benefit of this formal recognition of the mathematics leadership role is it's manifestation to the school community that this individual acts with the authority and support of the school leadership structure, particularly the principal. A small number of participants identified a personal reluctance to actively engage with work which might bring them into professionally challenging situations with colleagues, principally the close monitoring of mathematics teaching and learning standards. Such negative feelings typically stemmed from a perceived lack of respect from colleagues, and a suspicion that colleagues would see such supervision as "over stepping the mark". A mathematics leader, appointed by the school's board of management (through a competitive process) and publically invested with the imprimatur of his/her principal, is entitled to feel more professionally secure in wielding their mandated authority. Such a scenario is also likely to have a quelling effect upon school staff who may harbour doubts about the legitimacy of the influence that the leader is expected to exercise. Furthermore, participation in leadership-specific PD, as sketched out in section 6.2 above, and the obvious best practice it would inculcate, is likely to further reinforce the competence and general standing of local leaders when engaging with colleagues.

6.5 Conclusion Four:

Most mathematics leaders are time-poor, and typically feel ill-equipped and practically unsupported in their role. Teaching leaders are particularly susceptible to role overload. The sustainability of single-person mathematics leadership constructs requires urgent consideration.

The time poverty of the cohort emerged as one of the most prominent features of the analysis. Participant after participant bemoaned the lack of adequate, dedicated time to fulfil the broad remit of their mathematics leadership duties. This exasperation was not uniquely confined to the teaching leaders within the cohort, but was also unmistakably expressed by administrative principals who cited multiple, high-level, competing demands for their attention. However, the consequence of the dual teaching and leading mandate held by seven of the ten profiled leaders is particularly noteworthy – each of the septet expressed an ongoing, personal dilemma about how best to strike a balance between their two primary, yet rival roles. The activity logs contain a multitude of reflections where participants commented upon pressing classroom and whole-school circumstances which resulted in intended mathematics leadership work being pushed aside. All were clear in their credo – when a conflict of priority arose between both roles, the teaching role naturally predominated. Consequently, mathematics leadership was side-lined.

Accommodations by the leaders to cope with this unfortunate reality resulted in accumulated data where over 10% of leadership interventions were completed during an official lunch/break period, and where close to 40% of all actions were shoe-horned into the already congested school day. This has clear consequences for pupil contact time. Although indicative of the sheer dedication of the cohort to their leadership work, and their enviable capacity to multi-task, neither practice could be considered as a sustainable response going forward.

Understandably, this enforced compression of activity resulted in a more fleeting, ephemeral form of engagement by the leaders in their work – close to three quarters of all logged activity lasted for only fifteen minutes or less. On average, over one in four of all leadership acts were less than five minutes in duration. Such actions were typically more transactional in nature and were enacted with the minimum of professional consideration, clearly out of necessity. Given the complexity of the discipline to hand, and its requirement for consistent and specialised direction (as demonstrated throughout this study, and in section 6.2 from this chapter), one could legitimately ask if such hamstrung leadership can have any meaningful impact upon mathematics teaching and learning standards. Many of the cohort indicated similarly mixed feelings in their interviews – although doing their best, some felt this may simply not be good enough.

When directly queried if they felt sufficiently “equipped and supported” to carry out their leadership duties, a resounding 80% answered in the negative. Given that most participants were quick to clarify their appreciation for the localised support they receive from their principal and other colleagues, their disapproving judgement should be interpreted as a rebuke of the patent dearth of centrally-provided assistance, specifically dedicated release time. Section 6.3 in this chapter also captures this disenchantment, and provides suggestions as to how these credible concerns ought to be addressed.

The few participants who were part of either a loosely constructed or a more formalised collective leadership structure, to steer Mathematics in their schools, indicated a less frenetic approach to their work. Participant I is a case in point of this more evolved approach – during his interview, he made countless references to how he would seek advice, practical assistance and rudimentary collegiality from others within his leadership cell. The juxtaposition between such leaders and the remaining majority who often times expressed isolation, frustration and genuine dissatisfaction in their role, could not be more obvious. It is blatantly apparent to the researcher that role effectiveness and role satisfaction of mathematics leaders are naturally symbiotic – a better-supported leader is a more productive force within his/her local school community. This begets additional resilience to withstand the demonstrable challenges that the role entails. This philosophy, alongside the very real time poverty of the participants, shapes the final two recommendations of this research. The initial proposal addresses the need for enhanced collaborative leadership structures in schools - **Collaborative leadership structures, along the In-School Management Team model, provide a more sustainable form of mathematics coordination in schools. Schools, once adequately resourced by the DES, should explore the capacity of such structures [Recommendation 7].**

Whilst the researcher has little doubt that single-person mathematics leadership structures will endure, this is more a measure of necessity that desirability. Sub-section 2.2.4 outlined the somewhat beleaguered condition of middle-management structures in most primary schools in Ireland – a system largely bereft of opportunity or reward for those willing to make a greater whole-school contribution. In such a landscape, school principals will likely accept any offer of voluntary assistance in the management of the school with considerable enthusiasm, akin to the sentiments of Participant D, for example. In the event of such altruism, it is incumbent upon the school principal to ensure that any available training is provided for the volunteer, and where possible, that some reduction in the individual's teaching load is achieved. Ultimately though, such ad hoc arrangements are tantamount to papering over the cracks, most likely being inadequate to give the full level of attention and expertise that a core curricular subject demands.

Recent DES circulars (2019b) do provide some optimism - schools are being urged to adopt a greater "in-school management team" approach when tackling key aspects of the whole-school agenda. In concrete terms, this suggests that the principal, deputy principal and other formally appointed middle-management colleagues would co-steer the school's overall policy and practice response. This shared responsibility structure may help address issues of individual role overload and professional isolation, as found in this study. It also represents a step-change from a traditional leadership model that vested very specific curricular, organisational and pastoral duties in identifiable individuals. Reinstatement of suppressed promotional positions in all schools by the DES, not just those above a particular pupil population, would be a welcome catalyst for local acceptance of this new leadership approach – such leadership teams do need a critical mass of membership, after all.

Schools ought to tread carefully to ensure that such teams are democratic in their operation and representative in their makeup. As recommended by Nazareno (2013) and Vale et al. (2010), it is crucial that the team's evolving membership can take account of specific expertise among all the staff, and that additional, willing volunteers are harnessed in a sustainable and non-exploitative way. The input of mainstream class teachers is particularly necessary, given their key role in delivery of virtually all teaching and learning initiatives. As this study has shown, whether misdirected or not, logistical duties form a core element of mathematics leadership. It is important that the more visionary and transformational work of the leadership team is complemented by a realisation that this organisational work is equally crucial, and requires the direct attention of the group.

The researcher's final recommendation revisits an old chestnut of the literature, a universal refrain of the participants, and, a constantly emerging thread in the analysis - **Dedicated release time must be made available to school leaders who, either individually or collectively, lead Mathematics in their school [Recommendation 8].** Irrespective of local configuration, dedicated release time for mathematics leaders is essential to sustain the impressive strides that

Irish primary schools have made in their mathematics attainment over the last decade. In our system that forces teachers-leaders to choose between their regular teaching duties and their leadership work, it is inevitable that the classroom will always predominate. Time and time again, this study has shown the hugely positive imprint of mathematics leaders in their local school context. This achievement is all the more remarkable considering the intolerable restraints that such individuals must work under. Specific key duties, such as classroom observations and modelling to colleagues, can only truly happen during contact time. Ring-fenced release time for mathematics leaders would be a gamer-changer in this respect. One can only wonder about the indisputable benefit that would be evident in Irish schools were they to be served by appropriately-resourced mathematics leaders. In light of the example from other international education systems, this provision should not be seen as a concession but rather as an unremarkable, obvious support to our mathematics leaders and the crucial work they do. An initial investment to fund one dedicated release day per working week, for all mathematics leaders, must be granted immediately by the DES. This allocation should then be extended to two days discharge per week within the next three years. Serious consideration should be given to full-time seconded (mathematics) leadership positions, free of any direct teaching responsibility, which could be available to larger schools and to clusters of small schools who wish to pool together their DES allocation.

6.6 Areas for Further Investigation

As would be anticipated, this research process has given rise to a number of additional, related areas that are each worthy of further scrutiny. Whilst all merit investigation in their own right, each one would also greatly assist in adding additional depth to an evolving understanding of mathematics leadership as enacted in our primary school sector. The researcher has identified three such areas.

Given that it is over a decade since the publication of the last major piece of research to examine levels of MKT among Irish primary school teachers (see Delaney, 2010), it is now timely for this construct to be re-examined in a more comprehensive manner. Following on from this piece of research, such a study could perhaps expand its terms of investigation to include an appraisal of mathematics leaders’ specific comfort with, and utilisation of, the various MKT domains. This would assist in pinpointing domains of mathematical strength and weakness among our leadership cohort, which would in turn inform PD providers of priority areas needing attention. Such a national study might also help build enhanced awareness of MKT theory within the teaching and leadership communities, and create a bottom-up demand for additional, mathematics-specific leadership training built upon the framework.

It is the researcher's expectation that there will be a gradual, but noticeable increase in the amount of Irish research that is devoted to examining the workings and overall potential of collaborative leadership constructs. Although the focus may well be spread across various aspects of school management and organisation (including, but not confined to curricular areas), this will undoubtedly have a clear dividend for the evolution of shared mathematics leadership too. As such collective constructs become more mainstream, enhanced detail and guidance will be needed about how these leadership units function in practical terms, their division of labour processes, the internal interpersonal dynamics at play, and, the integration of both formally-appointed and voluntary leaders within the one structure. By comparison with our international partners, and as demonstrated in the review of the literature, Irish researchers and policy makers have some catching up to do.

A final recommendation for additional, future research relates to the development of mathematics-specific frameworks to guide the work of mathematics leaders. This chapter's second commendation (see section 6.2), which addressed the pressing, current need for such a work charter, also provided a brief prevue of the detail that is likely to be demanded by potential end-users of such a resource. Indeed, the participants in this study have affirmed the general appetite for such thorough and systematic guided self-reflection and self-evaluation. However, a comprehensive framework which addresses all of the many facets of mathematics leadership still appears a long way off, specifically in the Irish context. Therefore, formulation, piloting and appraisal of possible mathematics leadership framework formats represents fertile ground for future research. A collaborative effort involving academics and experienced school-based practitioners would stand a greater chance of success. Learnings from both primary and post-primary settings could also be interwoven to form a more comprehensive evaluation of their usefulness, and a better understanding of their possible application in schools.

6.7 Closing Remarks

Motivated by the professional experiences of the researcher, this study intended to shine a light upon the leadership of Mathematics as a core curricular area within the Irish primary school sector. More specifically, the researcher addressed these sub-strands of inquiry:

- How do primary schools practically respond to the need for mathematics leadership?
- How do individual mathematics leaders conceptualise and enact their role?
- What is the nature of this mathematics leadership work and its associated challenges?
- Which supports do mathematics leaders presently exploit as part of their duties, and what additional, currently unavailable supports would make their role more impactful and professionally sustainable?

The review of the literature exposed the topic to be grossly under-examined within the Irish context. Yet, somewhat reassuringly, this reprise also revealed its considerably enhanced scrutiny in the international research. Crucially, this dearth of Irish-based investigation is symptomatic of the under-developed subject-specific leadership infrastructure within primary schools in Ireland. More evolved education systems in Britain, North America and Australia, characterised by enhanced staffing, funding and other ancillary supports for subject-specific in-school leadership, provide direction, and significant inspiration for what is possible when policy makers are engaged.

To achieve the study's stated investigative intentions, ten diverse leaders, in ten unique locations, were identified and profiled. Although distinct in their characterisation, certain similarities of leadership constructs were evident among this cohort, and five main models of leadership emerged within the study – administrative principal leaders, teaching principal leaders, promoted teaching leaders, volunteer teaching leaders, and, teaching leaders within a larger committee structure. This miscellany, and its comparative capacity, offered a huge degree of potential for the subsequent data analysis.

Through a carefully rationalised approach, a mixed-methods methodology was chosen to examine the targeted phenomenon. Drawing heavily from the case-study tradition, a variety of research instruments were exploited – participant questionnaires/profilers, activity logs and semi-structured interviews. As intended, this assortment afforded a true, triangulated glimpse into the professional background, on-the-job experiences, and underlying opinions of the sample.

The data-analysis process was characterised by Creswell's (2009) sense-making philosophy. Although sequential in nature, it remained sufficiently responsive to the study's pragmatic, mixed-methods roots to allow for integration of ideas, codes and subsequently themes, that simultaneously drew from both qualitative and quantitative data instruments. This process eventually culminated in the presentation of five themes which responded to the emerging common, and indeed outlying trends of the full data base. Ranging from a clear articulation of the PD needs of the cohort, through to questioning the very sustainability of the role as currently conceptualised, the analysis hypothesised in a manner that drew credence and reinforcement from the data. A robust benchmarking of the study's headline findings against the accepted wisdom of the available national and wider international literature, as presented in Chapter Five, helped give rise to a more credible and tested set of conclusions and recommendations.

The presented set of conclusions and recommendations form the core legacy of this study. The opening paragraph of this reprise cited the dearth of interest in mathematics leadership by the national research community, and most tellingly, by Irish policy makers. It is inevitable that one follows the other, so therefore an intervention in this cycle is required. This researcher's four core conclusions, and their accompanying recommendations, address diverse and important aspects of the findings and analysis. Although varying in focus, the quartet all share a core, baseline demand for greater consciousness of mathematics leadership in Irish primary schools. Whether it's the provision of adequate release time for teaching leaders, the design and rollout of bespoke PD, or the official recognition of the specialised nature of the mathematics leadership position, an immediate policy-level response is needed to demonstrate a new, welcomed awareness. All of these recommendations arising from the research are fundamentally contingent upon an acknowledgement of the local importance of the role, and the potential it has to tangibly benefit the teaching and learning agenda of all primary schools. It now falls upon policy makers to acknowledge these obvious truths. It is the researcher's sincere hope that this study makes a small contribution to enhancing these painstakingly slow realisations.

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Appendix A: Recruitment Advertisement

Recruitment Advertisement

(Inserted in Irish Primary Principals Network (IPPN) monthly e-zine, *é-scéal*, in October 2018)

Damien Burke, a school principal and long-time associate IPPN member, is hoping to carry out research in the coming months that looks at how the teaching and learning of Mathematics is being led within our primary schools. This is part of his doctoral studies at the Dublin City University Institute of Education (DCUIoE). Damien is actively seeking recruits to get involved in the project by sharing their opinions and experiences of this important challenge facing school leaders. If you are interested in getting involved, or would like to learn more about this research, please click on this **link**. (Links to *Initial Approach Letter to Schools)*

Appendix B: Initial Approach Letter to Schools

Instititiúid Oideachais
DCU Institute of Education

28th September 2018

Dear colleague,

My name is Damien Burke. I am a primary school principal and am currently seconded to the mathematics education department at the Marino Institute of Education, Dublin 9. I am also a third year student on the doctoral programme at the Dublin City University Institute of Education (DCUIoE). I am presently embarking on research, entitled "*Private Lives: The Work of Primary-Level Mathematics Leaders*", that aims to examines how the teaching, learning and promotion of Mathematics is being led in Irish primary schools. I would be very grateful if your school might consider becoming involved in the project; specifically, you or one of your staff who hold responsibility for mathematics teaching and learning. Please allow me provide you with more information about the project and what participation practically entails.

It is my contention that leading the teaching, learning and promotion of Mathematics is highly specialised work, and that it plays the pivotal role in influencing the success of schools in meeting their own and other state-mandated numeracy targets. Particularly in the Irish context, it is an under-researched aspect of school life. I intend to carry out a multiple-case research project that will examine this phenomenon within ten diverse schools, each with particular leadership structures for Mathematics. In all cases, my primary focus is the person/persons who hold a particular responsibility for Mathematics within their school. It is hoped that my sample will not only include principals, but will also comprise of senior/middle management leaders, volunteer leaders and shared/committee leadership structures. The variety of leadership configuration is crucial in order to comprehensively respond to my core research question; how is the teaching, learning and promotion of Mathematics being led in our primary schools?

The project has three distinct phases; initial participation will entail a one-hour profile meeting where relevant background detail about the participant-leader will be sought. Following this, the participant will be asked to complete an activity log, for two 2-week periods, which will enable them to chronicle and quantify all work undertaken within their mathematics leadership role for those representative periods. It is anticipated that this will entail a fifteen minute demand at the end of each working day. The final phase of the research will entail an in-depth semi-structured interview where the leadership experiences of the participant, the challenges of the role, and the supports that such leaders access, will be scrutinised. The contents of the activity log may also influence the topics under discussion. This interview will be audio-recorded for subsequent transcription.

It is envisaged that the three phases will run over a three-month period in the second half of the 2018/19 school year. This accumulated data set will allow me to contrast the experiences of those leading Mathematics within my sample, to depict the characteristics of these leaders, to establish the range of duties that fall under this role, and to identify the particular supports that such leaders require in order to successfully carry out their specialised work.

Strict protocols will be put in place to protect the identity of participants and of their schools, including the use of pseudonyms as required. Their true identities will not be disclosed at any stage, including in the final thesis document. All paper-based data collected will be stored under lock and key in a secure location and all digital data will be stored on a password-secure personal computer, and will be backed-up through a secure cloud service. This raw data will not be shared with any third party, save the project supervisors (identified below). Please note that these safeguards are curtailed by legal limitations to data confidentiality, and that data could potentially be released should such legally-specified circumstances arise, however unlikely. Participation is entirely voluntary; participants also hold the absolute and unfettered right to withdraw from the project at any time, and without justification. This entitlement also extends to the withdrawal of participant data. The research project will have no impact upon teaching time.

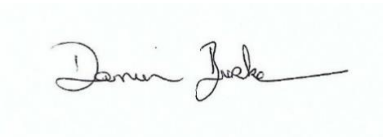
My research proposal has been approved by the university's Research Ethics Committee (REC) and my research project is being co-supervised by Dr. John White & Dr. Elaine McDonald, faculty members within the School of Policy and Practice at DCUIoE. Should you wish to learn more about the project, or to clarify any aspect of this letter, I am contactable via e-mail at damien.burke52@dcu.mail.ie or via telephone at (086) 8476591.

Given the key position you hold in your school, it is my hope that you would be in a position to identify a member of staff (including yourself), with particular responsibility for Mathematics, who might be in a position to participate. I will use the contact details that you may supply (with the individual's consent) to contact the nominee and appraise them of my plans, prior to a formal request to become involved.

I appreciate that time is a precious commodity in schools – should you or one of your colleagues be unable to become involved, I understand entirely and thank you for considering my invitation. If you or a colleague are interested in participating, I would ask that you briefly contact me at the above e-mail address, noting the details of the potential participant, by Friday, 26th October and I will then follow up accordingly.

If you have concerns about this study and wish to contact an independent person, please contact: The Secretary, Dublin City University Research Ethics Committee, c/o Research and Innovation Support, Dublin City University, Dublin 9. Tel 01-7008000, e-mail rec@dcu.ie

Kindest regards,



Damien Burke.

Appendix C: Plain Language Statement for Participants

Instití́uid Oideachais
Institute of Education

October 2018

Dear *************,

As a doctoral student at the School of Policy and Practice, Dublin City University Institute of Education (DCUIoE), I am undertaking research entitled "*Private Lives: The Work of Primary-Level Mathematics Leaders*". It aims to explore how the teaching, learning and promotion of Mathematics is being led in primary schools. Although chronically under-researched, I propose that such work is highly specialised, thus demanding investigation. I intend to document this phenomenon within ten schools; my core focus being the person/s holding particular responsibility for Mathematics. My sample will include principals, senior/middle-management leaders, volunteer leaders and shared/committee structures.

Initial participation entails a one-hour profile-building meeting seeking relevant background detail. The participant's name, gender, qualifications, place-of-work and relevant professional history constitutes the entirety of personal data to be collected. The participant then completes an activity log, over two 2-week periods, to chronicle the work attached to their mathematics leadership role. Logging entails a fifteen-minute daily demand. The final phase involves an in-depth interview (1.5 hours approx.) where participant experiences of their role will be scrutinised. The project has a three-month duration, starting in December 2018.

Strict protocols will protect participants' identities, including use of pseudonyms. Paper-based data collected (profile sheets and logs) will be stored under lock-and-key. Digital data (interview transcripts and audio recordings) will be stored on one password-secure personal computer. Raw data will not be shared with third parties, save the project supervisors. Such safeguards are curtailed by legal limitations to data confidentiality; data could potentially be released should legally-specified circumstances arise. Data will be retained for five years, before irrevocable deletion. These data handling procedures comply with the General Data Protection Regulation (GDPR) EU 2016/679. I am the project's nominated data controller. The university's data protection officer is Mr. Martin Ward (contactable at data.protection@dcu.ie 01-7005118). It is likely that the research findings will be exploited in oral presentations and other written papers that I may undertake in future – guarantees of anonymity still apply in this eventuality.

Participants will receive a digital copy of the final thesis. Partakers may independently utilise this as a catalyst to further reflect upon their leadership role. Participation is voluntary; participants hold the unfettered right to withdraw at any time. This entitlement also extends to the withdrawal of data. I have audited all potentially negative consequences of involvement for participants; given the project's relatively benign nature, I have concluded that it is highly unlikely that any adverse effects will accrue.

My research proposal has been approved by DCU's Research Ethics Committee. My co-supervisors are Dr. John White & Dr. Elaine McDonald, faculty members at DCUIoE. I am contactable at damien.burke52@dcu.mail.ie or (086) 8476591.

To formalise your participation, please consult the attached *Informed Consent Form*.

If participants have concerns about this study and wish to contact an independent person, please contact:

The Secretary, Dublin City University Research Ethics Committee, c/o Research and Innovation Support, Dublin City University, Dublin 9. Tel 01-7008000, e-mail rec@dcu.ie

Kindest regards,

____

Damien Burke.

Appendix D: Informed Consent Form

Institiúid Oideachais
Institute of Education

Informed Consent Form

1. I am aware that this project, entitled "Private Lives: The Work of Primary-Level Mathematics Leaders", is being conducted by Damien Burke, a doctoral student at the School of Policy and Practice at Dublin City University Institute of Education (DCUIoE), and is supervised by Dr. Elaine McDonald & Dr. John White.

2. I understand the researcher's intention to examine how the teaching, learning and promotion of Mathematics is being led in schools.

3. *Please circle Yes or No for each*
    - *I have read and understand the Plain Language Statement (or had it read to me)*
      Yes/No
    - *I understand the three-phase nature of the project and the scope of my involvement per stage*
      Yes/No
    - *I have had an opportunity to ask questions and discuss this project*
      Yes/No
    - *I am aware that data generated (profiles, logs, interview recordings and transcripts) will be retained for five years*
      Yes/No
    - *I understand that Damien Burke is the project's nominated data controller*
      Yes/No
    - *I understand that I may withdraw from the project at any point*
      Yes/No

4. I have been informed that strict protocols will be in place to protect my identity. Paper-based data will be stored under lock-and-key. Digital data (interview transcripts and audio recordings) will be stored on a password-secure personal computer. Raw data will not be shared with third parties, save the researcher's supervisors. These safeguards are subject to legal limitations of data confidentiality, and data could potentially be released should legally-specified circumstances arise. The project's data handling procedures comply with the General Data Protection Regulation (GDPR) EU 2016/679.

5. I understand the likelihood that the research findings will be used in oral presentations and written papers that the researcher may undertake in future – I consent to the inclusion of my data within such expositions. I understand that guarantees of anonymity still apply in this eventuality.

6. I will receive an opportunity to review the transcript of my interview to correct potential inaccuracies or to redact certain passages. I have been assured that all data digital records will be irrevocably deleted, and all physical documents will be destroyed, after five years.

7. *I have read and understood the information in this form. My questions and concerns have been answered, and I have a copy of this form. Therefore, I consent to take part in this research project.*

Participants Signature: ______________________________

Name in Block Capitals: ______________________________

Witness: ______________________________

Date: ______________________________

Appendix E: Participant Questionnaire/Profiler

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Institute of Education

Leadership in Primary Level Mathematics Profiler

A. Background Information

1. *Are you male or female?*

◯ Male

◯ Female

2. *What role do you hold in your current school?*

◯ Teaching principal

◯ Administrative principal

◯ Mainstream class teacher

◯ Special education teacher

3. *How large is your school?*

◯ Less than 100 pupils

◯ Between 101 and 200 pupils

◯ Between 201 and 300 pupils

◯ Greater than 300 pupils

4. *How many years teaching experience have you?*

◯ 1 - 5 years

◯ 6 - 10 years

◯ 11 - 20 years

◯ Greater than 20 years

5. In the case of principals, did you actively seek to take on this specific leadership role for mathematics?

- ☐ Yes
- ☐ No
- ☐ N/A

6. In the case of mainstream and special education teachers, do you hold a promotional post of responsibility linked to mathematics?

- ☐ Yes
- ☐ No
- ☐ N/A

7. In the case of mainstream and special education teachers without a promotional post linked to mathematics, how did you acquire the role?

- ☐ Volunteered for it
- ☐ Approached by principal/other senior management
- ☐ It just seemed to happen
- ☐ N/A
- ☐ Other (please specify)

8. Which model best describes the leadership structure for mathematics in your school?

- ☐ Me, alone
- ☐ Me, with occasional help from others
- ☐ A committee structure where the workload is evenly shared
- ☐ A committee structure which I lead and do most of the work
- ☐ A committee structure which I lead and where others do most of the work

9. For how long have you held your leadership position in mathematics?

- ☐ Less than a year
- ☐ Between one and five years
- ☐ Longer than five years

10. Have you held this or another leadership position in this or any other school in the past, and if so, for approximately how long? (Clarify the role)

- Yes
- No

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Leadership in Primary Level Mathematics Questionnaire

B. Leadership functions

11. Ranging on a scale from "not important at all", to "somewhat important", to "important" to "very important", can you specify the importance you place upon these mathematics-related leadership duties?

	Not important at all	Somewhat important	Important	Very important
Curating and (re)developing the plean scoile for mathematics	○	○	○	○
Articulating the school's agreed vision for the teaching and learning of mathematics	○	○	○	○
Coordinating the on-going School Self-Evaluation process in numeracy	○	○	○	○
Procuring, organising and distributing resources to teach mathematics	○	○	○	○
Informing colleagues of CPD opportunities and other new developments in the area of mathematics	○	○	○	○
Promoting the status and importance of mathematics in the broader school community (e.g. Maths Week)	○	○	○	○

	Not important at all	Somewhat important	Important	Very important
Advising and mentoring new colleagues on mathematics-specific teaching, learning and planning issues				
Advising and mentoring existing colleagues on mathematics-specific teaching, learning and planning issues				
Engaging with external services/providers to enhance the provision of mathematics teaching within the school				
Preparing materials for, and/or involvement in the administration of, student mathematics testing/other assessment				
Monitoring the standards of mathematics teaching and learning within the school				
Seeking and/or utilising the support of parents to enhance the teaching and learning capacity of mathematics in school and/or at home				

12. Are there any other mathematics-leadership related duties that you engage in that are not included on this list?

(**Note:** *a written list of the duties will be given to the participant to assist their reflection*).

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Leadership in Primary Level Mathematics Questionnaire

C. Background skills and competencies

13. With 1 representing an "unwillingness" and 4 representing "a strong willingness", how would you evaluate your personal inclination to continue in your mathematics leadership role?

1 4

14. With 1 representing "no experience whatever" and 4 representing "significant leadership experience", how would you evaluate your level of general leadership experience prior to acquiring this mathematics leadership role?

1 4

15. With 1 representing "not competent" and 4 representing "highly competent", how would you evaluate your own personal competency of primary school mathematics?

1 4

16. With 1 representing "poor knowledge" and 4 representing "a high level of knowledge", how would you evaluate your own personal knowledge of the field of mathematics pedagogy?

1 knowledgeable 4

17. What additional mathematics-related CPD have you engaged in and fully completed over your teaching career? You may choose more than one answer.

- ☐ Teacher summer Courses
- ☐ In-term evening courses offered by local education centre
- ☐ In-term PDST training for mathematics coordinator/link person
- ☐ Further undergraduate studies
- ☐ Further postgraduate studies (Masters, doctorate)
- ☐ Other (please specify)

18. *Do you feel that you are fully equipped and supported to carry out your leadership in mathematics duties?*

- ○ Yes
- ○ No

19. If you answered "no" to the previous question, please identify specific supports you require in order to fully carry out your leadership in mathematics duties. Include as many suggestion as you wish.

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Leadership in Primary Level Mathematics Questionnaire

D. Role effectiveness

20. How would you rate your overall effectiveness in your role of leading mathematics?

Ineffective	Somewhat effective	Effective	Very effective	Unsure
◯	◯	◯	◯	◯

21. More specifically, how would you rate your effectiveness in these broad areas of responsibility?

	Ineffective	Somewhat effective	Effective	Very effective	Unsure	Not Applicable
Curating and (re)developing the plean scoile for mathematics	◯	◯	◯	◯	◯	◯
Articulating the school's agreed vision for the teaching and learning of maths	◯	◯	◯	◯	◯	◯
Coordinating the on-going School Self-Evaluation process in numeracy	◯	◯	◯	◯	◯	◯
Procuring, organising and distributing resources to teach mathematics	◯	◯	◯	◯	◯	◯
Informing colleagues of CPD opportunities and other new developments in the area of mathematics	◯	◯	◯	◯	◯	◯

	Ineffective	Somewhat effective	Effective	Very effective	Unsure	Not Applicable
Promoting the status and importance of maths in the broader school community (e.g. Maths Week)	◯	◯	◯	◯	◯	◯
Advising and mentoring new colleagues on mathematics-specific teaching, learning and planning issues	◯	◯	◯	◯	◯	◯
Advising and mentoring existing colleagues on mathematics-specific teaching, learning and planning issues	◯	◯	◯	◯	◯	◯
Engaging with external services/providers to enhance the provision of mathematics teaching within the school	◯	◯	◯	◯	◯	◯
Preparing materials for, and/or involvement in the administration of, student mathematics testing/other assessment	◯	◯	◯	◯	◯	◯
Monitoring the standards of mathematics teaching and learning within the school	◯	◯	◯	◯	◯	◯
Seeking and/or utilising the support of parents to enhance the teaching and learning capacity of mathematics in school and/or at home	◯	◯	◯	◯	◯	◯

22. Taking 1 as "deeply frustrating" and 4 as "highly rewarding", how would you describe the satisfaction you get from carrying out your mathematics leadership role?

1 somewhat rewarding 4

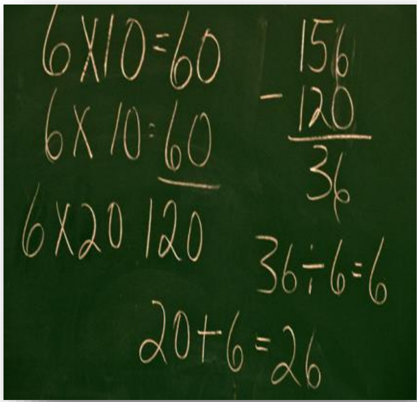
23. Please provide an explanation of your response to question 22.

24. Thank you for your participation in this profile exercise. Please indicate if you would like to review or amend any of your responses.

Appendix F: Participant Activity Log

(Cover page and sample of recording pages for one logging day)

Mathematics Leadership - Daily Activity Log



November 2018

Dear participant,

Thank you very much for agreeing to participate in this research project; the insights that you provide will go a long way towards shaping the findings and conclusions of the study.

The purpose of the activity log is to give a sense of the typical daily actions you engage in as part of your leadership in Mathematics work. Alongside classifying your activity, the log seeks detail on the competencies that you draw upon, the time demand of your response and the self-assessed effectiveness of your interventions.

There are two distinct logging periods, both of two-week duration:

- 26th November – 9th December 2018 (inclusive)
- 28th January – 8th February 2019 (inclusive)

At the end of each working day, I am asking you to reflect upon your mathematics-related leadership activity and to record it using the provided template. Please insert the day and date at the top of each entry. It is envisaged that completion of the log will require 10 - 15 minutes per day. The template contains twelve activity domains. An optional comment box is also included at the end of each daily template and you are free to make note of general observations relating to your work for that day, or to catalogue duties that were not reflected in the template's suggested domains. Should your school be closed, or in the case of a personal absence for whatever reason, please simply note this on the relevant page(s) of the log. Based upon our initial face-to-face discussion, I will also operate a daily "text prompt" for participants who wish to receive daily reminders for completion.

Following completion of the first logging period, I would ask that you retain the log safely in preparation for the subsequent phase in late January/early February. I will make contact with all participants well in advance of the second logging period in order to address any concerns arising from phase one, and also to re-set arrangements for the upcoming logging period.

Should you encounter any difficulties during either of the logging period, please do not hesitate to contact me directly; (086) 8476591 or damien.burke52@mail.dcu.ie

Once again, your participation is gratefully appreciated.

Kindest regards,

Damien.

Mathematics Leadership – Activity Log: Prompts/Abbreviations

When did it happen?

- Before contact time (BC)
- After contact time (AC)
- During contact time (DC)
- During a break time (DB)
- During staff meeting/"Croke Park" hours (DS)

How much time did it require?

- <5 (minutes)
- 5 – 15 (minutes)
- Around 30 minutes
- Around an hour
- More than an hour

Which expertise did you draw on?

- Organisational skills (OS)
- Mathematical competency (MC)
- Pedagogical knowledge (PK)
- Curricular knowledge (CK)
- Mentoring skills (MS)
- Facilitation skills (FS)
- Analytical skills (AS)
- Consultation skills – internally or externally (CS)

Effectiveness rating scale:

- Effective (E)
- Somewhat effective (SE)
- Not effective (NE)

*A "new" colleague has taught for less than a year in your school.

**An "existing" colleague has taught in your school for longer than a year.

Day and Date: ____

Please reflect upon the day and indicate if you engaged in any of the following mathematics-related leadership activity. Please consider the follow-up prompts.

Over the course of today, did you engage in any work related to:

1. **Curating and/or (re)developing the Plean Scoile for Mathematics:** YES ☐ NO ☐
   a. Was this a pre-planned action? ____________________
   b. When did it happen? ____________________
   c. How much time did it require? ________________ mins
   d. Which expertise did you draw on to engage with the task? ____________
   e. Rate your effectiveness: ____________________

2. **Articulating the school's agreed vision for the teaching and learning of Mathematics:** YES ☐ NO ☐
   a. Was this a pre-planned action? ____________________
   b. When did it happen? ____________________
   c. How much time did it require? ________________ mins
   d. Which expertise did you draw on to engage with the task? ____________
   e. Rate your effectiveness: ____________________

3. **Coordinating ongoing School Self-Evaluation processes in Numeracy:** YES ☐ NO ☐
   a. Was this a pre-planned action? ____________________
   b. When did it happen? ____________________
   c. How much time did it require? ________________ mins
   d. Which expertise did you draw on to engage with the task? ____________
   e. Rate your effectiveness: ____________________

4. **Procuring, organising or distributing resources to teach Mathematics:** YES ☐ NO ☐
   a. Was this a pre-planned action? ____________________
   b. When did it happen? ____________________
   c. How much time did it require? ________________ mins
   d. Which expertise did you draw on to engage with the task? ____________
   e. Rate your effectiveness: ____________________

5. **Informing colleagues of CPD opportunities and other new developments in the area of Mathematics**: YES ☐ NO ☐

   a. Was this a pre-planned action? ______________________________
   b. When did it happen? ______________________________
   c. How much time did it require? _________________________ mins
   d. Which expertise did you draw on to engage with the task? _________________
   e. Rate your effectiveness: ______________________________

6. **Promoting the status and importance of Mathematics in the broader school community**: YES ☐ NO ☐

   a. Was this a pre-planned action? ______________________________
   b. When did it happen? ______________________________
   c. How much time did it require? _________________________ mins
   d. Which expertise did you draw on to engage with the task? _________________
   e. Rate your effectiveness: ______________________________

7. **Advising and mentoring new colleagues on mathematics-specific teaching, learning and planning issues**: YES ☐ NO ☐

   a. Was this a pre-planned action? ______________________________
   b. When did it happen? ______________________________
   c. How much time did it require? _________________________ mins
   d. Which expertise did you draw on to engage with the task? _________________
   e. Rate your effectiveness: ______________________________

8. **Advising and mentoring existing colleagues on mathematics-specific teaching, learning and planning issues**: YES ☐ NO ☐

   a. Was this a pre-planned action? ______________________________
   b. When did it happen? ______________________________
   c. How much time did it require? _________________________ mins
   d. Which expertise did you draw on to engage with the task? _________________
   e. Rate your effectiveness: ______________________________

9. **Engaging with external services/providers to enhance the provision of mathematics teaching within the school:** YES ☐ NO ☐

   a. Was this a pre-planned action? ______________________________
   b. When did it happen? ______________________________
   c. How much time did it require? _________________________ mins

d. Which expertise did you draw on to engage with the task? ________________
e. Rate your effectiveness: ____________________________

10. Preparing materials for, and/or involvement in the administration of, student mathematics testing: YES ☐ NO ☐

a. Was this a pre-planned action? ____________________________
b. When did it happen? ____________________________
c. How much time did it require? ________________________ mins
d. Which expertise did you draw on to engage with the task? ________________
e. Rate your effectiveness: ____________________________

11. Monitoring the standards of mathematics teaching and learning within the school: YES ☐ NO ☐

a. Was this a pre-planned action? ____________________________
b. When did it happen? ____________________________
c. How much time did it require? ________________________ mins
d. Which expertise did you draw on to engage with the task? ________________
e. Rate your effectiveness: ____________________________

12. **Seeking and/or utilising the support of parents to enhance the teaching and learning capacity of Mathematics in school and/or at home:** YES ☐ NO ☐

a. Was this a pre-planned action? ____________________________
b. When did it happen? ____________________________
c. How much time did it require? ________________________ mins
d. Which expertise did you draw on to engage with the task? ________________
e. Rate your effectiveness: ____________________________

If you wish to comment on any specific aspect of the day, please do so here (optional):

____
____
____
____

Appendix G: Sample of One Day's Logging

Day and Date: Thursday, January 31st

Please reflect upon the day and indicate if you engaged in any of the following mathematics-related leadership activity. Please consider the follow-up prompts.

Over the course of today, did you engage in any work related to:

1. **Curating and/or (re)developing the Plean Scoile for mathematics:** YES ☐ NO ☑
   a. Was this a pre-planned action? ________
   b. When did it happen? ________
   c. How much time did it require? ________ mins
   d. Which expertise did you draw on to engage with the task? ________
   e. Rate your effectiveness: ________

2. **Articulating the school's agreed vision for the teaching and learning of mathematics:** YES ☑ NO ☐
   a. Was this a pre-planned action? Yes
   b. When did it happen? DB
   c. How much time did it require? 5 - 15 mins
   d. Which expertise did you draw on to engage with the task? FS, CS, CK, OS
   e. Rate your effectiveness: SE

3. **Coordinating ongoing School Self-Evaluation processes in numeracy:** YES ☑ NO ☐
   a. Was this a pre-planned action? Yes
   b. When did it happen? BC, DC
   c. How much time did it require? 5-15 mins
   d. Which expertise did you draw on to engage with the task? OS, CK, PR, CS, MS
   e. Rate your effectiveness: E

4. **Procuring, organising or distributing resources to teach mathematics:** YES ☑ NO ☐
   a. Was this a pre-planned action? Yes
   b. When did it happen? AC
   c. How much time did it require? <5 mins
   d. Which expertise did you draw on to engage with the task? PK CK, CS, FS, MC
   e. Rate your effectiveness: E

5. Informing colleagues of CPD opportunities and other new developments in the area of mathematics: YES ☐ NO ☑

a. Was this a pre-planned action? ________
b. When did it happen? ________
c. How much time did it require? ________ mins
d. Which expertise did you draw on to engage with the task? ________
e. Rate your effectiveness: ________

6. Promoting the status and importance of mathematics in the broader school community: YES ☐ NO ☑

a. Was this a pre-planned action? ________
b. When did it happen? ________
c. How much time did it require? ________ mins
d. Which expertise did you draw on to engage with the task? ________
e. Rate your effectiveness: ________

7. Advising and mentoring new colleagues on mathematics-specific teaching, learning and planning issues: YES ☑ NO ☐

a. Was this a pre-planned action? Yes
b. When did it happen? BC, DC
c. How much time did it require? 5-15 mins
d. Which expertise did you draw on to engage with the task? OS, CK, PR, NS
e. Rate your effectiveness: E

8. Advising and mentoring existing colleagues on mathematics-specific teaching, learning and planning issues: YES ☑ NO ☐

a. Was this a pre-planned action? No
b. When did it happen? DB
c. How much time did it require? <5 mins
d. Which expertise did you draw on to engage with the task? CK, PR, OS, GS
e. Rate your effectiveness: SE

9. Engaging with external services/providers to enhance the provision of mathematics teaching within the school: YES ☐ NO ☑

a. Was this a pre-planned action? ________
b. When did it happen? ________
c. How much time did it require? ________ mins
d. Which expertise did you draw on to engage with the task? ________
e. Rate your effectiveness: ________

10. Preparing materials for, and/or involvement in the administration of, student mathematics testing/other assessment: YES ☐ NO ☑

a. Was this a pre-planned action? ______
b. When did it happen? ______
c. How much time did it require? ______ mins
d. Which expertise did you draw on to engage with the task? ______
e. Rate your effectiveness: ______

11. Monitoring the standards of mathematics teaching and learning within the school: YES ☑ NO ☐

a. Was this a pre-planned action? Yes
b. When did it happen? DC
c. How much time did it require? 5 - 15 mins
d. Which expertise did you draw on to engage with the task? CK, AS, OS, CS
e. Rate your effectiveness: E

12. Seeking and/or utilising the support of parents to enhance the teaching and learning capacity of mathematics in school and/or at home: YES ☑ NO ☐

a. Was this a pre-planned action? Yes
b. When did it happen? BC
c. How much time did it require? <5 mins
d. Which expertise did you draw on to engage with the task? CS, OS, FS
e. Rate your effectiveness: E

If you wish to comment on any specific aspect of the day, please do so here (optional):

Analysed Maths stand. test results to prioritise kids for extra support in Maths at 4th class level & also for grouping students for team teaching in maths.
Parents consulted & briefed for weekly Maths for fun games.
New Problem solving Resources were received positively & teachers are enthusiastic to try them.

Appendix H: Interview Schedule

Date:

Start time: End time:

Location:

Interviewee identifier:

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1. Introduction and Orientation:

Brief description of the research project, its key phases thus far and the purpose of this interview. The interviewee has access to their activity log for the duration of the interview; they are encouraged to refer to it if required during the conversation.

2. Questions:

A. Can you tell me a little bit about your school? Its culture as you see it? Its priorities? Can you say what makes it unique? What words best describe it? Can you describe the successes/challenges of the school relating to the teaching and learning of Mathematics?

B. Can you give me a brief sense of your career here and/or in primary education?
   - Length of service, diversity of teaching roles, promoted positions…
   - Probe for general leadership experiences in this school and elsewhere.
   - Probe for experience of other models of mathematics leadership

C. Can you tell me the circumstances of how you became responsible for Mathematics in the school?
   - In the case of principals; was it a conscious decision or did you just assume the role upon appointment? Did your predecessor hold this role? Was it expected of you? Did you offer it to someone before you took it?
   - In the case of post-holder; why did you apply for the position? Were you initially enthused by the mathematics portion of the role?
   - In the case of a volunteer, why did you volunteer for this role specifically? Were any other colleagues interested?
   - In the case of a committee structure, how did you join the group? How was the groups constituted? How does the group function? Is there a formal/informal leader?

D. What do you believe is the purpose of your mathematics leadership/coordinator role in your school?

- Is there a written statement of duties? Have they been reviewed recently? How is the role informed/formulated?
- Probe the responses to explore the practical implications of some of these responsibilities e.g. *when you say "organise the mathematics store-room/review the school's mathematics plan/purchase new equipment/critique new textbooks/lead SSE of Numeracy…" what does this entail in practice?*
- Do you see a mentoring/expert role as part of your work?
- Have you ever watched colleagues teaching mathematics lessons? (or vice versa)
- If this has not previously happened, would this be a possibility in this school? Why/why not?
- Earlier you noted that ___________________________ were challenges for the teaching and learning of Mathematics in this school, have these been addressed through your role? How?

E. What would you consider are the key skills and competencies that an effective leader of Mathematics requires?
    - Can you justify your selections with specific instances?
    - What about a teacher's mathematical competency?
    - Would additional qualifications/CPD feature on your list? Elaborate on these.

F. Over the course of a typical week, can you give me a sense of the in-school and out-of-school time demand that your mathematics-specific responsibilities entail?
    - How much of your role is dedicated to directly influencing mathematics teaching and learning?
    - How is the in-school time managed alongside your other regular duties?
    - Describe how your work brings you in to contact with your colleagues.
    - Do you feel supported in your work, or would you say that you are left to your own devices?

G. Log-related question; this will be a query based upon an observation from the personalised log that each interviewee will have submitted in advance of the interview. Likely observations could include the dominant or minority duties the participant engages in, variations between the first and second logging windows, time management etc…

H. Looking back over the last term, what specific supports might have allowed you to carry out responsibilities more efficiently and effectively?
    - Distinguish between logistical supports and more fundamental professional needs.
    - Probe why these supports are not available.

I. On the whole, taking "very *rewarding*" and "*deeply frustrating*" as opposing ends of a continuum, how would you describe the satisfaction you get from your responsibilities?
   - Can you give a rationale for your reply?
   - In general, what are the main frustrations of this role?
   - How do you measure how successful you are in your role from year-to-year?

J. As part of my research, I have been interviewing middle school leaders (some with promotional positions, some without) and principals who are responsible for the teaching & learning of Mathematics; do these other models of leadership have advantages/disadvantages compared with your school's approach? Can you elaborate upon these?

3. Wrap-up:

Expression of gratitude to the participant; review of arrangements for member-checking.

Appendix I: Research Ethics Committee (REC) Application Form

Dublin City University

RESEARCH ETHICS COMMITTEE

APPLICATION FOR APPROVAL OF A PROJECT INVOLVING **HUMAN PARTICIPANTS**

Application No. *(office use only)* DCUREC/2018/____

Please read the following information carefully before completing your application. Failure to adhere to these guidelines will make your submission ineligible for review.

- **Applications must be e-mailed to the DCU Research Ethics Committee at rec@dcu.ie** –no hardcopy required**.**
- **Student applicants must cc their supervisor on that e-mail** – this applies to all masters by research and PhD students. The form should be checked, approved and signed by the supervisor in advance of submission to REC. ***NB – Taught Masters and Undergraduate students apply for ethical review via their local review panels, not via REC.***
- **The application should consist of one electronic file only,** with an electronic signature from the PI. The completed application must incorporate all supplementary documentation, especially that being given to the proposed participants. It must be proofread and spellchecked before submission to the REC**.**
- **All sections of the application form must be answered as instructed and within the word limits given.**

Applications which do not adhere to all of these requirements will not be accepted for review and will be returned directly to the applicant.

Applications must be completed on the form; answers in the form of attachments will not be accepted, except where indicated. No hardcopy applications will be accepted. **Research must not commence until written approval has been received from the Research Ethics Committee.**

Note: If your research requires approval from the Biosafety Committee (BSC), or review by the School of Nursing and Human Sciences Ethics Advisory Committee (SNHSEAC), this must be in place prior to REC submission. Please attach the responses from these committees to this submission as directed below.

PROJECT TITLE	"Private Lives: The Work of Primary-Level Mathematics Leaders"
PRINCIPAL INVESTIGATOR(S) *The named Principal Investigator is the person with primary responsibility for the research project. In the case of Taught Masters projects the supervisor is the Principal Investigator.*	Damien Burke (student researcher) Dr. John White (supervisor) Dr. Elaine McDonald (supervisor)

START AND END DATE	October 2018 – February 2020.
LEVEL OF RISK *Please indicate whether this project requires (a) notification (b) expedited* ***or*** *(c) full committee review. Justification for your choice is required under section 3.1*	Low – expedited review required.

Please confirm that <u>all</u> supplementary information is included in your application (in electronic copy). If questionnaire or interview questions are submitted in draft form, please indicate this by putting (draft) after YES. A copy of the final documentation must be submitted for final approval when available.

My application has been collated as one electronic file which includes the following documentation:	**INCLUDED (mark as YES)**	**NOT APPLICABLE (mark as N/A)**
Bibliography	**Yes**	
Recruitment advertisement	**Yes**	
Plain language statement/Information Statement	**Yes**	
Informed Consent form	**Yes**	
Personal Data Security Schedule	**Yes**	
Evidence of external approvals related to the research		N/A
Questionnaire/Survey	**Yes**	
Interview/Focus Group Questions	**Yes**	
Debriefing material		**N/A**
Other (e.g. BSC approval, SNHSEAC review letter)	**Yes:** **Participant Activity Log**	

Please note:

1. Any amendments to the original approved proposal must receive prior REC approval.
2. As a condition of approval investigators are required to document and report immediately to the Secretary of the Research Ethics Committee any adverse events, any issues which might negatively impact on the conduct of the research and/or any complaint from a participant relating to their participation in the study

1. ADMINISTRATIVE DETAILS

PROJECT TYPE: **(mark Y to as many as apply)**	Research Project	…Y	Funded Consultancy	N…
			Clinical Trial	N…
	Student Research Project (please indicate level, e.g. PhD/MSc Research)	…	Other - Please Describe:	…N/A
	PhD / Other Doctorate	Y…		
	MSc Research	…		

1.1 INVESTIGATOR CONTACT DETAILS

PRINCIPAL INVESTIGATOR(S): *Doctoral researchers and Research Masters or their supervisors may be listed as Principal Investigators, depending on the conventions of the discipline and on the individual case. It should be made clear, in subsequent sections of this application, who is carrying out the research procedures.*

NAME	*SCHOOL/UNIT*	*EMAIL*
Damien Burke (student)	School of Policy and Practice (DCUIoE)	damien.burke52@dcu.mail.ie
Dr. Elaine McDonald	School of Policy and Practice (DCUIoE)	elaine.mcdonald@dcu.ie
Dr. John White	School of Policy and Practice (DCUIoE)	john.white@dcu.ie

OTHER INVESTIGATORS:

NAME	*SCHOOL/UNIT*	*EMAIL*

1.2 WILL THE RESEARCH BE UNDERTAKEN ON-SITE AT DUBLIN CITY UNIVERSITY?

YES or NO
No…

(If NO, state details of the off-campus location – provide details of the approval to gain access to that location in section 2.7.)

The research will be undertaken in ten primary schools, mostly within the east Leinster region, with one likely in the west of the country. As the research is not classroom-based, locations convenient to the participants may also be used for some elements of data collection.

1.3 IS THIS PROTOCOL BEING SUBMITTED TO ANOTHER ETHICS COMMITTEE, OR HAS IT BEEN PREVIOUSLY SUBMITTED TO AN ETHICS COMMITTEE?

YES or NO

No

(If YES, please provide details and attach copies of approval(s) received etc.)

N/A

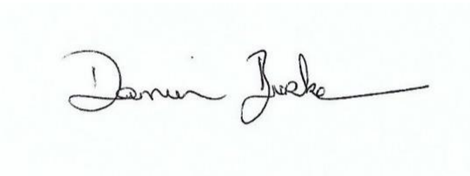
DECLARATION BY PRINCIPAL INVESTIGATOR(S)

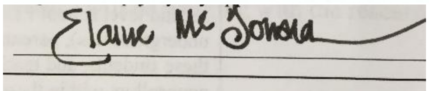
The information contained herein is, to the best of my knowledge and belief, accurate. I have read the University's current research ethics guidelines, and accept responsibility for the conduct of the procedures set out in the attached application in accordance with the form guidelines, the REC guidelines (https://www.dcu.ie/researchsupport/researchethics.shtml), the University's policy on Conflict of Interest, Code of Good Research Practice and any other condition laid down by the Dublin City University Research Ethics Committee. I have attempted to identify all risks related to the research that may arise in conducting this research and acknowledge my obligations and the rights of the participants.

If there exists any affiliation or financial interest for researcher(s) in this research or its outcomes or any other circumstances which might represent a perceived, potential or actual conflict of interest this should be declared in accordance with Dublin City University policy on Conflicts of Interest.

I and my co-investigators or supporting staff have the appropriate qualifications, experience and facilities to conduct the research set out in the attached application and to deal with any emergencies and contingencies related to the research that may arise.

Electronic Signature(s):





Principal investigator: Damien Burke

Co-Supervisors: Dr. John White and Dr. Elaine McDonald

Date: 16th August 2018

2. PROJECT OUTLINE

2.1 LAY DESCRIPTION *(Approx. 300 words)*

Please outline, in terms that any non-expert would understand, what your research project is about, including what participants will be required to do. Please explain any technical terms or discipline-specific phrases.

This proposed research project is focused upon the leadership of the teaching, learning and promotion of Mathematics at the micro-level in Irish primary schools. Fundamentally, the project asks "*who is leading Mathematics in our schools, and how do they do it?"* More specifically, the project intendeds to examine the various recognised models of leadership currently in place in primary schools, to profile the individuals involved in this critical work, and to chronicle the breadth of organisational, curricular and pedagogical functions that these leaders undertake within their specific roles. The project is premised upon five accepted models of mathematics school leadership currently exploited within our primary school system: administrative principal alone, teaching principal alone, teacher-leader with an assigned middle management role, teacher-leader with no formal middle management role/volunteer, and committee structure. The project also strives to identify the unique challenges of this important work, between and across the various models, alongside a realistic appraisal of the supports that such leaders self-identify as being vital to the successful execution of their role.

Participants will be required to complete an initial profiling questionnaire which will seek relevant professional background data (e.g. years of teaching experience, relevant professional development, self-assessed mathematical competency, self-assessed role-effectiveness and role-satisfaction). This will be followed by the completion of a daily activity log for two blocks; participants will record and classify all tasks undertaken that fall within the remit of leading the teaching, learning and promotion of Mathematics. The final phase of participation will entail an individual interview where the relevant leadership experiences of the participant will be probed, along with possible qualitative exploration of some recurring and/or unique themes that are evident in their logging record.

2.2 AIMS OF AND JUSTIFICATION FOR THE RESEARCH *(Approx. 400 words)*

State the aims and significance of the project. Where relevant, state the specific hypothesis to be tested. Please provide a brief description of background research, a justification as to why this research project should proceed in that context and an explanation of any expected benefits to the community. NB – all references cited should be listed in an attached bibliography.

Six inter-related sub-inquiries emerge:

- What is the profile of those leading the teaching, learning and promotion of Mathematics in primary schools?
- What are their assigned duties?
- What proportion of the typical working-week is dedicated to this work?

- What are the specific challenges of the role?
- What supports do such leaders access? What additional unfurnished aids do they consider critical to their effectiveness?
- What are the commonalities and differences between the different leaders/models as evidenced by the aforementioned lines of inquiry; can variations be rationalised?

Supported by Katterfeld's (2013) and Leithwood, Harris & Hopkins' (2008) respective assertions about school leadership's critical influence upon teacher effectiveness and pupil learning, this proposal is premised upon this influence having a mathematics-specific dimension.

As evidenced by encouraging improvements in Ireland's primary-school numeracy standards (Clerkin et al., 2016), many school leaders are manifestly doing tremendous things for mathematics teaching and learning. However, little is known about their behind-the-scenes work. Despite ample international literature stressing the importance of Mathematics and other subject-specific leadership, a dearth exists in chronicling and analysing this work (Sexton & Downton, 2014; Seashore Louis et al., 2010; Good, 2008). In an era where policy-makers demand ever-rising numeracy standards, and the accompanying high-stakes accountability this entails (See Hopkins et al. (2013), it is imperative that school leaders are informed, and best-equipped to allow them effect maximum impact.

Credible concerns surrounding the sustainability of principal-only leadership for subject-specific instruction (Seashore Louis et al., 2010) have forced policy-makers to broaden their traditionally narrow understanding of who holds leadership influence. In Ireland, recent Department of Education and Skills circulars (2017b) demonstrate a welcomed recognition that what constitutes school leadership is evolving, having long since surpassed solely traditional principal/deputy-principal roles. Can this fluidity of leadership benefit mathematics teaching and learning? From a highly evolved U.S. system, unsurprisingly both Balka et al. (2010) and the National Council of Supervisors of Mathematics (NCSM, 2008) display considerable breadth in their conceptualisation of who leads Mathematics locally; teacher-leaders, year-heads, curriculum specialists, coaches, mentors and mathematics boards all sit comfortably in this crucial leadership space, alongside the ubiquitous school principal. Little is known about comparable variants in the Irish system.

Whilst the publishing of the Department of Education and Skills' quality framework for schools (2016; 2003) provides a worthwhile instrument for sustainable improvement processes across school leadership, the guidelines are not intended to provide subject-particular benchmarks; thus they lack the specificity of focus that mathematics leadership demands. In contrast, the NCSM's *PRIME Leadership Framework* (2008) encapsulates a mathematics-specific leadership construct that identifies specific principles, knowledge and skills for U.S. school leaders. It is hoped that this proposed research, and the effective leadership practice that it could potentially document, may contribute to an Irish movement that ultimately provides the subject-specific mathematics (leadership) charter that this specialised domain deserves.

2.3 DESCRIBE THE METHODOLOGY BEING USED TO ACHIEVE YOUR STATED AIMS

Provide an outline of the proposed method and state who is doing which task – include details of data collection techniques, the tasks participants will be asked to do, the estimated time commitment involved, and how data will be analysed. If the project includes any procedure which is beyond already established and accepted techniques please include a description of it. There should be enough detail provided to facilitate ethical review, but applicants are encouraged to keep it as succinct as possible.

A multiple-case format is proposed as the most flexible and workable approach in order to provide the required perspective of mathematics leadership at the micro-school level. Stake captures the kernel of the context-sensitive case approach; "a case (study) is expected to catch the complexity of a single case" (1995, p.xi) – what it lacks in breadth of cases is compensated for by the in-depth investigation of the particular.

The five recognised models of mathematics school leadership (Administrative principal alone, teaching principal alone, teacher-leader with an assigned middle management role, teacher-leader with no formal middle management role/volunteer, and committee structure) will each be represented as one of the groups of analysis. The proposed methodology comprises of an initial questionnaire, participant activity log and semi-structured interview, and follows this ordinal sequence over a projected three-month period from start to finish.

The initial questionnaire will be orally administered to participants in advance of the logging period. Primarily, it aims to create a profile of the participants – their professional characteristics (teaching experience, relevant professional development, self-assessed mathematical competency, self-assessed role-effectiveness etc…), some background data about their school and their initial perceptions of the leadership work that they do. Therefore, this profile-building will not need to be done at the post-logging interview stage, thus facilitating examination of the more substantial issues to hand. The quantitative analysis of the arising profile data (despite the small number) will demand some use of descriptive statistical methods. The data that emerges from the questionnaire (variables such as the teaching experience, leadership experience, mathematical competency etc…of the respondent) is informative in its own right, however it will also be explored to examine potential relationships with the respondent's own self-assessed effectiveness in their role. One might expect higher levels of self-assessed effectiveness to positively correlate with greater teaching and or leadership experience, for example.

Inspired by Spillane and Zuberi's (2009, p.375) "Leadership Daily Practice" (LDP) log, the self-identified mathematics leader in each of the case schools will be asked to complete a record of their mathematics leadership-related activities for two 2-week periods. Practical considerations of restricted release time for the researcher and the risk of unnecessary intrusiveness at the research site (during the working day) all contribute to the rejection of observational data collection. It is intended that the activity log will specify typical duties associated with leading Mathematics (such as *(A) Curating and (re)developing the Plean Scoile for Mathematics, (B) Procuring, organising and distributing resources to teach Mathematics*, *(C) Advising and mentoring new colleagues on maths-specific teaching issues…*) and will require the participant to indicate if they undertook these specified duties during that particular day. Further supplementary information, (whether the episode was pre-planned or spontaneous, when it happened and the time demand involved, the expertise required and a rating of personal effectiveness) will be sought about the action. It is envisaged that the activity log will require a daily fifteen-minute completion window.

Stake (1995, p.64) provides a compelling rationale for the use of interviews within a multiple-case structure, such as the one proposed for this study: "the interview is the main road to multiple realities". Similarly, Yin (2009) notes the absolute centrality of interviews in informing the case-study process, whilst Warren (2001, p.83) similarly identifies the unique capacity of the interviewee to be the "meaning maker" behind accompanying data sources. The schedule for the proposed one-hour long interview comprises of six core areas of inquiry, each denoted by a foundation question: journey to leadership, core responsibilities, essential competencies, commitment required, supports, and overall role satisfaction/frustrations. A semi-structured format will be exploited owing to its desirable equilibrium between the deliberate use of standardised, open-ended pillar questions for all interviewees, and yet its inherent flexibility to allow the interviewer probe and pursue unique lines of inquiry that may emerge during certain interviews (Gillham, 2005). As the interviews will be held post-logging, the researcher may choose to explore particular patterns that have been noted in the participant's record. Piloting of the interview schedule is crucial (Creswell, 2013; Gillham, 2005; Stake, 1995) and this key action has been built in to the researcher's proposed timeline of actions.

Yin (2009) outlines a range of possible analytic techniques for case studies; however a "cross-case analysis" (as exploited by Casey, Houghton & Smyth, 2017, as a useful example) is proposed as being the most suitable in light of the researcher's chosen research design, and the implied comparative nature of some of the research sub-questions themselves (i.e. what challenges do different leaders/models experience?). Whilst treating (and comprehensively reporting) each case as a single study, thus fully contextualising each, the technique also provides the flexibility to subsequently aggregate findings and themes across cases. Creswell (2013, p.180) outlines the three-phase process involved in qualitative analysis; the initial coding of the data, the subsequent amalgamation of codes into broader categories or themes, and finally, the communication of the data and its inherent comparisons and contradictions. The initial open-coding, followed by selective coding of the interviews, will enable the researcher to "(capture) what he sees in the data in categories that simultaneously describe and dissect the data" (Charmaz, 2001, p.684). Yin (2009) warns that despite the autonomy afforded by the coding process, codes must be clearly rationalised and must bear obvious correspondence with the initial research question(s). It is proposed that NVivo software be utilised to expedite the coding process. The benefits of such coding tools are clear; "the efficiencies afforded by software release some of the time used to simply manage data and allow an increased focus on…(the) meaning of what is recorded" (Bazeley and Jackson, 2013, p.2). Finally, in keeping with the advices of fellow research students and as directly recommended by Stake (1995), the researcher intends to keep a personal diary where

informal records, random thoughts, observations and ideas will be collated. Such a record may have a potential import during the research process, or during a post-project review.

2.4 PARTICIPANT PROFILE

Provide the number, age range and source of participants. Please provide a justification of your proposed sample size. Please provide a justification for selecting a specific gender, age, or any other group if this is done in your project.

The ten participants in this study will be either serving primary-school principals or serving primary-school teachers. All ten will hold particular responsibilities in the leadership of Mathematics within their places of work. Their age range will span from 21 to 65 years of age. There is no specific gender requirement. The ten participants will each represent an individual case within the multiple-case design that is being proposed; the five models of leadership (identified in item 2.1) will each be represented by two units (or replications).

2.4(a) PARTICIPANT VULNERABILITY

Are some or all of participants vulnerable in any way? (e.g by virtue of the group they belong to, people who have undergone traumatic or adverse emotional events, people with diminished cognitive ability, power relations between researchers and participants etc.)? If they are, state what this vulnerability (or vulnerabilities) is and justify why this research is being done with such participants.

No

2.4(b) CHILD PARTICIPANTS (anyone under 18 years old)

*If your participants include children, you **must** confirm that you are in compliance with the research specific guidelines as detailed in "Keeping Children Safe - Policies and Procedures supporting Child Protection at DCU" - available at:* **https://www4.dcu.ie/sites/default/files/policy/157%20-%20child_protection_handbook_rev1%282%29%281%29.pdf**

Please indicate your compliance with the following guidelines:	**Mark here**
We confirm that we have read and agree to act in accordance with the DCU Child Protection policy and procedures	**N/A**
We confirm that we have put in place safeguards for the children participating in the research	**N/A**
We confirm that we have supports in place for children who may disclose current or historical abuse (whether or not this is the focus of the research)	**N/A**

2.5 EXPLAIN HOW PARTICIPANTS ARE TO BE RECRUITED

Please provide specific details as to how you will be recruiting participants. How will people be informed that you are doing this research? How will they be approached and asked if they are willing to participate? If you are mailing or phoning people, please explain how you have obtained their names and contact details. If a recruitment advertisement is to be used, please ensure you attach a copy to this application.

The researcher will exploit his network of colleagues within education to directly recruit likely participants, and/or to seek referrals of potential contributors. Given the similarity of this referral strategy to snowball sampling, Noy's telling comment that such sampling "is essentially social" (2008, p.332) strongly resonates - it is highly likely that the researcher will have to initially rely on acquaintances, former colleagues and others within his immediate social network. From a preliminary list of potential recruits drawn up, the researcher has mobile/home telephone numbers and/or personal/work e-mail addresses for thirteen of the eighteen suggested individuals. These contact details have been garnered over many years

of personal and professional relationships. In the case of the remaining five individuals, the researcher has identified mutual acquaintances who may be in a position to initiate contact. The researcher will ensure that any third party approached for this purpose will seek the explicit consent of the likely recruit before passing over their contact details. It should also be noted that this initial reliance on known contacts is not exclusive, and a recruitment advertisement will also be issued to all primary school principals in the Dublin and Kildare region through *E-Scéal*, the monthly newsletter of the Irish Primary Principal's Network (of which the principal researcher is an active and long-standing member). This will direct interested parties to an *Initial Approach Letter to Schools*, which in turn will lead to the *Plain Language Statement for Participants* and the *Informed Consent Form*. In order to maximise the appeal and potential audience for the research, some further "criterion-based selection" (LeCompte and Preissle, 1993, p.69) is desirable: at least two of the ten chosen research sites should be schools classified as disadvantaged. This "proportional stratified" approach (Teddlie and Tashakkori, 2009, p.173) is intended to mirror the some 19.6% of primary schools nationally that are classified as such (Department of Education and Skills, 2017c). Similarly, it is also proposed that at least three of the research sites will be rural schools. It is permissible that one school may simultaneously meet both aforementioned criteria. The specific inclusion of teaching principals as one of the core models of leadership guarantees that a minimum of at least two smaller schools (of 176 pupils or less) will be included as cases.

2.6 PLEASE EXPLAIN WHEN, HOW, WHERE, AND TO WHOM RESULTS WILL BE DISSEMINATED, INCLUDING WHETHER PARTICIPANTS WILL BE PROVIDED WITH ANY INFORMATION AS TO THE FINDINGS OR OUTCOMES OF THE PROJECT?

Apart from the typical presentation of findings within the completed dissertation document itself, the researcher aims to offer abridged versions of the results (and analysis) to peer-reviewed journals and other relevant periodicals for publishing. As in the dissertation text, protocols for anonymity will ensure that neither participants nor their base schools are identified in any way. This will be done by the use of participant pseudonyms and of a random alphabetised system for identifying and differentiating the various case schools (cases A – J). The precise location of the case schools will not be revealed, other than reference to their broad geographical location (e.g. north county Dublin). Similar safeguards will be exploited for the possible oral presentation of findings at relevant conferences or other appropriate fora. Participants will be furnished a digital copy of the full dissertation document upon full completion of the viva-voce process. As an expression of gratitude, each partaker will also be gifted a bound copy of their activity log (including a graphical summary of their data gathered over the logging period, and how it compares to the full data set gathered across the sample) and their interview transcript, including a personalised note of appreciation from the researcher.

2.7 ARE OTHER APPROVALS REQUIRED TO GAIN ACCESS TO ANOTHER LOCATION, ORGANISATION ETC.?

YES or NO
Yes

(If YES, please specify from whom and attach a copy of the approval documentation. If this is not yet available, please explain when this will be obtained.)

As this proposal's core research focus is centred on school personnel and the work that they do, it is necessary to seek preliminary consent from the principals of the various schools prior to approaching likely participants on staff. Liaising with this key gatekeeper has other dividends – in some of the cases, the principal will also be the potential participant; and in instances where teacher-leaders are being sought, the principal will play a pivotal role in identifying such individuals to the researcher. Given the principal's related role as an member of the school's board of management, it is important to make him/her aware of the profile and background of the researcher himself, the nature of the research, any potential benefits of participation to the individuals/school community, the demand it places upon participants, the likelihood of any disturbance to the workings of the school, and, the ethical precautions that will be taken by the researcher to minimise all identified risks. Only when the consent of the principal/board is secured will potential participants at the site be approached. Institutional acquiescence is no guarantee of individual agreement to become involved – the involvement of each potential participant will be sought on a standalone basis in line with the stated protocol.

2.8 HAS A SIMILAR PROPOSAL BEEN PREVIOUSLY APPROVED BY THE DCU REC?

YES or NO
No

(If YES, please state both the REC Application Number and Project Title)

N/A

3. RISK AND RISK MANAGEMENT

3.1 JUSTIFICATION OF STATED LEVEL OF RISK TO RESEARCH PARTICIPANTS

You must provide a justification for the stated level of risk, as indicated on the cover page of your application. Note that the level of risk may be influenced by the vulnerability of the research group, the methods employed and the nature of the research itself. For further information on risk levels, please refer to the Levels of Review information on the website: https://www.dcu.ie/researchsupport/researchethics.shtml

It is this researcher's view that given the non-critical and relatively benign nature of the proposed research, and the fact that no manifestly vulnerable partakers will be involved, there is a negligible risk of maleficence to the participants and their places of work. Whilst the risks identified in section 3.4 fully warrant a considered response from the researcher, none could be considered as excessively perilous, and impossible to counteract; it is suggested that the pre-emptive actions to be taken by the researcher will negate any potential hazards.

3.2 DOES THE RESEARCH INVOLVE:

	YES or NO
• use of a questionnaire? (attach copy)?	Yes
• interviews (attach interview questions)?	Yes
• observation of participants without their knowledge?	No
• participant observation (provide details in section 2)?	No
• audio- or video-taping interviewees or events?	Yes
• access to personal and/or confidential data (including student, patient or client data) without the participant's specific consent?	No
• administration of any stimuli, tasks, investigations or procedures which may be experienced by participants as physically or mentally painful, stressful or unpleasant during or after the research process?	No
• performance of any acts which might diminish the self-esteem of participants or cause them to experience embarrassment, regret or depression?	No
• investigation of participants involved in illegal activities?	No
• procedures that involve deception of participants?	No
• administration of any substance or agent?	No
• use of non-treatment of placebo control conditions?	No
• collection of body tissues or fluid samples?	No
• collection and/or testing of DNA samples?	No
• participation in a clinical trial?	No
• administration of ionising radiation to participants?	No

3.3 POTENTIAL RISKS TO PARTICIPANTS AND RISK MANAGEMENT PROCEDURES

Identify, as far as possible, all potential risks to participants (physical, psychological, social, legal, economic, etc.), associated with the proposed research. Please explain what risk management procedures will be put in place to minimise these risks.

- Both the Plain Language Statement and the Informed Consent form will ensure that the potential participant fully understands the nature of the research, the ethical responsibilities of the researcher towards the participant, and the practical scope of their required involvement. Consequently, the unfettered right of the participant to withdraw from the project at any time will be emphasised, and will be immediately actioned by the researcher if so instructed by the participant. The participants' right to withdraw their data will be fully respected.
- The researcher will make his contact details available to all participants in order to respond to any queries or concerns that they may have prior, during or (for a reasonable period) after, the research project.
- It is the stated approach of the researcher to visit and to speak directly to each potential participant before a decision on their personal participation is taken; coercion from an ill-informed gatekeeper (or an over-bearing researcher) is unacceptable. Institutional acquiescence is no guarantee of individual agreement to become involved – the involvement of each potential participant will be sought on a standalone basis in line with the stated protocol.
- Measures to protect the identity of participants and the schools that they work in, will ensure that should any findings emerge that may reflect negatively upon themselves, their colleagues or their place of work, they will not suffer any adverse consequences as no one will be in a position to identify them or their school. Participants and case schools will be simply labeled randomly as cases a – j.
- Any incidental or unintended observations that the researcher may make whilst visiting the participants' schools, but which are extraneous to the research project, will remain confidential.
- In order to avoid the loss of important teaching and other contact time in schools, meetings (including interviews) between the researcher and the participants will be held outside of typical school hours, although most likely on the school premises for participant convenience.
- For the welfare of the participants, the researcher will seek to limit their daily logging time to a fifteen-minute window per day. Should the researcher form the view that the participant is over-burdened, by their involvement in the project or through other external circumstances, the aforementioned right to withdraw will be re-brought to the attention of the participant.
- Data handling and storage procedures will comply with the General Data Protection Regulation (GDPR) EU 2016/679. This includes digital storage of text and audio files on only one, password-secured, personal computer in the home of the researcher. The physical data generated during the project (profile sheets, participant logs and printed interview transcripts, if necessary) will be stored under lock-and-key at the same location. Such physical documents will not carry the name of the participants, just their case identifier (as set out above). The sharing of any element of personal data, other than aggregated findings with the aforementioned strict anonymity protocols applying, will be strictly forbidden.
- As the initial profile instrument/questionnaire will be orally administered, the researcher will re-read given responses back to the participant prior to completion. This will enhance accuracy and build trust with the respondent.
- Member checking of interview transcripts within a ten-day period of the interview itself will enable the interviewee to assess accuracy. It will also facilitate the participant to withdraw or redact any passages or particular identifying or inappropriate information that was stated during the interview.

3.4 ARE THERE LIKELY TO BE ANY BENEFITS (DIRECT OR INDIRECT) TO PARTICIPANTS FROM THIS RESEARCH?

YES or NO
Yes

(If YES, provide details.)

Following the completion of the project write-up and the subsequent grading process, each participant will receive a copy of their own activity log. Alongside each individuals' unaltered entries, this document will also include graphical summaries of the participants' logging data over the period, and will also present similar aggregated data across the full sample. This will allow the individual to consider the generalisation and/or outlying nature of their own leadership practices. It may be possible for the participants, if they so wish, to utilise this data as a catalyst to further examine and possibly refine or consolidate their typical leadership approaches. Furthermore, the participants' own data, and indeed the entire process (from profiling, to logging, through to interviewing) could also carry some benefit within a robust school self-evaluation process where the individual (as part of a wider collective) wishes to investigate the leadership of Mathematics, or other parallel curricular areas, within the school.

3.5 ARE THERE ANY SPECIFIC RISKS TO RESEARCHERS?

Examples include use of dangerous materials, asking certain types of questions, research being undertaken in certain locations, researchers working alone in isolated areas, etc.

YES or NO
No

(If YES, please describe and explain what risk management procedures will be put in place to minimise these risks.)

N/A

3.6 DEALING WITH ADVERSE/UNEXPECTED OUTCOMES

Please describe what measures/protocols you have put in place in the event that there are any unexpected outcomes or adverse effects to participants arising from involvement in the project.

Given the relatively benign, non-critical nature of the research, it is highly unlikely that any adverse effects to participants will result from their involvement in the project. Should such improbable effects materialise, the protocols of confidentiality and anonymity for participants (see sub-section 3.3) will insulate the individuals against any such personal or professional repercussions. Furthermore, should the researcher form the opinion that the raw data collected from any particular individual/case may inadvertently damage the personal and/or professional standing of the individual (or another third party), this concern will be communicated to the participant who will make the final decision concerning its redaction, complete omission or inclusion within the project.

3.7 HOW WILL THE CONDUCT OF THE PROJECT BE MONITORED?

Please explain how the principal investigator will monitor the conduct of the project (especially where several people are involved in recruiting or interviewing, administering procedures, etc.) to ensure that it conforms with the procedures set out in this application. In the case of student projects please give details of how the supervisor(s) will monitor the conduct of the project.

The student researcher/principal investigator and his supervisors will work closely through a series of supervision meetings. A detailed project timeline will be negotiated and the student researcher will keep his supervisors regularly updated on his progress through this timeline. Deviations from the timeline and its agreed milestone actions will be flagged and approved in advance, if necessary. Should logistical challenges, particular ethical issues or other unforeseen mitigating circumstances arise during the lifetime of the project, the student researcher appreciates that the guidance and recommendation of his supervisors and REC (where applicable) is considered as the ultimate arbitration on the issue.

3.8 SUPPORT FOR PARTICIPANTS

Depending on risks to participants you may need to consider having additional support for participants during/after the study. Consider whether your project would require additional support, e.g., external counselling available to participants. Please advise what support will be available.

Given the relatively benign, non-critical nature of the research, it is highly unlikely that participants will require specialised, additional support during or after the participation-window. Therefore, the researcher does not propose to specifically offer such services to partakers. However, the researcher will ensure that participants have multiple means to contact him during the research window (for logistical back-up, for example), and for a reasonable period afterwards also (should they wish to inspect or clarify some aspect of their raw data).

3.9 DO YOU PROPOSE TO OFFER PAYMENTS OR INCENTIVES TO PARTICIPANTS?

YES or NO
No

(If YES, please provide further details.)

N/A

3.10 DO ANY OF THE RESEARCHERS ON THIS PROJECT HAVE A PERSONAL, PHILOSOPHICAL, FINANCIAL OR COMMERCIAL INTEREST IN ITS OUTCOME THAT MIGHT INFLUENCE THE INTEGRITY OF THE RESEARCH, OR BIAS THE CONDUCT OR REPORTING OF THE RESEARCH, OR UNDULY DELAY OR OTHERWISE AFFECT THEIR PUBLICATION?

YES or NO
No

(If YES, please specify how this conflict of interest will be addressed.)

N/A

4. INVESTIGATORS' QUALIFICATIONS, EXPERIENCE AND SKILLS *(Approx. **200 words**)*

*List the academic qualifications and outline the experience and skills relevant to this project that the PI, other researchers and any supporting staff have in carrying out the research and in dealing with any emergencies, unexpected outcomes, or contingencies that may arise. **State specifically who will be carrying out the research procedures***

The student researcher holds a Bachelor of Education degree, a Masters of Mathematics Education degree and a Post-graduate Diploma in Educational Leadership. The latter two qualifications entailed a considerable research component, and consequently they give the researcher a solid grounding in school-based research, particularly qualitative-research methodologies. This burgeoning skillset has been enhanced through the completion of three research methodology modules during the first two years of the doctorate programme. Professionally, the researcher has worked in various primary schools over the last twenty years, as teacher and principal. Such roles allow ample opportunity to test, and improve one's project management skills, and to build resilience in dealing with unexpected and sometimes challenging events. This professional experience also builds "insider knowledge" about the typical functioning of schools, and the attractiveness of certain types of research topics to school staff. It also allows the researcher tap into a collegiate network in order to guarantee project participation. In his current role as a teacher educator, the researcher is currently participating in an *Erasmus Plus* project which affords an opportunity to not only hone one's research skillset, particularly in analytical writing, but also to collaborate with experienced Irish and European co-researchers. The student researcher has recently undertaken two 2-day training courses on the NVivo software package.

5. CONFIDENTIALITY/ANONYMITY

5.1 WILL THE IDENTITY OF THE PARTICIPANTS BE PROTECTED?

YES or NO
Yes

(If NO, please explain why.)

N/A

IF YOU ANSWERED YES TO 5.1, PLEASE ANSWER THE FOLLOWING QUESTIONS:

5.2 HOW WILL THE ANONYMITY OF THE PARTICIPANTS BE RESPECTED?

Please bear in mind that where the sample size is very small, it may be impossible to guarantee anonymity/confidentiality of participant identity. Participants involved in such projects need to be advised of this limitation in the Plain Language Statement/Information Sheet. If you intend to fully anonymize the data, please provide details

Participants and case schools will be labeled randomly as cases a – j; this identification system will apply to all documentation generated by each case, and to specific references within the various sections of the dissertation itself. Incidental references to the identities of individuals, particular locations, or other similarly sensitive data, either in interview transcripts or logging documents, will be redacted as necessary. The researcher will solely retain a document which matches the alphabetised case identifier with the true identities (and places of work etc…) of the various participants. This electronic document will be password secured.

5.3 LEGAL LIMITATIONS TO DATA CONFIDENTIALITY

Participants need to be made aware that confidentiality of information provided cannot always be guaranteed by researchers and can only be protected within the limitations of the law - i.e., it is possible for data to be subject to subpoena, freedom of information claim or mandated reporting by some professions. This information should be included in your Plain Language Statement and Informed Consent Form. Depending on the research proposal and academic discipline, you may need to state additional specific limitations.

State how and where participants will be informed of these limitations

These limitations will be outlined in both the Plain Language Statement and the Informed Consent Form.

6. PERSONAL DATA - COMPLIANCE WITH THE GENERAL DATA PROTECTION REGULATION

Personal data is data relating to a living individual (i.e. the 'Data Subject') who is, or can be, identified either from the data itself or from the data in conjunction with other information that is in, or is likely to come into, the possession of the 'Data Controller' (i.e. DCU and its constituent units e.g. research teams etc.). ***Further information available at https://www.dcu.ie/ocoo/dp/guides.shtml***

6.1 IS PERSONAL DATA BEING PROCESSED AS PART OF THIS PROJECT?

YES or NO
Yes

If YES, Please indicate your compliance with the following guidelines:	**Mark here**
We confirm that we have read and agree to act in accordance with DCU guidance and procedures regarding personal data	**Yes**
We confirm that we have put in place a Personal Data Security Schedule (PDSS) for the project and have attached it to this application	**Yes**

IF YOU ANSWERED YES TO 6.1, PLEASE ANSWER THE FOLLOWING QUESTIONS:

6.2 WHAT KIND OF PERSONAL DATA IS BEING PROCESSED?

Note special categories of personal data include health data, genetic data and/or data relating to ethnicity/race of participants, their sex lives and/or sexual orientation

- The participant's name and stated gender.
- The name and location of the participant's place of work.
- The specific role of the participant in their place of work.
- The professional history of the participant (general level of experience in the workplace, qualifications, working relationships with colleagues, self-assessment of effectiveness in the workplace).

6.3 WILL ANONYMISATION/PSEUDONYMISATION OF THE PERSONAL DATA BE UNDERTAKEN?

YES or NO
Yes

(If NO, please explain why.)

N/A

7. DATA/SAMPLE STORAGE, SECURITY AND DISPOSAL

For the purpose of this section, "Data" includes that in a raw or processed state (e.g. interview audiotape, transcript or analysis). "Samples" include body fluids or tissue samples.

7.1 HOW AND WHERE WILL THE DATA/SAMPLES BE STORED?

Note that the REC recommends that all data be stored on campus – please justify any off-site storage.

As the researcher resides a considerable distance from campus, and therefore spends very little time there (other than for supervision meetings), accessibility and convenience considerations dictate that the data be stored at the researcher's private residence. Data storage procedures will comply with best practice, including digital storage of text and audio files on only one, password-secured, personal computer in the home of the researcher. This computer is preloaded with up-to-date anti-virus malware software. Such data will also be backed-up through a cloud source, which has robust firewalls, and is password-secured. The physical data generated during the project (profile sheets, participant logs and printed interview transcripts, if necessary) will be stored under lock-and-key at the same location.

7.2 WHO WILL HAVE ACCESS TO DATA/SAMPLES?

If people other than the main researchers have access, please name who they are and explain for what purpose.

Only the student researcher and his supervisors will have access to the data.

7.3 HOW LONG IS THE DATA TO BE HELD/RETAINED FOR?

*Note that with very few exceptions **personal data** may not be retained indefinitely. It is up to the unit or research team to establish an upper retention limit for each category of personal data under its control.*

The data will be retained for five years from the conclusion of the thesis-grading process.

7.4 IF DATA/SAMPLES ARE TO BE DISPOSED OF, PLEASE EXPLAIN HOW, WHEN AND BY WHOM THIS WILL BE DONE?

*Note that simply deleting files is not sufficiently secure. The additional steps to be taken to maintain data security should be given. **Personal data** must be disposed of in a safe and secure manner at the end of its retention period. If the data is stored in a: a) paper based format then shredding or disposal via a secure bin is recommended; or b) if it is stored in an electronic based format then deletion of the record or full anonymization of the data is recommended.If data/samples are NOT being disposed of, please justify this decision.*

The physical data generated during the lifetime of the project (profile sheets, participant logs, informal researcher notes and printed interview transcripts, if necessary) will be shredded and disposed of responsibly five years following the conclusion of the thesis grading process. Digital records will be permanently and irrevocably deleted from the hard-drive of the principal researcher's personal computer and from the particular cloud server utilised, within the same time-span. The principal researcher will personally carry out the data disposal.

8. FUNDING OF THE RESEARCH

8.1 HOW IS THIS WORK BEING FUNDED?

Self-funded

8.2 PROJECT GRANT NUMBER *(If relevant and/or known – otherwise mark as N/A)*

N/A

8.3 DOES THE PROJECT REQUIRE APPROVAL BEFORE CONSIDERATION FOR FUNDING BY A GRANTING BODY?

YES or NO
No

8.4.1 HOW WILL PARTICIPANTS BE INFORMED OF THE SOURCE OF THE FUNDING? *(e.g. included in the Plain Language Statement)*

N/A

8.5 DO THE FUNDERS OF THIS PROJECT HAVE A PERSONAL, FINANCIAL OR COMMERCIAL INTEREST IN ITS OUTCOME THAT MIGHT COMPROMISE THE INDEPENDENCE AND INTEGRITY OF THE RESEARCH, OR BIAS THE CONDUCT OR REPORTING OF THE RESEARCH, OR UNDULY DELAY OR OTHERWISE AFFECT THEIR PUBLICATION?

YES or NO
No

(If YES, please specify how this conflict of interest will be addressed.)

N/A

9. PLAIN LANGUAGE STATEMENT *(Attach to this document. Approx. 400 words)*

A Plain Language Statement (PLS) should be used in all cases. This is written information in plain language that you will be providing to participants, outlining the nature of their involvement in the project and inviting their participation. The PLS should specifically describe what will be expected of participants, the risks and inconveniences for them, and other information relevant to their involvement. Please note that the language used must reflect the participant age group and corresponding comprehension level – if your participants have different comprehension levels (e.g. both adults and children) then separate forms should be prepared for each group. The PLS can be embedded in an email to which an online survey is attached, or handed/sent to individuals in advance of their consent being sought. See link to sample templates on the website: ***https://www.dcu.ie/researchsupport/ethicsapproval.shtml***

PLEASE CONFIRM WHETHER THE FOLLOWING ISSUES HAVE BEEN ADDRESSED IN YOUR PLAIN LANGUAGE STATEMENT/ INFORMATION SHEET FOR PARTICIPANTS:

	YES or NO
Introductory Statement (PI and researcher names, school, title of the research)	**Yes**
What is this research about?	**Yes**
Why is this research being conducted?	**Yes**
What will happen if the person decides to participate in the research study?	**Yes**
How will their privacy be protected?	**Yes**
How will the data be used and subsequently disposed of?	**Yes**
What are the legal limitations to data confidentiality?	**Yes**
What are the benefits of taking part in the research study (if any)?	**Yes**
What are the risks of taking part in the research study?	**Yes**
Confirmation that participants can change their mind at any stage and withdraw from the study	**Yes**
How will participants find out what happens with the project?	**Yes**
Contact details for further information (including REC contact details)	**Yes**
Details relating to GDPR Compliance if Personal Data is being sought	**Yes**

If any of these issues are marked NO, please justify their exclusion:

N/A

10. INFORMED CONSENT FORM *(Attach to this document. Approx. 300 words)*

In most cases where interviews or focus groups are taking place, an Informed Consent Form is required. This is an important document requiring participants to indicate their consent to participate in the study, and give their signature. If your participants are minors (under 18), it is best practice to provide them with an assent form, while their parents/guardians will be given the Informed Consent Form. In cases where an anonymous questionnaire is being used, it is enough to include a tick box in the questionnaire (underneath the information section for participant), where participants can indicate their consent.
See link to sample templates on the website: ***https://www.dcu.ie/researchsupport/ethicsapproval.shtml***

NB – IF AN INFORMED CONSENT FORM IS NOT BEING USED, THE REASON FOR THIS MUST BE JUSTIFIED HERE.

N/A

Appendix J: Personal Data Security Schedule

Personal Data - Security Schedule

Date: 16th August 2018 **Prepared by**: Damien Burke

Purpose: 1. To list all types of personal data held or processed as part of this research project and the security measures to be applied.

2. To compliment an ethical approval application to DCU Research Ethics Committee.

Ref	Personal Data - Type or description	Format - Electronic / Paper / Both	Reason / Purpose for holding onto data	Responsibility for security of data assigned to	Who may access data	Who may amend data	To whom only may data be provided	Security controls in place over data	How long is Data to be held?	Responsibility for deleting data assigned to	Method of disposal of data	Any other comment?
1	The participant's name and stated gender.	Both	To ensure that the identity of the participant matches the intended pseudonym. To assess and subsequently prove the gender composition (and proportionality) of the sample.	Damien Burke (principal investigator).	The principal investigator and his two DCU-appointed supervisors (Staff members; Dr. Elaine McDonald and Dr. John White).	Alteration of the raw data is not permitted under any circumstances. The principal investigator will mantain the data when required (e.g. adding pseudonyms, redaction of details/passages if necessary, creation of back-ups).	(1) The relevant participant. (2) A third party who holds the appropriate legal warrant and authority to inspect the data, should such an improbable circumstance arise.	(1) Paper-based data will be stored under lock and key in the private residence of the principal researcher. He will solely retain a key for access. (2) Electronic data will be stored in a password-secured desktop computer in the private residence of the principal researcher. It will be further backed-up through a password-secured cloud-based and highly reputable server.	Five years following completion of thesis grading.	Damien Burke (Principal Investigator).	Shredding and appropriate recyclng of paper records. Irrevocable deletion of electronic records from desktop computer and back-up cloud server.	N/A
2	The name and location of the participant's place of work.	Both	To ensure and subsequently prove the divsersity of the school settings that the research will be conducted in (as per the project's sampling strategy).	Damien Burke (principal investigator)	The principal investigator and his two DCU-appointed supervisors (Staff members; Dr. Elaine McDoanld and Dr. John White).	Alteration of the raw data is not permitted under any circumstances. The principal investigator will mantain the data when required (e.g. adding pseudonyms, redaction of details/passages if necessary, creation of back-ups).	(1) The relevant participant. (2) A third party who holds the appropriate legal warrant and authority to inspect the data, should such an improbable circumstance arise.	(1) Paper-based data will be stored under lock and key in the private residence of the principal researcher. He will solely retain a key for access. (2) Electronic data will be stored in a password-secured desktop computer in the private residence of the principal researcher. It will be further backed-up through a password-secured cloud-based and highly reputable server.	Five years following completion of thesis grading.	Damien Burke (Principal Investigator).	Shredding and appropriate recyclng of paper records. Irrevocable deletion of electronic records from desktop computer and back-up cloud server.	N/A

Ref	Personal Data - Type or description	Format - Electronic / Paper / Both	Reason / Purpose for holding onto data	Responsibility for security of data assigned to	Who may access data	Who may amend data	To whom only may data be provided	Security controls in place over data	How long is Data to be held?	Responsibility for deleting data assigned to	Method of disposal of data	Any other comment?
3	The specific role of the participant in their place of work.	Both	To ensure and subsequently prove that the individual is the bona-fide leader of mathematics teaching and learning within their school.	Damien Burke (principal investigator)	The principal investigator and his two DCU-appointed supervisors (Staff members; Dr. Elaine McDoanld and Dr. John White).	Alteration of the raw data is not permitted under any circumstances. The principal investigator will mantain the data when required (e.g. adding pseudonyms, redaction of details/passages if necessary, creation of back-ups).	(1) The relevant participant. (2) A third party who holds the appropriate legal warrant and authority to inspect the data, should such an improbable circumstance arise.	(1) Paper-based data will be stored under lock and key in the private residence of the principal researcher. He will solely retain a key for access. (2) Electronic data will be stored in a password-secured desktop computer in the private residence of the principal researcher. It will be further backed-up through a password-secured cloud-based and highly reputable server.	Five years following completion of thesis grading.	Damien Burke (Principal Investigator).	Shredding and appropriate recyclng of paper records. Irrevocable deletion of electronic records from desktop computer and back-up cloud server.	N/A
4	The professional history of the participant (general level of experience in the workplace, qualifications, working relationships with colleagues, self-assessment of effectiveness in the workplace).	Both	To provide the researcher with background participant detail which may help rationalise possible similarities and differences in the leadership approaches of the various participants.	Damien Burke (principal investigator)	The principal investigator and his two DCU-appointed supervisors (Staff members; Dr. Elaine McDoanld and Dr. John White).	Alteration of the raw data is not permitted under any circumstances. The principal investigator will mantain the data when required (e.g. adding pseudonyms, redaction of details/passages if necessary, creation of back-ups).	(1) The relevant participant. (2) A third party who holds the appropriate legal warrant and authority to inspect the data, should such an improbable circumstance arise.	(1) Paper-based data will be stored under lock and key in the private residence of the principal researcher. He will solely retain a key for access. (2) Electronic data will be stored in a password-secured desktop computer in the private residence of the principal researcher. It will be further backed-up through a password-secured cloud-based and highly reputable server.	Five years following completion of thesis grading.	Damien Burke (Principal Investigator).	Shredding and appropriate recyclng of paper records. Irrevocable deletion of electronic records from desktop computer and back-up cloud server.	N/A

END