In search of the excellent maths lesson: A case study comparing theory with reality in the secondary mathematics classroom in south Wales

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This dissertation is being submitted in partial fulfilment of the requirements of candidature for the degree of M.A. Education

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Abstract

This small scale mixed methods case study focuses on the mathematics learning and teaching experiences of pupils and teachers from a total of seven secondary schools in the south Wales area. It is set against a background in which many individuals, and perhaps certain sections of society, have a negative view towards mathematics and the way it has been taught in schools. The research investigates, from both pupil and teacher perspectives, what the key features of an excellent maths lesson are, as well as attempting to explore what challenges are faced in delivering excellent lessons on a daily basis. An extensive review of literature explores the impact of Government guidance and curriculum changes on mathematics teaching and learning in Wales and England, as well as revealing the drive towards more active engagement within the subject. The methodology uses questionnaires and semi-structured interviews to gather mainly qualitative data from a purposive sample, to compare and contrast the theory presented in the literature with the reality experienced in schools.

An analysis of the data reveals the view that excellent maths lessons should contain a variety of activities, high levels of pupil-pupil and pupil-teacher discussion and interaction, with a focus on revealing and exploring pupil misconceptions. However, the study also shows that there are challenges that prevent teachers working in this way with all classes in all lessons. These challenges include pressure to complete designated content, especially with examination classes, managing the behaviour of certain groups of learners, as well as a lack of preparation time. In addition, there is some evidence revealed that whole school policies on lesson structure, as well as pressure to improve external examination results may be stifling excellent teaching.

Based on the evidence gathered, this dissertation recommends a continued focus by teachers and teacher trainers on the development of active learning in mathematics, as well as the effective provision of funded opportunities for qualified teachers to further develop their skills and knowledge through Master's level study.
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Chapter One

1.1 Research statement

This small scale research study aimed to explore the key factors which contribute towards an excellent mathematics lesson in the secondary phase. Through a case study approach, it was intended to summarise the views of a variety of stakeholders including teacher trainers, teachers and pupils in order to share best practice in day to day teaching and to detail how this compares with the ideals purported by current academic literature and government bodies. It aimed therefore to compare and contrast the theory of excellent learning and teaching in mathematics with the reality of the practical day to day challenges that teachers encounter.

The mathematics teachers involved in the study had different degrees of experience, with the sample including those in their first year of teaching (newly qualified teachers or NQTs) as well as more experienced teachers from a variety of schools in the south Wales area. As Flutter and Rudduck (2004) remind us, pupil consultation can be crucial to improving teaching and learning, with Noyes neatly describing this process as an attempt to ‘reorient research from outside-in to a more inside-out focus’ (2005, p.533, italics in original). Therefore, in addition to seeking the views and experiences of mathematics teachers, those of the pupils that they teach were explored to give a more holistic view of what might make an excellent maths lesson.

The study and its write up took place over a period of approximately seven months from October 2011 through to April 2012 (see timetable in Appendix 1) and involved the use of research tools such as questionnaires and semi-structured interviews to gather the data necessary in order to attempt to answer the three specific research questions detailed below:-
Research Question 1
What are the key elements of an excellent maths lesson?

Research Question 2
What are the challenges that maths teachers face in order to deliver excellent lessons on a consistent basis?

Research Question 3
To what extent is there a link between teaching experience and the ability to deliver excellent maths lessons?

1.2 Rationale

1.2.1 Professional role and leadership

The seeds of this research project were sown in the autumn of 2010 when I first took up the post of programme leader for PGCE mathematics at a higher education institution (HEI) in Wales, after a career of some twenty five years as a maths teacher and head of department in a variety of secondary schools in Wales and England. One of the key motivations for me to become involved in initial teacher education and training (ITET) was a keen desire to share the knowledge and skills that I had gained over this time with a broader range of teachers than those within my own department and school, and to try to establish what Blake and Landsell (2000, p.64) describe as a ‘teacher educator team’ with the trainees and partnership teacher mentors with whom I would be involved. In this way, I hoped that I could influence in a positive way the maths learning experiences of a wider range of pupils in a wider range of schools in the future. Early on in my new role, in the autumn of 2010, oral feedback that was received from trainees revealed that the sort of active learning that authors such as Swan (2005) and Zweck (2006) discuss, and which I
was promoting with trainees, varied extensively in its frequency and perceived effectiveness across partnership schools, which further developed my interest in this research area. I realised that I needed to explore the realities that teachers in different schools faced on a daily basis rather than relying on some self imagined reality based on personal experience.

My own philosophy of leadership for improvement echoes that of Sergiovanni (2001, cited in Harris et al., 2003, p.2), who contends that ‘developing a community of practice may be the single most important way to improve a school’. I would argue further that to develop such communities, it is essential that, where subject teams exist, there is a consistency and shared philosophy regarding learning and teaching within that subject team and that in fact it is within classrooms that this community of practice is most important. A careful focus on the actual experiences encountered by pupils in the classroom on a daily basis is a key driver to improved engagement and enjoyment in maths learning and consequently to higher levels of attainment. In order to achieve high quality and effective teaching and learning within mathematics, it is vital that leaders, including those in initial teacher education, are committed to the professional development of all colleagues with whom they come into contact and to creating the right atmosphere within which knowledge can be grown and shared. This view is supported by authors including Busher and Harris who suggest that:

The modes of professional development associated with improved teaching and learning are those focused upon and located within the classroom. When teachers work collaboratively, the possibility and potential for improved classroom practice are greatly increased.

(2000, p137)
Again, it became clear to me that for my own involvement in leading and supporting new teachers to ultimately play a part in improving the experiences of pupils within the secondary classroom, it was vital that I strengthen my own understanding of what makes for effective and excellent learning and teaching in a broader variety of contexts than those I had experienced to date. Through this focused research, I aimed to be able to more effectively develop in future maths teachers the skills and habits of mind (Costa and Kallick, 2008) that are required to deliver learning experiences in lessons that are of a consistently high standard; to the ultimate benefit of the pupils that they teach.

1.2.2 Mathematics learning

This section outlines further extrinsic influences on the choice of this area of study as a final dissertation topic including drivers such as national policy both in Wales as well as across the United Kingdom (UK).

The UK government inquiry led by Sir Adrian Smith reported the negative image that mathematics has in wide areas of society. At the same time it suggested that maths is a vital part of that same society. It described maths as being 'of central importance to modern society. It provides the vital underpinning of the knowledge economy' (2004, p.11). The report also confirms that 'problems with numeracy lead to the greatest disadvantages for the individual in the labour market and in terms of general social exclusion' (Smith, 2004, p.13). Maths therefore can be seen as a crucial part of the development and success of both the individual and of the society in which they hope to prosper both economically and socially.

The traditional view of mathematics is that it is 'boring and irrelevant' (Smith, 2004, p.2), with Noyes (2007, p.18) suggesting that 'many learners are not well served by
their mathematics education... and in the actual learning processes in the classroom'. The views of Tanya, a year nine pupil, described by Boaler (2009, p.163) are sadly not uncommon – describing maths lessons as 'a whole hour of silence'.

The recent Welsh Government (WG) document Effective Practice in Learning and Teaching – A Focus on Pedagogy describes how teachers from all subject areas should be prepared to try new approaches as well as wanting ‘to enable learners to become more engaged, effective and motivated and thus able to achieve better quality outcomes’ (Wales. Department for Children, Education, Lifelong Learning and Skills (DCELLS), 2009a, p.3). It is evident, from both the research and from personal experience, that more traditional 'transmission' teaching methods in mathematics, that are seen in some schools, do not adequately meet the demands of this aim nor do they meet the needs of the learner. Indeed, Swan reports that even students who have sufficient interest to have chosen maths at A level may lack satisfaction in their learning, with some sixth form students describing their most frequent behaviours in maths lessons as:–

"I listen while the teacher explains."
"I copy down the method from the board or textbook."
"I work on my own."
"I try to follow all the steps of a lesson."
"I practise the same method repeatedly on many questions."

(2005, p.3)

As a teacher educator and someone who is passionate about effective teaching and learning in mathematics, I see it as my challenge and responsibility to help reverse the longstanding negative views that most people have of the subject. Sadly, it appears to be socially acceptable to admit to being 'useless' at maths whereas few
would admit with the same vigour that they are 'useless' at reading, for example. As a local south Wales newspaper reported in recent times

> Have you ever noticed how admitting you've got literacy problems is regarded, however misguidedly, as something awkward and embarrassing, whereas "being useless at maths" is seen by many as almost a badge of honour.

*(The Western Mail, 2009, p.25)*

By being aware of, and reflecting on, some of the negative aspects of learning in mathematics, it should be possible to better identify those that produce an excellent experience, even in schools which may have different 'classroom cultures' to those being promoted by current research and by ITET tutors (Noyes, 2007, p.69).

### 1.2.3 Government policy in Wales

Developed as part of The Learning Country programme of reforms beginning in 2001 and produced by the then National Assembly for Wales, there has been an intention in recent years for schools in Wales to focus on several areas which are intended to have a common 'joined up' approach, to produce improved outcomes for learners. Based on a growing body of international evidence, the School Effectiveness Framework (SEF) (Wales. DCELLS, 2008a) describes in detail a national purpose for schools with core themes to be supported by the government, local authorities and schools themselves with the aim of improving educational experience and success for all children, regardless of their background or the community in which they live.

There has been much criticism of the Learning Country programme and the lack of progress and impact that it has had in terms of international measures such as those produced by the Programme for International Student Assessment (PISA), with a former Head of School Improvement in south Wales recently commenting that:
The results reveal that our educational vision since 1999 has been in the main backward-looking, negative and derelict of its duty to the poor and the vulnerable. The PISA stats are inarguable and the trends are depressing. Our global PISA position has deteriorated badly overall, with maths taking a real tumble.

(Mackie, 2011)

The BBC in Wales reports further that ‘Wales again ranked lowest of the UK countries and is now cast adrift from England, Scotland and Northern Ireland’ (BBC, 2010).

Whilst agreeing with much of the criticism of a lack of specific focus and rigour in guiding and supporting schools in being able to deliver some unrealistic expectations put forward by the Learning Country agenda, there has been one specific aspect of the SEF that schools have been able to see a practical way forward with and begun to address – that of the development of skills. As the Leitch review suggests, ‘Skills were once a key lever for prosperity and fairness. Skills are now increasingly the key lever’ (HM Treasury, 2006, p.3, italics in original). The Skills Framework for 3 to 19-year-olds aims to produce lifelong learners, equipped with transferable skills through a curriculum which meets their needs. It suggests that:

An important determinant of school effectiveness is the access practitioners have to professional knowledge about how children and young people learn and develop skills, together with the understanding practitioners have for the implications of this for learning and teaching.

(Wales. DCELLS, 2008b, p.21)

Although the Skills Framework is not a statutory document, schools are currently at various stages in endeavouring to address the development and application of the core skills that it promotes – thinking, communication, ICT and number (Wales. DCELLS, 2008b, p.4). In addition, the development of the Skills Framework is reflected in the changes that were made in 2008 to the National Curriculum for
Mathematics (Wales), which means that all learners in the secondary phase of education are working to this changed curriculum at the time of writing (Wales. DCELLS, 2008c). These changes to the National Curriculum again attempt to focus on producing learners with better skills to meet the needs of an ever changing workforce and society.

1.2.4 The National Curriculum and GCSE mathematics

The recently implemented Mathematics National Curriculum for Wales (Wales. DCELLS, 2008c) consists of a single attainment target rather than the four separate attainment targets described in the previous version (Wales. Qualifications, Curriculum and Assessment Authority for Wales (ACCAC), 2000), with the current programme of study at each Key Stage being divided into ‘Skills’ and ‘Range’.

The ‘Skills’ section is subdivided into

1) Solve mathematical problems
2) Communicate mathematically
3) Reason mathematically

and suggests that ‘pupils should develop their application and understanding of their mathematical skills using contexts and techniques from across the Range’ (Wales. DCELLS, 2008c, p.16). It is the ‘Range’ that indicates the sort of content that could be used to develop mathematical skills in the study of ‘Number’, ‘Measures and money’, ‘Algebra’ and ‘Shape, Position and Movement’.

The currency of the skills agenda and changes to the philosophy of teaching that it promotes adds to the rationale for this research. As the Smith Inquiry reminds us, in order for young people to have a greater mastery of appropriate mathematical skills,
one key factor is that 'the teaching and learning process and environment effectively encourages and promotes the mastery of these skills' (2004, p.13).

At the same time as changes were made to the National Curriculum in Wales, GCSE specifications in maths were also changing, with a greater focus on what is often referred to as functional maths. Prompted by reports such as the Tomlinson review of 14-19 reform (Great Britain. Department for Education and Skills (DfES), 2004), which claimed that pupils could achieve a C grade at GCSE level in maths without actually being numerate, and by the Leitch report (HM Treasury, 2006) with its skills focus, specifications for GCSE maths now include more 'functional' questions. These test pupils' abilities to use and apply their thinking and communication skills alongside their maths skills to solve problems of the sort that they might encounter in their life beyond school.

In order to equip young people with the skills necessary to solve such problems there is an opportunity to move away from the more traditional rote learning that is often associated with mathematics, towards what one examination board describes on their website as 'encouraging a teaching approach that is enriching and engaging for all students' (Assessment and Qualifications Alliance (AQA), 2011)

If a mathematics lesson is to be excellent then it needs to address the development of skills such as thinking and communication and not just the specific mathematical routines required to answer sometimes relatively closed questions. These changes are naturally of current interest to heads of mathematics and their teams in maintaining and improving A*-C pass rates at GCSE level through improving pupils' skills. They are of further special interest and focus for head teachers and school governors in Wales due to the impact that GCSE qualifications in mathematics can
have on the recently announced ‘School Banding’ system developed by the Welsh Government (Wales. School Standards Unit, 2011).

It is hoped therefore that this study will assist in improving outcomes for pupils studying mathematics by exploring and sharing excellent day to day practice in learning and teaching and considering how to embed this practice in a realistic way.

1.3 Ethical considerations

In order to effectively carry out the processes necessary to answer the research questions previously stated, it is appropriate at this point to discuss the ethical issues involved. As Mertler reminds us, when considering the planning stage of a research study,

> Consideration must be paid to how participants who are involved in a study are treated, the level of honesty and openness that participants are afforded, and the manner in which results are reported.

(2009, p.34)

This basic ‘doing the right thing’ approach (Mills, 2007) is one that must be followed in my view, and it is also important to be able to reflect on the situation from both sides: from the researcher viewpoint as well as from the point of view of the participants and potential participants. As Grieg, Taylor and MacKay neatly remind us ‘Ethics is one part of the research project that should never be learned in practice’ (2007, p.169).

Inevitably, as Miles and Huberman suggest (1994, cited in Punch, 2009), where other adults and young people are involved in research, there will be dilemmas and conflicts arising which need careful consideration. As a result, the researcher needs to negotiate trade offs in terms of what Cohen, Manion and Morrison describe as the ‘costs/benefits ratio’ of the project (2007, p.51); a level of empathy for the situation,
rather than a strict application of rules, is crucial to the smooth running of a research project such as this. I found it helpful therefore to summarise, in diagrammatic form, the five key areas that the British Educational Research Association (BERA) guidelines (2011) suggest (see Figure 1 below) and to return to this image when possible ethical issues arose in the study.

![Diagram of BERA ethical considerations]

**Figure 1: Summary diagram of BERA ethical considerations**

The starting point in practical terms was 'honesty and openness' with all parties involved. This meant talking to teachers involved and explaining in a non technical way the key elements of the five points in Figure 1. A number of separate meetings took place in October 2011 with potential participants, who were given the opportunity to ask questions and to ultimately decide whether they were willing to take part in the study. I explained that people were free to choose whether or not to participate and that the data and final report would be available on request to all involved and that neither participants nor schools would be named or identifiable.
In order to be able to manage pupil participation more easily, I asked three colleagues if they would be willing to involve their pupils in the research. As 'gatekeepers' to the young people involved (Denby et al., 2008), I suggested that they should discuss the nature of the research with their classes to gain a level of informed consent in a way appropriate to the ages of the pupils involved. As well as being open and honest in my approach, I strongly encouraged such openness and honesty from the adults that I was involved with and I encouraged them to transmit this message, in the way they saw fit, to the pupil participants.

I have certainly intended to act in an ethical way throughout the research but am certainly aware that my own effect as a researcher may influence some of the responses that I receive. I have also reminded myself that I need to act in an ethical way at all stages of the study including when analysing and interpreting the data gathered. As Blaxter, Hughes and Tight describe:

You owe a duty to yourself as the researcher, as well as to other researchers and to the subjects of and audiences for your research, to exercise responsibility in the processes of data collection, analysis and dissemination.

(2006, p.158)
Chapter Two

2.0 Literature Review

Having outlined a personal and professional rationale for this study, which focuses on the pursuit of factors necessary to deliver an excellent or outstanding maths lesson, this literature review takes a critical look at relevant documents in relation to this specific piece of research. It explores several themes through a range of sources, revealing and developing arguments in each in order to give further support to the value of the study in the professional context. With this research taking place in the south Wales area, it includes policy and guidance which is specific to this Principality, but also reflects on wider aspects of teaching and learning in mathematics across the UK and internationally.

2.1 Attitudes to mathematics

Any analysis of learning and teaching must have the learners at its heart and this review begins by exploring learners’ attitudes to the subject which may be encountered by mathematics teachers in their daily practice. This exploration is particularly relevant to the second research question which focuses on the challenges that maths teachers face in delivering excellent lessons.

Mathematics may be said to hold a unique position within the curriculum and within wider society. There are few other school subjects that have the same hierarchical nature and few that seem to produce such strong emotions in people. When discussing public images of mathematics, and whilst acknowledging that ‘much evidence of society’s antipathy towards mathematics is anecdotal’, Noyes again reminds us that ‘it is generally acceptable to be able to claim to be non-mathematical or innumerate but socially far less acceptable to claim to be illiterate’ (2007, p.13).
This view seems not to have changed in recent times as echoed in the similar quote from *The Western Mail* (2009) mentioned in the rationale. Undeniably, public perceptions of mathematics are poor.

Johnston-Wilder *et al.* (2011, p.46) cite earlier research by Hoyles in which pupils' good and bad learning experiences across all subjects in a secondary school were sought. On the positive side, one third of the 'good stories' related to learning in mathematics, but at the same time about one half of the 'bad stories' were also maths related. Perhaps more worryingly, Johnston-Wilder and Lee (2010, p.46) describe the anxiety and even panic that a 2008 cohort of primary teacher trainees reported in relation to their own use of mathematics skills, let alone their ability to teach these skills. Similarly, Thilmany (2009, p.11) reports that in a study of 885 university students, 60 per cent evidenced maths anxiety, regardless of their field of study, with female students reporting even greater concern (62%) compared to their male counterparts (47%).

A review by Black *et al.* (1996, cited in Hoyles, Morgan and Woodhouse, 1999) showed evidence that maths is perceived, even by students who have had some success in the subject, to be 'boring, hard and badly taught' (p.84). These sentiments are echoed in the Smith Report (2004) and further by authors such as Galton *et al.* (2002, cited in Noyes, 2007), Swan (2005) and Boaler (2009). Indeed Swan reminds us that many pupils taught via a traditional 'transmission' method may feel they have nothing to contribute to their mathematics lessons and simply take on the attitude – 'Just tell me what to do' (2005, p.4). The concern remains that these sorts of negative attitudes to the subject continue to be held and one must wonder if it is the quality of the teaching and learning experience that is perpetuating this view for many young people.
2.2 Government guidance in Wales and England

2.2.1 Curriculum changes in mathematics

As the third research question in this study seeks to explore the possibility of a link between length of teaching experience and the ability to teach excellent lessons, it is useful at this point to reflect on ways in which the mathematics curriculum has changed over recent decades and the ways in which this may have influenced mathematics teachers in this time.

Before the introduction of the National Curriculum (NC) for England and Wales in 1988, schools had a degree of autonomy over what content should be taught in maths in the secondary phase and how this content would be delivered. Although the National Curriculum prescribed the content to be taught, it failed to address the fundamental issue of how this might best be interpreted or delivered. Indeed Apple (1993) suggests that the actual curricula that schools deliver is as much the product of market driven textbook schemes as it is of any national curriculum.

In 1999 the National Numeracy Strategy (NNS) (England. Department for Education and Employment (DfEE), 1999) for primary schools was launched in England. It provided guidance on the classroom delivery of mathematics, with a focus on whole class teaching rather than on individualised schemes. This was followed in 2001 by the publication of the Key Stage 3 National Strategy – Framework for Teaching Mathematics: Years 7, 8 and 9 (commonly referred to in the secondary phase as 'the Framework') for secondary schools, which contained similar guidance for the teaching of mathematics in Years 7, 8 and 9 (England. DfEE, 2001); the document provides yearly teaching programmes, planning charts, examples of lesson plans as well as advice on teaching. Although not statutory documents, both have come to
dominate the maths curriculum in Key Stage 3 in both England, its intended audience, and in Wales, where by this time a new National Assembly Government had produced its own separate version of the National Curriculum (Wales. ACCAC, 2000).

Although Wales has continued to develop its own NC and associated assessment systems, with the most recent change being made in 2008 (Wales. DCELLS, 2008c), personal experience reveals that maths departments in Welsh schools continue to use the guidance of the KS3 National Strategy to inform their planning. In addition, mathematics textbook schemes published since 2001 have mirrored the content, if not the intended approach, of the Framework.

Morgan, Watson and Tikly confirm the position of this document, suggesting that the KS3 Strategy 'is often treated as a statutory document in its own right by government, schools and inspectors' (2004, p.190). They argue further that though the intentions of the KS3 National Strategy are laudable, being based on research, or drawing on the best practice in secondary schools and providing 'all teachers with the raw materials for good teaching' (2004, p.191), its presentation as almost statutory teaching practices is unhelpful and possibly misleading. Noyes (2007, p.55) agrees that 'the Framework was not mandatory but was often accepted as such' and the tone of his work often reflects the frustration that he seems to have with a top down approach to the development of effective teaching practices – reflected in the title of his work 'Rethinking School Mathematics'. Further criticism of the structure of the Framework comes from Morgan, Watson and Tikly (2004, p.191) who conclude that 'All of these items of guidance have been given to avoid what might be worse, but may restrict what could be better'.

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2.2.2 The three part lesson

A feature of the Framework (England. DfEE, 2001) that has come to dominate the teaching of mathematics in secondary schools is the section entitled 'A typical lesson' (p.28) which 'highly recommends' dividing a lesson into three parts: a beginning, a middle and an end. The guidance expands upon the three parts further, suggesting:-

- An oral and mental starter (about 5 to 10 minutes)
- The main teaching activity (about 25 to 40 minutes)
- A final plenary to round off the lesson (from 5 to 15 minutes)

(England. DfEE, 2001, p.28)

Noyes takes issue with the way that the majority of schools have adopted the 'three part lesson' as the norm; 'as if this is the only way to teach' (2007, p.56). He questions also whether learning can be conveniently broken up into three slices, each within a one hour time frame and suggests that this ubiquitous approach has received little critique from teachers themselves. Chambers also acknowledges the impact that the typical lesson guidance has had, stating that

Unfortunately, this style of structuring a lesson has become too dominant a theme in the minds of some teachers, who characterize the recommendations of the Framework as being 'the three part lesson'.

(2008, p.78)

In contrast to the often critical views of Noyes, Chambers is however a little more pragmatic in his discussion of the three part lesson, reminding us that 'This suggested structure is presented as 'typical', and should not be followed mechanistically' (Chambers, 2008, p.78). He reflects that viewing the Framework as solely 'the three part lesson' does it a disservice as it contains many useful recommendations about styles of teaching, learning and assessment. He further
prompts the reader to take ownership of the lesson structure and concludes that 'The important thing is to realize that many well structured lessons do not have three parts!' (2008, p.79).

Pepper (2011) reflects on reasons why the three part lesson is still prevalent in both the primary and secondary maths classroom some ten years after the National Framework was launched. He suggests that the inspection regime and associated pressures felt by schools and teachers to conform to, albeit non statutory, government guidance have led teachers to be less creative and spontaneous than they might otherwise have been;

Understandably the majority of teachers are likely to feel under an enormous amount of pressure at the prospect of having a lesson observed by an inspector. There is a great deal at stake both for the individual teacher and for the school. A major incentive for the teacher is to secure sufficient actual or symbolic ticks from the inspector. It also follows that universally a three-part lesson will be planned.

(Pepper, 2011, p.26)

John Hibbs, a former school inspector (HMI) himself, also expresses concern over the three part lesson in stating: 'Now I have nothing against three-part lessons, only their indiscriminate use...the notion that all lessons should be straitjacketed into three parts is bad' (2010, p.26). Hibbs shares his further concerns over the associated practice of sharing learning objectives at the start of a lesson -

Sharing with pupils your learning objectives is also not a new idea and not a bad idea — it is just that it is not always the most appropriate thing to do at the start of every lesson, and learning objectives written on the board for pupils to copy down in their exercise books without discussion or understanding may be a controlling technique, but may have nothing to do with learning.

(2010, p.27)
It is interesting to note that the available literature on the three part mathematics lesson almost exclusively focuses on concerns over its use, especially by specialist maths teachers in secondary schools, but that at the same time it remains the standard approach promoted in schools and on some initial teacher training (ITT) courses in Wales across all subject areas. For example, one ITT institution's standard lesson plan proforma contains prompts in the 'Lesson structure' section for 'Starter, Development, Plenary' (see Appendix 2) - a clear reflection of the 'three part lesson' structure. The relevant Standards for Qualified Teacher Status (QTS) in Wales (Wales. DCELLS, 2009b) require student teachers to demonstrate that they: ‘use learning objectives to plan lessons and sequences of lessons ... ’ (2009b, p.56).

and also that they ‘teach clearly structured lessons or sequences of work which interest and motivate learners, making learning objectives clear, employ interactive teaching methods and ... promote active and independent learning’ (2009b, p.90).

These QTS Standards do not however specify when lesson objectives should be clarified and there is no mention of the 'three part lesson' in this extensive guidance.

In his discussion of metacognition and autonomous learning, Dix (2010) agrees that across all subject areas ‘the three part lesson has become universally accepted as the only “correct” way to structure a lesson’ (p.30). He argues persuasively against this formulaic approach and often puts the reader into the learners' shoes, describing how the 'objectives, activities, plenary' mantra may be seen by learners who experience this ad nauseam as ‘Today I learned again, that teachers are interested in what they want to teach and not what I would like to learn” (Dix, 2010, p.31).

As Hibbs notes, it would be fascinating to know 'Where do these bits of modern mythology come from and why do they take on such a hold?' (2010, p.27). It is clear
from authors such as Noyes (2007) and Dix (2010) that they perceive a need for teachers to regain control of their teaching and their pupils’ learning:

At what point do we take our ball and stop playing a game that we do not believe in? At least, when do we start protesting that the rules are not in the students’ interests?

(Dix, 2010, p.31)

2.2.3 The National Strategies

As mentioned earlier, in 2000 the Welsh government (Wales. ACCAC, 2000) produced a new and separate National Curriculum document to that in England, where the Key Stage Three Strategy evolved into the National Secondary Strategy materials: these included a range of focused guidance on specific aspects of maths learning and teaching, including ‘The Standards Unit: Improving Learning in Mathematics’ (Swan, 2005). These and similar resources were produced between 2005 and 2011, initially in response to the Smith report (2004), and offered practical and effective ways to improve learning in mathematics. With the latest revision of the National Curriculum for Mathematics in England (Qualifications and Curriculum Authority (QCA), 2007) came the launch of the ‘renewed Framework’, its intention being to ‘promote teachers’ professional judgement in developing sequences of lessons that respond flexibly to the needs of pupils’ (England. Department for Education, 2008).

It is interesting to note that the extensive training and materials provided for maths teachers and leaders in England were not provided for schools in Wales as a result of the devolved powers of the Welsh government. Consequently, teachers in Wales have had more limited exposure to these materials as well as having their own revised National Curriculum document with which to work (Wales. DCELLS, 2008c).
2.3 Excellent mathematics learning and teaching

The first of the three research questions in this study focuses on exploring the key elements of an excellent mathematics lesson. This section of the literature review considers further some of these aspects and how they impact on learning.

2.3.1 A change of focus

In the last decade, there has been an increasing change in the way that education is perceived within schools. As West Burnham describes, ‘The emphasis has switched from “teaching”, through “teaching and learning” to the situation where learning is seen as the key activity’ (cited in Ginnis, 2002, p.vii, italics in original). At the same time, as well as the emphasis switching from teaching to learning, there has necessarily been a shift in attention from the teacher to the learner. The current focus has moved away from delivery of curriculum content and is now firmly on the learner and the development of their skills, as well as what authors such as Goleman (2005), Lewkowicz (1999) and Brearley (2001) describe as their ‘emotional intelligence’. There has been a further recognition of young people’s individual needs and a change from an education system with an emphasis on knowledge and content to one focused on holistic development and the development of transferable skills appropriate for members of twenty first century society. Muijs and Reynolds also discuss the increased emphasis in schools in recent years on teaching thinking skills and problem solving. In particular, they claim that

This has been caused in part by research that has pointed to the link between pupils' generic thinking skills and their achievement in school subjects such as mathematics, but also by changes in society, especially the move towards a society in which knowledge and information are becoming ever more complex and ever more quickly redundant.

(Muijs and Reynolds, 2005, p.119)
It is against this background that we must consider what makes an excellent or outstanding lesson. Clearly this is a subjective matter and one which again appears to be influenced by the views of school inspectors as much as by academics in the field of education. As McNicholas suggests, when discussing what makes an outstanding lesson,

> I have asked this question numerous times yet I have never been given a definitive answer. I even asked an inspector and I was told, "Well, you know it when you see it!" His response leads me to the view that there is no definitive, concrete answer. There is no one thing that a teacher can do that will make a lesson outstanding, but in aiming for the top there are a number of things that the observer is looking for...

(McNicholas, 2009)

Again, perhaps unwittingly, this author highlights the tension that Dix (2010) alludes to throughout his work: practitioners may feel themselves to be in conflict as to what they feel is best for their pupils and what external forces such as the Government and their inspection teams may be seeking.

### 2.3.2 Interactive learning and teaching in mathematics

Since the results of studies in the nineties, such as the Kassel project (Kaur and Yap, 1996) and the Mathematics Enhancement Programme: Demonstration Project (Burghes, 1999), which compared mathematics teaching styles and pupil progress in several international countries with those in the UK, there has been an increased emphasis on moving mathematics teaching away from the traditional ‘chalk and talk’ or transmission methods towards a more connectionist and challenging interactive model. Swan suggests that some key elements of such an interactive mathematics lesson would be to:
- Build on the knowledge learners bring to sessions
- Expose and discuss misconceptions through effective questioning
- Use cooperative small group work
- Emphasise methods rather than answers
- Use rich collaborative tasks
- Create connections between mathematical topics

(Swan, 2005, pp.7-10)

In attempting to exemplify effective and enjoyable methods for improving the maths experiences for learners (and teachers) there is a clear emphasis on a move from ‘passive to active learning’ (Swan, 2005, p.3).

As well as being promoted in literature focused on maths teaching, this style is encouraged by more general literature focused on the learning process, with Muijs and Reynolds (2005, p.62) asserting that ‘Learning is always an active process. Learning is about helping pupils construct their own meaning, not just about “getting the right answer” ’. Indeed it is this social constructivist view of learning that permeates the current literature on how pupils learn best in all subjects. In order for pupils to be working in what Vygotsky (1978) describes as ‘The Zone of Proximal Development' the suggestion is that teachers should 'make the lessons as active as possible and as varied as possible' (Chambers, 2008, p.104). As Hattie (2009) succinctly describes in his study of what makes the most difference in the classroom, 'when learning is visible, students are active'.

As mentioned in the first chapter of this study, with schools and teachers presently influenced by the 'skills' agenda in Wales and by the School Effectiveness Framework (Wales. DCELLS, 2008a) within which this sits, it would appear that the teacher’s role in mathematics lessons needs to continue to change in order to teach
the sort of thinking, communication and problem solving skills that are desirable in modern society. As Muijs and Reynolds describe,

This has been caused in part by research that has pointed to the link between pupils' generic thinking skills and their achievement in school subjects such as mathematics, but also by changes in society, especially the move towards a society in which knowledge and information are becoming ever more complex and ever more quickly redundant.

(2005, p.119)

This view again concurs with the evidence from the Leitch Review which focused on the impact of skills on the global economy and suggested that 'Skills is the most important lever within our control to create wealth and to reduce social deprivation'

(HM Treasury, 2006, p.2). The literature points to excellent teaching and learning being inextricably linked to the development of skills through active learning in an interactive classroom.

2.3.3 Assessment and the excellent lesson

As the Key Stage Three Strategy evolved into the National Secondary Strategy, it produced guidance on a range of whole-school development issues which were all intended to help to raise standards of achievement. Building on the earlier seminal 'Black Box' work of Black and Wiliam (1998, 2002) and the Assessment Reform Group (1999), Assessment for Learning (AfL) was an integral part of this drive and has increasingly been a focus of improvement in schools over the last decade, gathering momentum to become part of the everyday language of most teachers. Beere (2010) suggests that 'The argument put by Dylan Wiliam and Paul Black... has been won and assessment for learning policy and practice has been driving school improvement strategies because it works'. In my opinion, what Beere fails to recognise and acknowledge sufficiently are the differences between subjects and therefore the potential to employ the full array of AfL strategies within each of them.
With this research project clearly focused on excellent teaching and learning in mathematics, it is interesting to explore more generic guidance such as that from Beere (2010) and to compare it with the more specific guidance available for mathematics. It is worth noting, for example, that within the series of ‘Black Box’ publications, the ‘Mathematics Inside the Black Box’ booklet dedicates over a half of its twenty-two pages to ‘Classroom dialogue: talking in and about maths’ (Hodgen and Wiliam, 2006, pp.5-18), with only three pages in total for ‘Feedback and marking’ and ‘Self and peer assessment’ (pp.19-21). In contrast, Beere (2010) provides roughly equal coverage for these aspects which perhaps reflects the different emphases which different subjects require. Despite her work often being focused a little too much on satisfying the Ofsted inspection regime in England – hence the title ‘The Perfect Ofsted Lesson’, Beere (2010) does present some useful practical guidance which helps teachers to become more reflective on the types of activities they provide for their pupils as well as the ways in which they can engage learners in these activities. She suggests that ‘the ‘X’ factor [in an outstanding lesson] means demonstrating exceptional progress in learning in your lesson’ (2010, p.8, italics in original) and provides a further list of what she describes as some of the other essential ingredients required for an outstanding lesson:

- Demonstrating expert subject knowledge and skills.
- Demonstrating that you can communicate effectively.
- Differentiating for various groups of learners.
- Engaging and motivating students.
- Developing independent and resilient learners.
- Delivering skills and content essential for passing exams.
- Assessment as part of developing progress in learning.
- Challenging the most able learners.
- Using technology and teaching assistants to make an impact on learning.
- Effective collaborative learning and peer review.
- Effective classroom management.
- Sharing the criteria for success.  

(Beere, 2010, pp.8-9)
It is interesting to explore whether teachers and learners feel whether, and how, such an extensive list can be achieved on a daily basis within the mathematics classroom.

2.4 Summary

This review of current and recent literature has focused on research, opinion and guidance, related, in turn, to the three questions being explored in this study. It has shown how societal attitudes to mathematics remain a concern, as well as providing some background on how both the mathematics curriculum and the nature of mathematics teaching and learning have changed and developed over the last decade and how the two are inextricably linked. The movement to a more interactive teaching style with a focus on young people being actively engaged in their learning to develop vital communication, thinking and problem solving skills has been explored, as have some of the differences between policy and support in England and in Wales, the focus area of the study. In addition, the review has revealed some of the disquiet felt over the perceived imposition of methodology in a ‘top down’ system regarding lesson structure, as well as illustrating how the inspection regime has a major influence on schools’ approaches to learning and teaching. Finally, reflecting the suggested unique nature of mathematics, it explores how there may need to be different emphases for the use of assessment strategies within mathematics compared to other subjects in order to meet some of the seemingly endless list of requirements to produce outstanding lessons.
Chapter Three

3.0 Methodology

A review of the research literature describing the many different types of research styles and paradigms could itself run to several thousand words at this point. Cohen, Manion and Morrison, for example, devote over one hundred and fifty pages to what they describe as 'styles of educational research' (2011, p.217) including naturalistic and ethnographic; historical and documentary; surveys and trend studies; case studies; ex post facto research; meta-analysis; action research and the latest virtual world simulations. Each of these styles align themselves with the overarching paradigms of quantitative or qualitative analysis or to the more recently accepted mixed methods approach which Johnson and Onwuegbuzie describe as 'a research paradigm whose time has come' (2004, cited in Cohen, Manion and Morrison, 2011, p.21). This section does not delve in great depth into the philosophical issues, terminology and standpoints regarding the research process, but attempts to present and justify the selection of a methodological approach which best fits this piece of research.

In attempting to justify a mixed methods approach as a definable paradigm for educational research, Newby (2010) suggests that its distinguishing feature is its 'pragmatism'. He usefully describes how, in this context, a pragmatic approach is about solving problems (in this case our research questions) and that 'if we are pragmatic, combine approaches and use “Does it work?” as a test of its adequacy, then we can combine methods to construct arguments that are compelling' (Newby, 2010, p.46). It is this practical and common sense nature of a mixed methods approach that best describes and fits the intention and practice of this piece of research. It is hoped that more can be learnt about this research topic by combining
the strengths of both qualitative and quantitative methods while compensating at the same time for the weaknesses in each method (Punch, 2009; Kumar, 2005). As Johnson and Onwuegbuzie describe, mixed methods research can: 'Combine the methods in a way that achieves complementary strengths and non-overlapping weaknesses' (Johnson and Onwuegbuzie, 2004, p.18).

In attempting to describe the specific methodology employed in this research under the mixed methods paradigm, it is useful to consider Table 1 below which has been adapted from that presented by Newby (2010, p.65)

**Table 1: How the methodologies compare**

<table>
<thead>
<tr>
<th>Distinctiveness</th>
<th>Ethnography</th>
<th>Case Study (Chosen methodology)</th>
<th>Evaluation</th>
<th>Action Research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purpose</td>
<td>Researcher focus</td>
<td>Learn from the particular</td>
<td>Question focus</td>
<td>Change focus.</td>
</tr>
<tr>
<td>Purpose</td>
<td>Understand, explain.</td>
<td>Explain, explore, describe.</td>
<td>Understand, test compliance, improve, inform. Outside the process but may be internal to project.</td>
<td>Change, improve, build, develop.</td>
</tr>
<tr>
<td>Researcher status</td>
<td>Hidden or visible participant.</td>
<td>External analyst.</td>
<td>Outside the process but may be internal to project.</td>
<td>Inside the process and the project.</td>
</tr>
</tbody>
</table>

Reflecting on this table, the intention of this research is certainly to explore, describe and hopefully explain the features of an excellent maths lesson in particular cases. This combines further with my position as an external analyst and with the intended
methods of data collection (to be described shortly) to suggest that it would be appropriate to describe this research as a mixed methods case study.

As Punch (2009, p.119) describes, ‘the case study aims to understand the case in depth, and in its natural setting, recognizing its complexity and its context’. Being an experienced practitioner myself adds further support for the use of a case study, with Anderson describing how researchers employing this methodology are often able to use their own knowledge as a starting point with ‘the researcher employing qualitative and/ or quantitative methods and measures as fit the circumstances’ (1998, cited in Burton and Bartlett, 2005, p.86).

As mentioned, in this study I am acting as an ‘outside analyst’ in seeking opinion on the key features of excellent mathematics lessons and am having no direct involvement or intervention in the study. In this way, the case study approach selected contrasts with that of an action research approach. Denby et al. point out when discussing research specifically into education, ‘action research focuses on improving teaching and learning through developing interventions’ (2008, p.67). Although ultimately this case study may lead on to a piece of action research focused on the implementation of effective teaching strategies with future student teacher cohorts, it should be viewed as a case study in its current form.

3.1 Research Methods

From a study of the literature on the research process it is not difficult to see why there remains some confusion for novice researchers between the terms methodology and methods. As Newby (2010) points out, some authors appear flexible (or perhaps careless) in their use of the terms and use the two almost
interchangeably. He provides a useful reminder that 'Research methodology is concerned with the assembly of research tools and the application of appropriate research rules. Research methods are the research tools themselves' (Newby, 2010, p. 51, italics in original). Having outlined the overall methodology in the previous paragraphs, the remainder of this section therefore focuses on the specific tools used in this study and how they were employed in practice.

3.1.1 Sampling

As outlined in the first chapter, this research sought opinion and evidence from a variety of stakeholder groups including pupils as well as newly qualified and more experienced mathematics teachers working in the south Wales area. This variety of participants was chosen in order to 'generate theory through the gradual accumulation of data from different sources' (Cohen, Manion and Morrison, 2011, p.156).

Miles and Huberman point out that: 'You cannot study everyone everywhere doing everything' (1994, p.27) and so there is inevitably a need to select a sample for any piece of research. Cohen, Manion and Morrison (2011) remind us that the larger the sample size is, the better in terms of the potential reliability of the results obtained especially in terms of quantitative data analysis. They suggest further that when selecting a sample from the overall population, some of the key elements to consider are the sample size, the representativeness of the sample and access to the sample (Cohen, Manion and Morrison, 2011, p.143). As this research was necessarily subject to constraints of time and practicality, the sort of probability sampling usually associated with representativeness was rejected in favour of what is often described
as deliberate or purposive sampling (Blaxter, Hughes and Tight, 2006; Punch, 2009; Cohen, Manion and Morrison, 2011).

In an attempt to achieve a representative group of secondary school mathematics teachers, participants were selected on the basis of a judgement as to their typicality in being able to deliver effective lessons; what Teddlie and Tashakkori (2009, p.174) might describe as 'intensity purposive sampling', where the sample provides clear examples of the issue in question. This choice was therefore informed by feedback received over a period of approximately eighteen months from student teachers, newly qualified teachers as well as more experienced maths teachers and mentors. In addition, previous personal observations of several participants enabled the selection of what was hoped would be an effective purposive sample consisting of teachers with a variety of styles, outlooks and experience. Another consideration was the ease of access to participants in their school setting and consequently all teacher (and pupil) participants were from secondary schools in the south east Wales area.

The final group of teacher participants selected consisted of three newly qualified maths teachers, alongside four maths teachers with current experience ranging from their third to fifteenth year in teaching. In order to follow ethical guidelines and so that identities were not revealed it was decided to describe these participants and the schools in which they worked as detailed in Table 2 below, throughout the remainder of the report. It is useful to note that NQT 1 and Teacher D were from the same school (School P).
Table 2: Details of mathematics teacher participants (n=7)

<table>
<thead>
<tr>
<th>Teacher description</th>
<th>Gender</th>
<th>Current year of teaching experience</th>
<th>School type</th>
<th>School 'name'</th>
</tr>
</thead>
<tbody>
<tr>
<td>NQT 1</td>
<td>Female</td>
<td>1</td>
<td>11 to 18 years mixed comprehensive</td>
<td>P</td>
</tr>
<tr>
<td>NQT 2</td>
<td>Female</td>
<td>1</td>
<td>11 to 18 years mixed comprehensive</td>
<td>Q</td>
</tr>
<tr>
<td>NQT 3</td>
<td>Male</td>
<td>1</td>
<td>11 to 16 years mixed comprehensive</td>
<td>R</td>
</tr>
<tr>
<td>Teacher A</td>
<td>Female</td>
<td>3</td>
<td>5 to 18 years mixed private</td>
<td>S</td>
</tr>
<tr>
<td>Teacher B</td>
<td>Male</td>
<td>5</td>
<td>11 to 18 years mixed comprehensive</td>
<td>T</td>
</tr>
<tr>
<td>Teacher C</td>
<td>Male</td>
<td>8</td>
<td>11 to 16 years mixed comprehensive</td>
<td>U</td>
</tr>
<tr>
<td>Teacher D</td>
<td>Female</td>
<td>15</td>
<td>11 to 18 years mixed comprehensive</td>
<td>P</td>
</tr>
</tbody>
</table>

Although the original intention was to include current student teachers in the sample used, it was decided that this may potentially introduce too great an element of bias into the study, which was best avoided. It was felt that my role as their tutor would unduly influence their responses as well as strongly colouring their views as to the nature of excellent mathematics lessons. As Punch (2009) reminds us, with any practitioner research it is crucial that the researcher takes into account the risks of subjectivity and bias both in the selection of the sample and in the interpretation of results.

The sample of participants was developed by asking three of the teacher participants (NQT 1, Teacher B and Teacher C) to each select a class of pupils from Key Stage 3 or Key Stage 4 (ages 11 to 16) with whom to conduct the questionnaire outlined in the following section. In addition, NQT 1 was asked to select a group of five pupils from her year 10 class who would act as a focus group to be interviewed.
by myself. Although this snowball sampling of the pupil participants (Cohen, Manion and Morrison, 2011, p.157) is again potentially subject to bias, having reflected critically upon the nature and character of the participants, it was hoped that their views would form a representative sample of those of the wider population. In order to meet ethical guidelines, the pupils were given pseudonyms as detailed in table 3 below.

**Table 3: Details of interview focus group pupils (n=5)**

<table>
<thead>
<tr>
<th>Pupil pseudonym</th>
<th>Pupil age</th>
<th>Gender</th>
<th>School</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andrew</td>
<td>14</td>
<td>Male</td>
<td></td>
</tr>
<tr>
<td>Bethan</td>
<td>15</td>
<td>Female</td>
<td></td>
</tr>
<tr>
<td>Carys</td>
<td>14</td>
<td>Female</td>
<td></td>
</tr>
<tr>
<td>David</td>
<td>15</td>
<td>Male</td>
<td></td>
</tr>
<tr>
<td>Emma</td>
<td>15</td>
<td>Female</td>
<td></td>
</tr>
</tbody>
</table>

All pupils interviewed were from the same Year 10 maths class. This was a set 3 out of 6 sets in School P, an 11 to 18 years mixed comprehensive.

Finally, as Bell reminds us, it is worth remembering that:

> All researchers are dependent on the goodwill and availability of respondents, and it will probably be difficult for an individual researcher working on a small-scale project to achieve a true random sample.

(Bell, 2005, p.145)

I was fortunate that teacher participants involved took such a positive interest in this study and hope that its findings will be of some value in informing future practice.

### 3.1.2 Data collection methods

In order to gather the data necessary to answer the three stated research questions, a number of research tools were selected. As Denby *et al.* suggest, 'Case studies
can draw upon a range of research methods' (2008, p.68) and the ones chosen in this case were pupil questionnaires, teacher questionnaires (see Appendices 3 and 4) as well as semi-structured interviews with teacher participants and the pupil focus group (see Appendices 5 and 6). Table 4 below indicates which research tools were used to gather evidence for each of the research questions.

Table 4: Tools employed to gather data on each research question

<table>
<thead>
<tr>
<th>Research question</th>
<th>Research tools used</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Research Question 1</strong></td>
<td>Pupil questionnaires</td>
</tr>
<tr>
<td>What are the key elements of an excellent maths lesson?</td>
<td>Teacher questionnaires</td>
</tr>
<tr>
<td></td>
<td>Semi-structured interviews - teachers</td>
</tr>
<tr>
<td></td>
<td>Focus group interviews - pupils</td>
</tr>
<tr>
<td><strong>Research Question 2</strong></td>
<td>Pupil questionnaires</td>
</tr>
<tr>
<td>What are the challenges that maths teachers face in order to deliver excellent lessons on a consistent basis?</td>
<td>Teacher questionnaires</td>
</tr>
<tr>
<td></td>
<td>Semi-structured interviews - teachers</td>
</tr>
<tr>
<td></td>
<td>Focus group interviews - pupils</td>
</tr>
<tr>
<td><strong>Research Question 3</strong></td>
<td>Teacher questionnaires</td>
</tr>
<tr>
<td>To what extent is there a link between teaching experience and the ability to deliver excellent maths lessons?</td>
<td>Semi-structured interviews - teachers</td>
</tr>
</tbody>
</table>

3.1.2a Questionnaires

As pointed out by Hopkins (2008, p.118), questionnaires 'are a quick and simple way of obtaining broad and rich information'. Grieg, Taylor and Mackay caution us, however, that 'Questionnaires are among the most common method used by
researchers – and the worst carried out' (2007, p.124). It was important therefore to consider both the design and layout of the questionnaires as well as the language used within them to frame the questions (Burton and Bartlett, 2005). In this way the intention was that the data responses gathered were relevant and useful to inform the study. As Cohen, Manion and Morrison state, piloting or pre-testing research tools or instruments is 'of paramount importance' (2011, p.402) with the function of such a pilot being to 'increase the reliability, validity and practicability of the questionnaire' (2011, p.402). Piloting was regarded therefore in this study as 'a formative step in creating the instrument as well as a first test of the instrument. Its aim was to evaluate whether a usable, reliable, and valid instrument had been constructed' (Taconis et al., 2010, p.383). Initial questionnaires for teachers were piloted with a critical friend who has taught mathematics in secondary schools for eleven years. This colleague was also willing to pilot the pupil questionnaire with a group of thirteen and fourteen year old pupils (Year 9) at his school, which was able to provide useful feedback on several important aspects including clarity, readability, question type and format (Cohen, Manion and Morrison, 2011, p.402). The final teacher and pupil questionnaires employed contained questions requiring a variety of response types, as described by Bell (2005), including Likert scales, ranking lists and open ended questions (see Appendices 3 and 4).

3.1.2b Interviews

The second major data collection method used was a series of semi-structured interviews with three teacher participants and a group interview with the year 10 pupil focus group. The intention of these interviews was to explore some of the
themes presented in the questionnaires in greater detail. As Punch states when describing the interview:

It is a very good way of accessing people’s perceptions, meanings, definitions of situations and constructions of reality. It is also one of the most powerful ways we have of understanding others.

(Punch, 2009, p.144)

However, to ensure that this understanding was gained effectively, it was important to be aware of my own role and potential impact as the interviewer. Therefore, as well as planning the schedule of interviews, it was important to reflect on the interview as a social interaction and to reconsider ethical issues, as well as the possible influence that my own views might unintentionally bring to the process.

Cohen, Manion and Morrison agree that ‘It is crucial to keep uppermost in one’s mind the fact that the interview is a social, interpersonal encounter, not merely a data collection exercise’ (2011, p.421). As Holland and Ramazanoglu describe (1994, cited in Blaxter, Hughes and Tight, 2006, p.172), the semi-structured interview is ‘a social event with its own set of interactional rules which may be more or less explicit’.

It was vital therefore before carrying out the interviews to remind myself of the ethical implications that this data collection method inevitably gives rise to and to ‘exercise responsibility’ (Blaxter, Hughes and Tight, 2006, p.174). To this end, I revisited my own summary diagram of the BERA (2011) ethical considerations (presented in section 1.3 of this study) and in particular ensured that I reminded myself of the ‘researcher effects’ as well as the ‘honesty and openness’ aspects before conducting the interviews. Before each interview began therefore, participants were again reminded of the purpose and nature of the process and how the data gathered were likely to be analysed and presented. In addition, the participants were offered again the opportunity to withdraw from this aspect of the study if they preferred.
Each teacher interview, and the focus group meeting, took place at the relevant school and at a time which was convenient to participants. Although this did cause some logistical challenges for me, it was felt that this consideration further strengthened the researcher-interviewee relationship by acknowledging the additional workload that this process meant for the participants (Kumar, 2005; Bell, 2005). Interviews were planned to take no more than thirty minutes and to be recorded if the consent of the participants was received. It was decided not to make notes during the interviews as this might be distracting for both parties as well as potentially influencing the way that respondents answer: as Blaxter, Hughes and Tight suggest,

Putting pen to paper may lead interviewees to think that they have said something significant. Conversely, when you don't make a note, they may think that you find their comments unimportant.

(Blaxter, Hughes and Tight, 2006, p.176).

The recordings made were replayed and analysed soon after each interview had taken place, with key elements being transcribed.

Although, as Newby points out (2010, p.338), 'All interviews are not the same', even with a semi-structured interview it was important to have an outline structure to keep an element of commonality throughout (see Appendices 5 and 6). In addition to this outline, a series of specific prompts and probes was initially considered to be used, but ultimately rejected. As Fowler (2009) cautions, the more the interviewer prompts and probes, the greater is the likelihood of bias entering the interview.
3.1.3 Triangulation, Validity and Reliability

The three different research tools described were used for two purposes; firstly to gather data in order to attempt to answer the research questions and secondly in order to triangulate the qualitative and quantitative data gathered. Bell (2005, p.116) describes triangulation as a multi-method approach of data collection used in an effort to cross-check findings. She cites Laws' view that:

The key to triangulation is to see the same thing from different perspectives and thus to be able to confirm or challenge the findings of one method with those of another.


Perhaps surprisingly, Bell fails to make explicit the link that many other authors make between the use of triangulation and the validity of the data gathered (Cousins, 2009; Newby, 2010; Hopkins, 2008; Flick, 2007). Cohen, Manion and Morrison (2001, p.195) for example state that 'Triangulation is a powerful way of demonstrating concurrent validity', with Koshy simply describing that: 'Triangulation is recommended as a way of establishing the validity of findings' (2005, p.143).

As Bell (2005) discusses, validity is a complex concept to which many authors apply simple definitions, such as that presented by Smith (1991, cited in Kumar, 2005, p.153): 'Validity is defined as the degree to which the researcher has measured what he has set out to measure'. Clearly it is important to consider whether each instrument used has validity by establishing a logical link between the questions and the objectives of the study (something which has been improved at the piloting stage). However, this definition is over simplistic and leaves many questions unanswered. Winter suggests that 'validity might be addressed through the honesty, depth, richness and scope of the data achieved...the extent of triangulation...and the
objectivity of the researcher’ (Winter, 2000, cited in Cohen, Manion and Morrison, 2011). It may be more useful therefore in the context of this largely qualitative study to use the definition of Sapsford and Jupp who take “validity” to mean

...the design of research to provide credible conclusions; whether the evidence which the research offers can bear the weight of the interpretation that is put on it


In this way, the validity of a research tool is characterised by the conclusions that can be drawn from the data it gathers rather than in its own face validity. Blaxter, Hughes and Tight agree with many authors that:

The concept of reliability has to do with how well you have carried out your research project. Have you carried it out in such a way that, if another researcher were to look into the same questions in the same setting, they would come up with essentially the same results?

(Blaxter, Hughes and Tight, 2006, p.221)

In this research study, the two questionnaires and the semi-structured interview questions could be reproduced for use as research methods by other researchers on different occasions. However, to be reliable they would need to be used with the same target population of participants and it is interesting to reflect whether it would be possible that the results would be ‘essentially the same’. As Denby et al. point out, educational research depends heavily on the rapport that the researcher has with participants, and therefore the common definition of reliability - ‘that another researcher can take your research tool and obtain the same data’ is undermined (Denby et al., 2008, p.82). In terms of this research, reliability and validity have been carefully considered, and it is perhaps this care and consideration that are most important in such small scale projects.
Chapter Four

4.0 Evaluation of methodology

This section of the research study presents a reflection on a variety of aspects relating to the final implementation of the methodology. It compares this actual implementation with the planned methodology, highlighting differences encountered and explaining how these arose and what their potential impact might have been. This section also attempts to evaluate the overall appropriateness of the methods employed in this mixed methods case study, as well as considering how the research itself may have been carried out even more effectively. As Creswell and Plano Clark tell us: 'Another component of all good research is a report on the validity of the data and results' (2007, p.133), with Flick (2007) also reminding us of the importance of reflecting on the validity and reliability of the data and the need to take care to 'reflect the boundaries of data and the sample of people they are based upon' (Flick, 2007, p.102). In this section, therefore, the themes of validity, reliability and 'generalizability' (Cohen, Manion and Morrison, 2011, p.294) will also be considered.

4.1 Evaluation of research methods

As detailed in greater depth in the previous chapter, the main research tools used to gather the data were pupil questionnaires, teacher questionnaires and semi-structured interviews with the teacher participants and pupil focus group. The following sub-sections discuss each of these in turn:
4.1.1 Pupil and teacher questionnaires

A total of eighty six pupil questionnaires were completed by three different classes at schools P, T and U under the supervision of three of the participant mathematics teachers as outlined in the table below:

Table 5: An overview of pupil participants (n=86)

<table>
<thead>
<tr>
<th>School ‘name’</th>
<th>Teacher description</th>
<th>Current year of teaching experience</th>
<th>Details of selected class</th>
<th>Pupil ages</th>
<th>Number of completed pupil questionnaires</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>NQT 1</td>
<td>1</td>
<td>Year 10 set 3 of 6</td>
<td>14 - 15 years</td>
<td>25</td>
</tr>
<tr>
<td>T</td>
<td>Teacher B</td>
<td>5</td>
<td>Year 8 set 1 of 4</td>
<td>12 - 13 years</td>
<td>30</td>
</tr>
<tr>
<td>U</td>
<td>Teacher C</td>
<td>8</td>
<td>Year 9 set 1 of 2</td>
<td>13 - 14 years</td>
<td>31</td>
</tr>
</tbody>
</table>

None of the teachers who administered the tests reported any queries or clarification sought by the pupils when completing the questionnaire, although NQT 1 did suggest that the questionnaire took a “variety of times” for the twenty five pupils in her set three maths class to complete. Overall, it was pleasing that the time spent piloting the pupil questionnaire with pupils of a similar age helped it to be carried out successfully. The lack of any confusion from the pupil participants suggests that the wording of questions was appropriate, thus adding to the reliability of the data obtained (Kumar, 2005, p.157).

An interesting point was raised by Teacher C, who asked about aspects of the consistency of conducting the questionnaire with pupils from different schools.
Although the three teachers who administered the questionnaire were given verbal instructions regarding how it might be run and how consent was to be obtained from the pupils, he felt that colleagues from other schools may have ultimately conducted the questionnaire differently. This was a useful point for consideration and on reflection it may have been useful to meet together with all of the teacher participants at the same time at the start of the study. Such a meeting was considered but the practicalities of gathering the group together in a single meeting meant that the idea was rejected in favour of individual meetings to discuss and shape the study (Hopkins, 2008).

Seven questionnaires were completed by the teacher participants, who came from six different secondary schools in the south Wales area. In order to create more flexibility for completion in the busy schedules of colleagues, the questionnaires were sent and returned via email with a suggested return date, as Bell recommends (2005, p.149). Two of the participants missed the initial deadline due to other commitments, but soon completed it following a polite reminder email to prompt them. These questionnaires provided valuable information including some open ended responses which were triangulated in the semi-structured interviews which took place at a later date. Again, no concerns were raised over the layout or content of the teacher questionnaire which had also been piloted prior to its use with an experienced maths teacher. This again proved to be time well spent and strengthened the reliability and validity of the data obtained.

An attempt was made to analyse responses to open-ended questions on both pupil and teacher questionnaires by grouping together those responses that were similar in nature.
### 4.1.2 Semi structured interviews

The main purpose of the semi-structured interviews was to gather further rich data from participants based upon their responses to the themes explored in the questionnaire. As Newby describes,

> Interviewers have the freedom to clarify people’s understanding and to ask follow-up questions to explore a viewpoint, to determine knowledge or to open up answers to questions that were not foreseen when the research questions were determined.

*(Newby, 2010, p.340)*

It was also intended that the interviews would triangulate the data gathered and therefore improve the reliability of the data, as well as improving the validity and generalizability of any conclusions that were reached from its analysis.

In conducting the actual interviews, it was important to reconsider ethical as well as practical issues so that the process was not regarded as onerous by the teachers involved. As previously described, interviews were arranged to be as convenient as possible for the participants, with teacher participants deciding that an interview at the end of the school day would be most convenient and the pupil focus group interview taking place during a lunchtime break. In order to maintain confidentiality and to complete interviews without interruption, venues were selected within each school which afforded the necessary privacy. Before each interview began, as planned, participants were again reminded of the purpose of the study and of the research questions as well as being given the opportunity to withdraw from this part of the study if they so wished. They were assured that they would remain anonymous in the final report and that all discussions would remain confidential in line with the BERA guidelines (2011). All participants were happy to give their
consent for the interview to be digitally recorded and all interviews were successfully completed.

Each of the three teacher interviews was conducted in a very positive atmosphere with much useful discussion, and the rapport established meant that teachers were open and honest in their comments, which helped to further improve the reliability and validity of responses. The intention outlined in the original methodology was that the interviews should last no longer than half an hour. In reality, interviews lasted approximately forty five minutes and it may be wise in future studies to have a slightly more structured approach using more specific prompts during the interview so as not to impinge overly on participants' time. After all, rather like teaching, research is something that should be done with participants rather than being something done to them.

The year ten pupils in the focus group interview were very mature and quite thoughtful in their responses and they appeared to enjoy having their voice heard. Recordings of interviews were not transcribed fully due to time limitations. Instead, key features discussed were identified, with some of these being presented in the following chapter. This selective choice may be criticised as leading to potential unreliability due to possible researcher bias, but, as Cohen, Manion and Morrison discuss, 'transcripts of interviews, however detailed and full they might be, remain selective, since they are interpretations of social situations' (2011, p.208). To maintain an ethical and unbiased approach it was useful to reflect upon the views of Hammersley (1992, cited in Cohen, Manion and Morrison, 2011, p.181), who suggests that as reality is independent of the claims made for it by researchers, our accounts will only be representations of that reality rather than reproductions of it.
4.2 Data analysis and coding

As both pupil and teacher questionnaires contained similar questions which participants responded to by either ranking their choices or by indicating their preferences using Likert scales, it was possible to code these qualitative responses to produce quantitative data. It was considered that this would be useful in comparing and contrasting the data obtained from the separate pupil and teacher cohorts as well as potentially enabling more effective graphical representations to be created. The coding system used was based on a simple ordinal scale so that the order of the responses was retained in the coding (Blaxter, Hughes and Tight, 2006, p.217). Although the two separate sets of pupil and teacher participants were of considerably different sizes (Pupils n=86 and Teachers n=7), the coding system used (see appendix 7) allowed for the calculation of an average to aid the comparison of the two data sets (Flick, 2007, p.104).
Chapter Five

5.0 Results and analysis

The methodology previously described was carried out in order to explore the original research title which focused on a comparison between the theory and reality of excellent lessons in the secondary mathematics classroom. Having explored the ‘theory’ in the literature review section, this chapter focuses on the ‘reality’ as perceived by the selected sample of participants. This part of the research study therefore presents an analysis of the results obtained from the questionnaires, as well as the pupil and teacher interviews, which inform each of the research questions in turn. It interprets and evaluates this analysis and attempts to synthesise and link these interpretations with some of the associated literature discussed in chapter two of this dissertation.

5.0.1 Sources of evidence

The pupil and teacher questionnaires used (see appendices 3 and 4) were designed to gather opinion on equivalent aspects (parts A, B and C), although the pupil questionnaire was worded differently to better match its intended audience (Hopkins, 2008). The teacher questionnaire also contained an additional part (D) which asked about potential links between teacher experience and ability to deliver excellent maths lessons, as well as a section (E) where teacher participants could add any further comments if they wished. This allowed those teachers who were not involved in interviews to have a further input by giving more extended opinion.
5.1 Research Question 1

What are the key elements of an excellent maths lesson?

The evidence used to help answer this research question came from parts A and B from both questionnaires as well as from the pupil focus group and individual teacher interviews.

Part A of the questionnaire gave eight statements relating to what pupils and teachers do in an excellent maths lessons. The responses were completed on Likert scales and coded using the system described in appendix 7. This system meant that a mean average response could be calculated for the data, with a higher mean value indicating a greater level of agreement with the statement.

The table below shows the mean values for pupil and teacher participant responses to part A of the questionnaire.

Table 6: Mean average values for responses to questionnaire part A

<table>
<thead>
<tr>
<th>Statement</th>
<th>In an excellent maths lesson......</th>
<th>Pupil mean value</th>
<th>Teacher mean value</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>...pupils interact with each other in pairs or groups.</td>
<td>4.0</td>
<td>4.1</td>
</tr>
<tr>
<td>A2</td>
<td>...pupils complete plenty of questions in their book.</td>
<td>3.1</td>
<td>3.0</td>
</tr>
<tr>
<td>A3</td>
<td>...pupils assess their own and each other’s work.</td>
<td>2.7</td>
<td>3.6</td>
</tr>
<tr>
<td>A4</td>
<td>...the teacher uses ICT to help explain.</td>
<td>3.4</td>
<td>3.0</td>
</tr>
<tr>
<td>A5</td>
<td>...the teacher exposes and discusses misconceptions.</td>
<td>4.0</td>
<td>4.3</td>
</tr>
<tr>
<td>A6</td>
<td>...pupils work quietly on the tasks set.</td>
<td>2.7</td>
<td>2.4</td>
</tr>
<tr>
<td>A7</td>
<td>...the teacher provides a variety of activities</td>
<td>4.2</td>
<td>4.1</td>
</tr>
<tr>
<td>A8</td>
<td>...the teacher shares learning objectives at the lesson start</td>
<td>2.9</td>
<td>3.7</td>
</tr>
</tbody>
</table>
For both sets of participants the three statements that had the highest mean values were A1, A5 and A7, each with a mean coded value of 4.0 or more, indicating agreement to strong agreement with the statement.

Statement A1 related to pupils interacting in pairs or groups within lessons and support for this aspect was also provided by some of the participants who were interviewed. Teacher B stated that:

Over the past two years or so, I have tried to get them [the pupils] to talk to each other about things a bit more in the lesson. I think it gets them to remember the work better if they can get a chance to talk about it

(Teacher B, School T)

Teacher C also voiced support for greater pupil-pupil interaction, focusing on the experiences that he had noticed pupils having in other subject areas.

I love getting the kids to talk in pairs. I did a pupil trial about two years ago I think, and it really sort of opened my eyes as to what they were doing in other subjects. There was lots of talk going on in lots of the lessons I saw and the kids seemed to be more involved and enjoying it. Maths lessons and science to be honest looked different. The kids were often doing more listening, which I know they need, but they seemed more sort of passive

(Teacher C, School U).

These teacher viewpoints support the ideas presented by Swan (2005) who regards the movement from a traditional ‘transmission’ view of maths teaching to a more ‘challenging’ view as crucial to improved learning. This ‘challenging’ view describes how learners ‘arrive at understanding through discussion’ (Swan, 2005, p.5).

As Kerry is keen to remind us, ‘Students have not learned until they have articulated for themselves the material’ (Kerry, 2002, p.50) and the pupil group interview revealed some strong support for this kind of paired and group discussion work. Emma pointed out:
Yeah, I think it's good that we get a chance to talk to our partner or to work in groups and stuff. I like it 'cos it gives you a chance to like think about it and you don't worry so much whether you are wrong. It gives me more confidence and you know it better. (Emma, School P)

However some concerns were also expressed by another of the Year 10 pupils who felt that the effectiveness of pupil-pupil interaction depended on relationships.

Miss [NQT 1] always asks us to 'talk to your partner or group', which is OK sometimes but doesn't work if you are sat by people you don't like when she does a new seating plan or puts you in groups. You might not get on with them that well so it's harder. (Andrew, School P)

Mercer and Sams reveal similar concerns over group work with pupils in primary schools, suggesting that they 'lack the necessary skills to manage their joint activity' (2006, p.507). One would hope that with the Skills Framework (Wales. DCELLS, 2008b) gathering momentum in recent years, learners will be better equipped with the social as well as practical skills needed to work effectively with a partner or in a group, although perhaps this might also be dependent on the pedagogical skills of teachers delivering maths in all phases.

The second statement to receive some of the strongest agreement from the questionnaire evidence was statement A5 which related to the teacher exposing and discussing misconceptions. The teacher questionnaire responses gave this strong support, and interviews revealed why this might be.

When I was taught maths, I remember being in top set and we usually were shown how to do something and then we did loads of practice to consolidate the method. If you got something wrong it was tough – the teacher just carried on. I think it's vital that we take time to look at where we might go wrong and to tell them [the pupils] that it is sometimes good to be wrong because it helps you learn more effectively. (Teacher B, School U)
It is encouraging to note that Teacher B had reflected on his own experience in school and was keen not to become the teacher who had taught him, as Noyes (2007) implies might be the case for some new teachers.

Pupils also liked the idea of talking about possible misconceptions as a class, agreeing in the group interview that they liked to see what sort of errors other people might make and that by working in this way, ‘It shows that the teacher has thought about us and wants us to understand’ (Carys). These comments imply perhaps that the ‘procedural’ teacher does not have as much empathy for the learners as one who is keen to take time to reveal, discuss and even make mistakes in lessons. The views of the pupils interviewed very much mirror those of pupils in a recent Australian study carried out by Murray into what makes a good maths teacher. It revealed that pupils felt ‘Social and emotional factors in teaching were also important’ (Murray, 2011, p.19) and that ‘they don’t go on when half the class has it and half the class don’t’ (p.18). It was clear that the pupils valued the social and emotional aspects of learning that were being developed through these interactions and that they appreciated their teacher being ‘emotionally intelligent’ (Goleman, 2005).

The statement that received the strongest support from both pupil and teacher questionnaires was the one focused on the variety of activities that the teacher provided (A7):

My best lessons are ones where the children have a variety of tasks to complete in the lesson, like card sorts, using mini white boards and getting them to work on a challenge together. I want to give them a bit more responsibility and get them to work a bit harder.

(Teacher B, School T).
I like it when we do lots of stuff in the lesson. It makes the time go quicker and it's fun to do the games and things.

(Bethan, School P).

Whilst this variety was popular, the pupil interview revealed that such lessons were not the norm:

Yeah, I wish we had more lessons like that though with the cards and that. It's much more fun when we do some different stuff but I suppose we have to do the other stuff as well.

(David, School P)

For both groups, the statement that received least support related to pupils working quietly on the tasks set (A6), with the focus group of pupils agreeing that it was 'more boring' than working with a partner or group. Teacher C, warned however that

Individual work must have a place in lessons. The pupils need to be able to access the questions in terms of their reading skills as they will be on their own in the exams.

(Teacher C, School U)

Whilst the interactive teaching style promoted by many authors (Swan, 2005; Muijs and Reynolds, 2005; Chambers, 2008) appears to address the needs of pupil engagement and enjoyment, this comment from teacher C reminds us that perhaps there needs to be a focus on how the skills developed in paired or group work can be effectively transferred by pupils to individual work.

For six of the eight statements in section A, pupil and teacher questionnaires gave approximately equivalent mean response values, indicating similar overall opinions. However there was some potential disagreement with two aspects – pupil self or peer assessment and the sharing of learning objectives; in both cases, teachers showed more agreement than pupils. Teacher interviews revealed that support for these aspects appeared to be based upon the influence of wider school policy which
required these aspects to be addressed as part of the generic school lesson plan. However, pupils were less supportive:

I don’t really see the point of just writing the LOs [learning objectives] every lesson. It’s just like doing a heading.

(Andrew, School P)

I prefer to mark my work myself when we go through it. If someone else marks it, they might mess it up or not know what they are doing.

(Carys, School P).

This study suggests that teachers might be inclined to ‘tick the boxes’ that are required by the school or by inspection regimes as Pepper notes:

It is not surprising that teachers will universally write objectives on the whiteboard. An expectation of identifying the objectives of the lesson is enshrined in the Ofsted Handbook. By the inclusion of written objectives the teacher can be satisfied that the required ‘evidence’ has been produced.

(2011, p.26, italics in original)

As suggested earlier in discussing Beere’s guidance on ‘The Perfect Ofsted Lesson’ (2010), it would appear that in this study there remains a gap between teachers’ and pupils’ understanding of the usefulness of certain assessment for learning strategies in the maths classroom.

Evidence gathered from part B of the pupil and teacher questionnaires provided further support for active learning and pupil engagement through a variety of activities within lessons. This part of the questionnaires invited participants to choose and rank four aspects that might be present an excellent maths lesson. The coded ranked responses (see appendix 7) are shown in figure 2 below:
Pupils and teachers ranked aspects such as participation and engagement relatively highly, with pupils again highlighting the importance of practical activities.

Figure 2 also reveals a significant difference in opinion on the use of a three part lesson. Pupils in the interview focus group felt that excellent maths lessons didn’t need to follow a particular pattern and that their involvement and interaction with each other were more important than having a particular structure. Teachers showed rather more support for the use of the three part lesson as an agreed template within the school, especially when internal or external reviews of teaching and learning take place:

We need to do it [the three part lesson] so that the department does well when we have a whole school review and so that we are ready for Estyn. The Head wants us to have a similar pattern across all of the subjects I think.

(Teacher B, School T)
This reiterates the influence that a whole school policy regarding lesson structure may have on day to day teaching within the maths classroom. One wonders if an art lesson should have the same structure as a maths lesson? As Reynolds, one of the key figures in school effectiveness, describes:

In Britain we have celebrated a "one size fits all" notion of teaching rather than celebrate and plan for a diversity of teaching methods within different age phases, subjects, etc. with of course a common core of effective practices throughout.

(Reynolds, 1998)

Reynolds’ argument that the biggest impact on learning is through teacher effects rather than school effects is a compelling one.

5.2 Research Question 2

What are the challenges that maths teachers face in order to deliver excellent lessons on a consistent basis?

The evidence used to help answer this research question came from part C from both questionnaires (Appendices 3 and 4), as well as from the pupil focus group and individual teacher interviews.

This part of the questionnaires invited participants to choose and rank three challenges or difficulties that might prevent an excellent lesson being delivered. The coded ranked responses (see appendix 7) are shown in figure 3 below:
Figure 3: Pupil and teacher rankings of challenges to an excellent lesson (Teachers n=7, Pupils n=86)

The graph in figure 3 clearly shows that, from the given options, the challenge judged to be the most significant by teachers was the pressure to complete the syllabus in time, with pupils also ranking this quite highly. The evidence from teacher questionnaires was clearly triangulated in all three teacher interviews conducted, with strong feelings being expressed:

We want the kids to enjoy their maths lessons don’t we? But the thing is that we are really under pressure to improve results every year. We have to get through the work and then give them tests to keep track of their progress...we need to take more time to teach things well rather than racing through and them not really understanding.

(Teacher B, School T)

There is pressure on you, especially with your exam classes, so you don’t seem to plan so creatively. With Key Stage 3 you can spend some more time in lessons trying things out like more practical things and group work which is good. Key Stage 4 is more like heads down and get on with it, especially with maths counting so much in the banding now.

(Teacher C, School U)
It would appear that the message from the Welsh Government that ‘Banding is not about labelling, naming or shaming schools, or creating a ‘league table’ (Wales. Welsh Government, 2011, bold print in original) has perhaps been misinterpreted or rejected by teachers. Pupils also imply that pressure to produce improved GCSE results might have a negative impact on the quality of lessons experienced by pupils.

As Bethan stated

Maths is much quicker and more serious in Year 10 because we've got module exams to get ready for. It's more of a rush and harder I reckon.

(Bethan, School P)

Behaviour was ranked overall as the challenge with the second biggest impact on producing excellent lessons. Pupils described how poor behaviour 'slows the lesson down' (Emma) or 'makes it harder to understand when people are messing about' (Carys). Teachers were more specific in making the link between teaching in an interactive way and potential misbehaviour.

With some of the less able classes it can definitely be harder to teach an excellent lesson. It is much more of a risk to try out different and more interesting things with them and you need to train them how to work in pairs or groups, especially when they are just used to working from the textbook before. When it works it's great, but it can put you off trying when things don't go so well and they don't buy into it and mess about.

(NQT 1, School P)

It is apparent from this response that the sorts of elements that have been highlighted as features of an excellent lesson are not always easy to achieve in reality with all classes. Research by Chapman (2010), reports similar views from a Canadian secondary school teacher who found pupils reluctant to move away from more traditional methods:
I am continually trying to keep alive the conversation about what it means to learn and understand mathematics [by making lessons more interactive] ...So, yes, there is resistance [from the pupils], and yes I just continue and continue and continue to work on it.

(Chapman, 2010, p.292)

Although the questionnaires revealed that a lack of general resources was less of a challenge than aspects such as behaviour or pace and match, it was revealed that another key challenge faced by teachers in producing excellent lessons was a lack of time resource. Although this aspect was not included as an option on the questionnaire, all teacher participants made written note of this and it was also mentioned in interviews:

Being head of department means that I don’t have as much time to plan as I would like.

(Teacher D, School P) (written)

Lessons with lots of variety take a lot of planning. I have adapted some that I did on my placements last year to save time but it is difficult to do those kinds of lessons all the time.

(NQT 1, School P)

I’m sure that I would do better lessons more often if I had more frees or if my frees weren’t all in one week. I don’t get much chance to talk to the others [in the same department] which is a shame ‘cos we could share more ideas about good things we have done.

(Teacher C, School U)

It was clear that teachers felt strongly about this issue and it is something that appears to be a challenge for many of them.
5.3 Research Question 3

To what extent is there a link between teaching experience and the ability to deliver excellent maths lessons?

The evidence used to help answer this research question came from part D of the teacher questionnaires and from the follow up interviews. Pupils were not asked about this research question as it was felt that it was an area of a more sensitive nature. Figure 4 below shows the data from teacher questionnaires:

![Pie Chart]

**Figure 4: Is there a link between length of experience and the ability to deliver excellent lessons? (n=7)**

The pie chart shown in figure 4 shows that the evidence gathered from the questionnaire was rather inconclusive. However, a clearer picture was obtained through reading the open ended responses provided by teacher participants as well as through the three teacher interviews conducted.

Two teachers responded 'No', indicating that they felt there was not a link between experience and the ability to deliver excellent lessons. One of these was NQT 1
(School P). Her firm view was that *all* maths teachers should be able to deliver excellent lessons regardless of their experience:

> From what I saw on my teaching practice last year it doesn't matter how long you have been teaching. I saw some really good lessons from people who had been teaching for quite a few years and some other good ones from people who had been teaching for only a year or two. I think all maths teachers can do excellent lessons if they have the right attitude, although it's hard to do it all of the time like I said.

(NQT 1, School P)

As a maths tutor on a teacher training programme, it is encouraging to note that this former student in her first year of teaching has such a positive view of the potential of herself and her fellow teachers.

Interestingly, the second teacher to respond ‘No’ was also a newly qualified teacher, NQT 3 (School R) who wrote:

> Teaching excellent lessons is down to attitude and enthusiasm, rather than experience. You need to show a genuine interest and passion for what you are doing and that's nothing to do with age or experience.

(NQT 3, School R)

These sentiments link back to the earlier discussion regarding attitudes to mathematics as well as to teacher identity and self-representation. In addition to the planning of content, questioning and interactions being important in an excellent maths lesson, it is vital that a teacher represents both their mathematical self and their personal self in a constructive way. Research by Chapman (2010) discusses how these representations are conveyed to pupils through both language and actions, and that ‘Self-representation can have both positive and negative impacts on students’ learning of mathematics depending on what it represents and the message it conveys’ (Chapman, 2010, p.293).
The two teachers who indicated by their responses that there was a link between experience and the ability to deliver excellent lessons were Teachers B and C, with five and eight years of experience respectively. They gave similar reasons, indicating that they felt their teaching had improved as they had become more experienced.

Teacher C commented that:

> It's hard to measure if my teaching has improved over the years, but I'm sure it has. I think I had to make sure that I was in control of the lesson by having quite a rigid structure which helped with the behaviour management but now I am more flexible and able to respond better to what the pupils do and say in class.

(Teacher C, School U)

Teacher B also felt that his teaching had improved with experience:

> It takes time to develop the skills of teaching, like using assessment for learning properly. I used to do some Red, Amber, Green and think that was it, but now that I am doing my master's and have done some reading and research it has improved my teaching a lot.

(Teacher B, School T)

The three remaining teacher participants indicated that there was a possible link but that other factors such as the departmental or school philosophy towards learning and teaching were potentially more influential than experience.
Chapter Six

6.0 Conclusion and recommendations

Having analysed the research evidence gathered in the previous section, this section reviews and summarises the findings of the project as well as reflecting on the study as a whole. This reflection leads to a set of recommendations and possible areas for further study based on these findings.

6.1 Conclusion

Set against a background of a generally negative public image of mathematics (Smith, 2004; Boaler, 2009; Johnston-Wilder and Lee, 2010) this study aimed to ascertain some of the key elements needed to produce excellent maths lessons that interest and inspire young people. More importantly perhaps, it sought to discover what challenges are faced by teachers on a daily basis in trying to deliver such lessons in south Wales, as well as investigating possible links between experience and the ability to teach excellent maths lessons.

Despite a focus from the Welsh Government in recent years on improving educational experience and attainment through the introduction of the School Effectiveness Framework (2008a), international comparisons via the PISA programme of assessments suggest that Wales lags behind many countries in its ability to produce youngsters with high level maths skills (Mackie, 2011). With the Leitch review (2006) suggesting that skills are the key lever to economic and social prosperity, and with changes to GCSE mathematics reflecting this emphasis, it was hoped that the evidence gathered in this small scale study would provide useful information for myself as a teacher educator as well as for a wider audience.
6.1.1 Research Question 1

What are the key elements of an excellent maths lesson?

The study found support from both pupil and teacher participants for the kinds of whole class interactive teaching methods promoted by much recent research literature (Swan, 2005; Hodgen and Wiliam, 2006; Hattie, 2009; Murray, 2011). Participants felt strongly that excellent maths lessons should provide opportunities for pupils to discuss and interact with each other and with their teacher, as well as pupils revealing that they wanted teachers to show empathy in their approaches to learning. Furthermore, discussions focused on exposing and discussing potential or actual misconceptions were regarded as an important aspect of these interactions, with pupils reporting that this verbalisation led to increased confidence in the material.

The study suggests that providing pupils with focused opportunities to work in pairs or groups can lead to improved understanding of mathematics, supporting the findings of Swan’s (2005) research with post-16 learners. It was evident, however, that a focus on increased talk in pairs or groups as a pedagogical tool was something that was relatively new to some participants, but that they were keen to explore this further.

The element most highly rated by pupils in answer to this question was the provision of a variety of tasks within maths lessons. Pupils enjoyed this variety and felt more engaged, although there was evidence that such variety was not necessarily the daily diet that pupils experienced.

Interestingly, despite the high profile of assessment for learning strategies as a means to improvement, as promoted by many authors (Black and Wiliam, 1998,
2002; Hodgen and Wiliam, 2006; Beere, 2010), and by the Welsh Government through its 'developing thinking and assessment for learning' programme (Wales. DCELLS, 2010a), there was relatively limited support for self and peer assessment from pupils. This would indicate that their experiences of these aspects of assessment for learning were of limited value. Perhaps, as Black et al. (2005) suggest, the effective use of formative assessment techniques is something that schools, teachers and pupils need to embed over a 'time horizon of at least two years, with persistence in initiation, support, evaluation and review' (Black et al., 2005, p.114). The evidence gathered in this small scale study would suggest that assessment for learning strategies in mathematics need further development to improve their impact on pupils’ learning experiences.

Some concerns were also evident over lesson structure. Pupil participants did not feel that a specific structure was required, whilst some teachers reported feeling somewhat constrained by an agreed whole school lesson structure such as a 'three-part lesson'. It was apparent that, as Dix (2010) suggests, teachers' daily practices are perhaps more strongly influenced by school policy and inspection regimes than by their own explicit and implicit knowledge of what works with learners in their particular environment. As Hibbs (2010), Noyes (2007) and Dix (2010) suggest, there was some evidence that teachers recognise a need to take greater control themselves of their teaching and their pupils' learning. It would appear from some of the interviews conducted that the teacher participants were generally keen to have a wider impact within their school, but perhaps that they lacked the opportunity or confidence to do so.
6.1.2 Research Question 2

What are the challenges that maths teachers face in order to deliver excellent lessons on a consistent basis?

In terms of the intention of this study to compare the theory of excellent teaching with the reality of trying to deliver it on a daily basis, the evidence gathered from this research question was perhaps the most useful.

From the choice of options provided on pupil and teacher questionnaires, it was clear that pressure to complete the syllabus and concerns over behaviour were major factors influencing teaching. Teachers rated completion of schemes of work as their major challenge, with classes at Key Stage 4 in particular. From interviews it was evident that they felt under increasing scrutiny and pressure to improve results year on year with a new national banding system potentially adding to that pressure. There was some evidence from pupils that they also recognised the pressure to get through work and that as a result teaching was more procedural at this level. Swan's research (2005) makes mention of similar concerns over syllabus coverage but reflects on the need for more permanent learning through effective methods rather than superficial or imagined learning which 'covers' the syllabus. The results of my study suggest that some teachers are torn between the drive for accountability through improved external exam results and the desire for teaching and learning to be more effective; the potential risk being spending more time deepening understanding at the risk of not completing the exam syllabus. Sadly, this accountability would also appear to be prevalent in other countries, including the United States, with Barlow reporting that: 'Measurement and data are watchwords in the ed biz [sic] these days... Data rules the day... Schools are not only criticized for inadequate test scores, they can be punished' (2011, p.67). Barlow also reports
unease from the US government over international comparisons such as the PISA tests:

...nothing has fuelled criticism of America's school system more than comparisons between American students' test scores and the test scores of students from schools in other countries around the world.

(Barlow, 2011, p.64)

This evidence would appear to mirror on-going concerns from the Welsh Government regarding the performance of Welsh students when compared with that of students from other countries involved in the PISA programme. One wonders if these concerns will lead to improved pupil performance through improved teaching or merely lead teachers to feel under greater pressure to teach towards yet more summative tests.

The second key challenge to excellent maths lessons recognised in this study was that of pupil behaviour. Whilst teachers were generally keen for learning to be 'active', they recognised the challenges that this meant in terms of the behaviour of certain classes or groups of learners. Some evidence pointed to the use of discussion in pairs or groups and the provision of a variety of pupil centred activities being more difficult to manage with groups of less able pupils. This is an area of challenge that is overlooked by Swan (2005) and one which would benefit from further specific research.

A challenge that was mentioned by all teacher participants, either through written or oral feedback, was a lack of time to plan and prepare lessons which they considered could potentially be excellent. The feeling was quite strong that more, or more carefully organised provision of, planning and preparation time would enable teachers to provide improved learning experiences for young people.
6.1.3 Research Question 3

To what extent is there a link between teaching experience and the ability to deliver excellent maths lessons?

The evidence gathered in order to answer this research question was rather inconclusive, with no evidence of a link established. On reflection, the inclusion on the teacher questionnaire of a single question focused on this aspect was inadequate, although interview questions focused on this area did provide interesting feedback from teacher participants.

Most encouraging, in terms of the currency of this research, was the ability of teachers to reflect constructively on their own practice and identity as a teacher, and how they might have developed these aspects, or how they hope they might develop them in the future. This ability to reflect on practice is one of the core priorities highlighted by the Welsh Minister for Education and Skills (Andrews, 2011) for teachers during their Induction and Early Professional Development periods, as well as for the Master’s in Educational Practice qualification due to be launched in September 2012. The thread of using research and post graduate study to improve understanding and skills relating to teaching and learning pedagogy was further highlighted by one teacher in response to this research question. He revealed how his own involvement in research, as part of a Master’s level qualification, had given him a much deeper insight into how he might use assessment for learning strategies more effectively within his day to day practice.

This study also revealed similar findings to recent research by Chapman (2010) focused on teachers’ self-representation. Some teachers highlighted a link between
the personal qualities of attitude and enthusiasm, the importance of relationships to pupils and the ability to teach at a high level.

6.2 Recommendations

The recommendations offered in this section are based on the conclusions of this study, as well as taking into account the background in which they were arrived at. It is hoped that they might be useful in improving future practice in schools as well as informing the teacher training and continued professional development of mathematics teachers.

**Recommendation 1: Active learning.**

This dissertation provides further evidence to support recent studies that mathematics teachers and their pupils enjoy learning in an interactive way, through a variety of activities which provide opportunities for them to discuss and explore mathematical ideas. Consequently, it is recommended that maths teacher trainers, maths teachers and maths departments in all schools focus on promoting and providing such opportunities. Whilst recognising that there will be concerns over content coverage in some quarters, it is believed that time invested in improving depth of understanding will reap benefits in the long run in terms of pupil performance as well as leading to an improved image of mathematics in schools and ultimately in wider society. In addition, active learning in mathematics will help to promote the kinds of transferable skills that the Leitch review (2006) and Skills Framework (2008b) remind us are so vital for personal and economic development and success in an ever increasingly competitive society.
Recommendation 2: Lesson structure.

The evidence gathered in this study supports the views of authors including Hibbs (2010), Dix (2010) and Noyes (2007) that generic lesson structures, such as the three part lesson format promoted by the National Strategy (2001) have become too prevalent within secondary schools across all subjects. The concern is that this system fails to sufficiently recognise the unique nature of different subjects and that as a result, teachers may be less willing to try newer approaches for fear of being criticised when internal or external reviews take place. The recommendation is that maths teachers seek more freedom to develop the sorts of approaches that the Welsh Government is attempting to promote through documents such as *Effective Practice in Learning and Teaching – A Focus on Pedagogy* (Wales. DCELLS, 2009a), so that learners are more engaged and motivated to learn. The sharing of good practice in this area through Professional Learning Communities (PLCs) both within and between schools should aim to focus specifically on those aspects that improve learning and teaching in mathematics rather than on generic themes. It would be useful for such PLCs to include maths teachers in schools, maths advisers as well as maths tutors on ITET programmes to more effectively share expertise.

Recommendation 3: Teacher effectiveness

Nearly fifteen years ago, David Reynolds, a sometimes controversial figure in the study and promotion of school and teacher effectiveness in the United Kingdom, stated provocatively that ‘Our ignorance in the area of teacher effectiveness is virtually total’ (1998, p.26). He suggested that our society, as well as many
teacher educators still had a rather old fashioned view that teachers were born to teach rather than the possibility existing that they could be created through appropriate training. He argued that there was an urgent need for the development of an 'applied science of teaching' (Reynolds, 1998, p.27) and suggested that the lack of motivation to develop such a practical approach to pedagogy lay in the low status that applied and practical research had in this country compared to South East Asia, for example. Interestingly, some fourteen years later, Reynolds has been involved in the development of the proposed Master's in Educational Practice (MEP) qualification in Wales (Andrews, 2011) mentioned earlier in this chapter.

There is evidence from Teacher B in this study that the research process can benefit both new and experienced teachers, if only to help them reflect upon and question in some way their own practice. The recommendation is therefore that teachers are encouraged to engage with research and further study through programmes such as the proposed MEP to keep their knowledge and pedagogical skills up to date.

However, with a lack of time shown to be an issue for all teacher participants in this study, it is clear that teachers pursuing this, or similar qualifications, should be given time by schools to effectively complete the course and their research. Consequently, if the programme is to serve its intended purpose, 'to produce highly skilled teachers...who are able to deliver more effective teaching and learning in the classroom' (Andrews, 2011, p.1), schools need to be provided with significant funds by the Welsh Government to reduce teaching loads sufficiently for teachers who are part of the programme.
Recommendation 4: Areas for further research

One challenge that participants highlighted as a potential barrier to teaching excellent lessons which were active, and engaged pupils in their learning, was that of pupil behaviour. This is an area that has gained increasing attention in recent years through UK research such as that presented in the Steer Report (2009) and by the Welsh Government in their document *Practical Approaches to Behaviour Management in the Classroom* (Wales. DCELLS, 2010b).

The evidence gathered through teacher interviews in my study suggested that some teachers were wary of working in a more pupil centred way with certain classes or groups of learners within their school due to potential disengagement or misbehaviour. They wondered in essence if the risk-reward balance would be positive. It would be both interesting and useful therefore to conduct further research into links between active learning strategies and pupil behaviour in mathematics, to see if these concerns have any basis. Such a study would help to further inform practitioners regarding likely responses from pupils perceived to be more challenging. This could lead in turn to some of the strategies for excellent teaching and learning discussed in this dissertation being used more widely with all learners.
Reference list


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Appendix 4: Teacher Questionnaire

Teacher questionnaire - What makes an excellent maths lesson?

Please complete the following questions which focus on your views and experiences of delivering excellent maths lessons. If you have any queries about completing this questionnaire, please email me at smccarthy@cardiffmet.ac.uk. Many thanks for taking the time to complete the questionnaire.

Name: ....................................................... School: ..............................................

At the end of this academic year, for how many years will you have been a maths teacher?

[ ] ....... years

A) For this question please tick the appropriate box to indicate your level of agreement with each statement regarding teaching and learning in excellent maths lessons.

<table>
<thead>
<tr>
<th>In an excellent maths lesson...</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1 ...pupils interact with each other in pairs or groups.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A2 ...pupils complete plenty of questions in their book.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A3 ...pupils assess their own and each other’s work.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A4 ...the teacher uses ICT to help explain.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A5 ...the teacher exposes and discusses misconceptions.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A6 ...pupils work quietly on the tasks set.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A7 ...the teacher provides a variety of activities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A8 ...the teacher shares learning objectives at the lesson start</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
B) Please select and rank in order of importance four aspects below which you think should be contained in an excellent maths lesson. Indicate your preferences by writing 1st, 2nd, 3rd and 4th next to your selections.

<table>
<thead>
<tr>
<th>‘Aspects’</th>
<th>Your ranking (1st, 2nd, 3rd and 4th only)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1 ‘Hands on’ activities are used</td>
<td></td>
</tr>
<tr>
<td>B2 There is broad pupil participation e.g. using mini-whiteboards</td>
<td></td>
</tr>
<tr>
<td>B3 Lessons are split into three parts</td>
<td></td>
</tr>
<tr>
<td>B4 Pupils are engaged in their learning</td>
<td></td>
</tr>
<tr>
<td>B5 Mistakes are used as learning opportunities</td>
<td></td>
</tr>
<tr>
<td>B6 Understanding is assessed throughout the lesson</td>
<td></td>
</tr>
<tr>
<td>B7 Questioning is used effectively</td>
<td></td>
</tr>
</tbody>
</table>

Are there any ‘aspects’ that you would add to the list above?

C) Challenges
Please select and rank in order of importance three aspects below which you consider to be the three biggest challenges that you face when teaching excellent lessons. Indicate your preferences by writing 1st, 2nd and 3rd next to your selections.

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Your three choices Please rank 1st, 2nd, 3rd</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1 Managing behaviour</td>
<td></td>
</tr>
<tr>
<td>C2 Matching level of work to ability</td>
<td></td>
</tr>
<tr>
<td>C3 Lack of resources</td>
<td></td>
</tr>
<tr>
<td>C4 Pace &amp; timing</td>
<td></td>
</tr>
<tr>
<td>C5 Need to complete syllabus or prepare for a test</td>
<td></td>
</tr>
</tbody>
</table>

Are there any other challenges that you would add to the list above?
D) Do you think that there is a link between the number of years that someone has been teaching and their ability to deliver excellent maths lessons?

Yes  [ ]  No  [ ]  Possibly  [ ]

Please give a reason for your answer:

E) Other comments

Please feel free to make any other points or comments in the space available here.

Thanks again for giving up your time to complete this questionnaire.
Steve McCarthy
Appendix 5: Questions for semi-structured interviews (Teachers)

The questions outlined below were used as a basis for discussion with the three teacher participants interviewed. They were not always asked in the same order, but all of the aspects mentioned were covered in each semi-structured interview.

(Using a blank questionnaire as a prompt for the interviewee).

T1) The first part of the questionnaire you completed asked about what pupils and teachers do in excellent maths lessons. Which aspects do you regard as the most important? Why do you think that?

T2) In part B of the questionnaire, you were asked to rank particular aspects of an excellent maths lesson. Could you explain why you chose your particular ranking order?

T3) Were there any other aspects that you felt should have been on the list of ‘positives’ for an excellent maths lesson?

T4) Perhaps you could give me an example of a couple of your experiences of using some of these aspects in your lessons? How successful do you think they are in improving learning?

T5) How do pupils respond to these sorts of approaches in your experience?

T6) Part C of the questionnaire asked you to rank the three biggest challenges to teaching excellent lessons. Could you tell me a bit more about your choices?

T7) Do you think there were things missing from the list?

T8) What is the impact of these challenges on your teaching and on pupils' learning?

T9) The last question on the questionnaire asked about links between experience and ability to teach excellent lessons. What are your thoughts on this?
Appendix 6: Questions for semi-structured group interview (Pupils)

The questions outlined below were used as a basis for a group discussion with the five pupil participants interviewed.

(Using blank questionnaires as a prompt for the pupils).

P1) The first part of the questionnaire you completed asked about what pupils and teachers do in excellent maths lessons. Which ones did you go for? Why did you choose those in particular?

P2) In part B of the questionnaire, which ones were most important to you? How often do those kinds of things go on in your maths lessons?

P3) Are there any other things that you think I should have put on the list of things that help to make an excellent maths lesson?

P4) Maybe you could tell me about what has gone on in some of the best maths lessons that you have had? Why have these things been good? What helps you learn best?

P5) Tell me about working in pairs or groups in maths.

P6) The last part of the questionnaire asked about things that make it difficult to have an excellent maths lesson. Which things did you choose this time? Could you give me an example of when lessons are not as good?

P7) Do you think there were things missing from the list? Do any of these stop you from learning?
Appendix 7: Coding system

Coding for questionnaire part A: In an excellent maths lesson

<table>
<thead>
<tr>
<th>Likert response</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coded value</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 6 in the main report displays mean average coded values for pupil and teacher participants.

Coding for questionnaire part B: Positive aspects

<table>
<thead>
<tr>
<th>Ranked response</th>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
<th>4th</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coded value</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

Figure 2 in the main report displays mean coded values for pupil and teacher participants.

Coding for questionnaire part C: Challenges

<table>
<thead>
<tr>
<th>Ranked response</th>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coded value</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

Figure 3 in the main report displays mean coded values for pupil and teacher participants.