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Teaching and learning practices and reported experiences of teachers and students in high, middle and low ability maths classes.

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Declaration of own work

I hereby declare that, except where explicit attribution is made, the work presented in this thesis is entirely my own.

Signed: P Warrington

Abstract

Much research has been conducted into the effects of ability grouping. Research suggests that there are a number of negative effects of ability grouping for students in low ability groups including: lack of motivation, stigmatisation, low self-esteem and reduced academic progress. Research has attempted to explore the experiences of students and teachers taught in ability groups. This research has highlighted teaching and learning experiences as being variable between ability groups. Relatively little research has attempted to capture the day to day, in class, experiences of students grouped by ability. The research that has done so completed this in a way that prevents replication and does not provide a detailed account.

This current research provides a detailed description of the nature of activities and teaching and learning interactions that take place within classrooms set by ability. The research aimed to provide a detailed account of the experiences of both teachers and students in relation to teaching and learning, classroom interactions, classroom environment and student's self-concept.

The research adopts a mixed method study design to explore and describe the experiences of ability grouping in high, middle and low ability maths classrooms in two inner city London secondary schools. The research draws on both quantitative and qualitative data to provide a rich account of the practices and experiences of ability grouped classes including: questionnaires, structured lesson observations, qualitative lesson observations, lesson audio recordings and semi-structured interviews.

The findings of the study suggest that students taught in high, middle and low ability groups have varying experiences in relation to: interactions with peers and teachers; classroom environment; teaching and learning experiences and students self-concept. The researcher highlights the complexity of inter-relating factors in this area and considers how the different experiences of students placed in ability groups may relate to outcomes for students.

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Chapter 1. Introduction

Ability grouping is the most common way for schools to organise students into classes in secondary schools in the UK, particularly for core subjects, such as maths, English and science (OFSTED, 2013). In the United Kingdom (UK) the government 'achievement-based priorities' (Boaler, 1997a) in addition to government guidelines (Department for Education and Employment [DfEE], 1997) have encouraged the use of ability grouping in schools in an attempt to eradicate underachievement (Boaler, 1997a).

The rationale for teaching students in ability groups presented by the New Labour government was that it 'allows students to be taught at a pace and level that is appropriate for them' (Department for Education and Skills [DfES], 2005) specifically it is a way of achieving differentiation. This view was supported by the Conservative government who released a Green Paper in 2007 where they advocated the use of grouping students by ability and pledged to 'alter guidance' to Ofsted to ensure that schools set all academic subjects by ability (Francis, Archer, Hodgen, Pepper, Taylor & Travers, 2016). The government policies were created with a view to raise standards in education. However, there appears to be some inconsistency between government policy and the findings from research in this area. Indeed, a review commissioned by the department for education suggests that there is a lack of any overall positive effect from ability grouping (Kutnick, Sebba, Blatchford, Galton, Thorpe, MacIntyre, & Berdondini, 2005).

A number of international studies have investigated the impact of ability grouping on academic achievement in schools across an array of countries. The on-going Programme for International Student Assessment (PISA) studies takes place every three years and involves assessments in reading, maths and science with 15 year olds across a large number of countries. These studies have repeatedly found that the more schools group by ability, the lower the pupil performance overall (Organisation for Economic Co-Operation and Development [OECD], 2010).

Contrary to the view of many politicians, ability grouping in schools seems to depress academic performance (Baines, 2012).

Wilkinson and Penney (2014) suggest that the intention of ability grouping is that students will not be overwhelmed by work that is too challenging and will not be bored by work that is too easy. However, research suggests that students are not allocated to classes purely based on their attainment and when placed in ability groups there is often little movement between these groups, with some allocation procedures appearing biased against some groups of students (Hallam & Ireson, 2007). This means that ability groups are often comprised of students with a range of attainment and ability (Wright & Burrows, 2006).

DfES (1997) states that ability grouping can "build motivation, social skills and independence; and most importantly can raise academic standards because students are better engaged in their learning". However, a wealth of research (e.g. Slavin, 1990; Kulik & Kulik, 1982, 1992; Wiliam & Bartholomew, 2004) indicates that ability grouping does not improve the net attainment of all students (Gillborn & Youdell, 2001). Furthermore, it has been found to produce: lowered academic expectations (Ireson, Hallam & Plewis, 2001); decreased motivation (Saleh, 2005); lower self-esteem (Cottle, 1974); and social stigmatisation (Chiska, 2002).

Research has considered the effects of ability grouping on attainment (Slavin, 1990), motivation (Saleh, 2005), teacher expectations (Ireson, Hallam, & Plewis, 2001) and self-concept (Hallam & Dearth 2002). However, very little research has attempted to describe how teaching and learning experiences differ for students taught in ability groups and consider the consequences this may have for them (Wilkinson & Penney, 2014). It is important to understand how the experiences of students and teachers differ between classes taught in high, middle, and low ability groups in order to understand why researchers have observed the differential outcomes for students.

A small number of studies have attempted to capture the different experiences of students in high, low and mixed ability groups in secondary schools in the UK (Boaler, 1997; Boaler, Wiliam & Brown, 2000; Hallam & Ireson, 2001; 2005; 2006;

2007; Solomon 2007). These studies explored students' experiences using questionnaires, interviews and qualitative observations. The findings of these studies can be discussed in relation to: teaching and learning approaches; classroom interactions; classroom environment; and student identities.

Teaching and learning

The research regarding different teaching and learning approaches suggests that when students are grouped by ability they are often taught as a homogenous group where they are all expected to work at the same level and pace (Boaler, 1997 a, b). Wiliam and Bartholemew (2004) argue that this perception leads to traditional transmission styles of teaching students grouped by ability, which in turn has an impact on students' academic progress. This could show that the process of grouping students by ability is perceived, by practitioners, as being differentiation in itself. Therefore this perception may lead to a lack of differentiation and individualised teaching within classes grouped by ability, which is likely to have an impact on the outcomes for some students.

Boaler, Wiliam and Brown (2000) found that this undifferentiated approach to teaching students leads to students in high ability groups being expected to work at a very fast pace at a high level, often resulting in students being unable to complete work and understand concepts. Meanwhile students in low ability groups mainly worked from textbooks, were taught from the board and were given long periods of time to complete work (Boaler et al., 2000). In contrast Boaler et al (2000) found that students taught in mixed ability groups had more individualised learning experiences. This was explained by teachers responding to the range of abilities within the classroom. Teachers of mixed ability classes differentiated tasks and expected students to work at their own pace unlike classes grouped by ability where there was little or no differentiation.

There is a small body of research that links teaching and learning experiences to student engagement and participation (Solomon, 2007). Solomon (2007) found that there were differences in how students, taught in low and high ability groups, perceived themselves as learners. Students in high ability groups reported high levels of engagement and participation with their learning whereas students in low

ability groups described learning that was dominated by remembering facts and formulas. This study highlights the difference between students in high ability groups who feel that they are a part of their learning experience and students in low ability groups who perceive learning as something that is done to them.

The research regarding the teaching and learning practices in ability-grouped classes does not provide a detailed examination of the processes and mechanisms that are used to teach students in these classes. There is a significant lack of clarity regarding the procedures used to collect and analyse data in these studies.

Classroom interactions

Research suggests that students in high ability groups work more frequently in small groups and with peers than those in low ability groups (Kutnick, Hodgekinson, Sebba, Humphreys, Galton, Steward, Blatchford & Baines, 2006). Solomon (2007) investigated the differences between ability groups with regards to classroom discourse. He used neo-Vygotskian theory to understand the important role that language and interaction play in the guided construction of knowledge. Solomon (2007) conducted rich interviews with 13-15 year old British students regarding their experiences of learning maths.

Solomon (2007) found that students in high ability groups described participative maths identities where they were actively engaged with maths through discussions with peers and teachers. In contrast, students from low ability groups described marginalised identities and considered that maths was something that was ‘done to them’ and did not engage with their learning and peers in the same way. This research highlights key differences between how students in different ability groups interact with learning and subsequently other students. However, the research fails to consider what factors may contribute to the development of these different learner identities. The research is based solely on interview data where the methodology for analysing the data is not clear. The results could be related to the students’ motivation and self-concept, which impact on how they perceive themselves as learners. It would be helpful to use structured observation to objectively examine what happens in classrooms grouped by ability. It would be interesting to observe whether students in high ability groups are given more opportunities to work in

groups and pairs than those in low ability groups and whether students in high ability groups engage in more reciprocal interactions with teachers than low groups. There is no research that has provided a detailed examination of the nature of interactions that take place within classes grouped by ability.

Classroom environment

Boaler, Wiliam and Brown (2000) suggested that teachers have expectations of classes that are taught in ability groups and this has an impact on the environment created within ability-grouped classrooms. They found that students taught in high ability groups were perceived as not making mistakes and did not need help or time to think. The environments of these classes were described as being anxiety provoking for some students where there was a culture of competition. Bartholomew (1999) suggested that teachers in these groups are more likely to focus on encouraging students to participate and they are more likely to engage with banter. In comparison, students in low ability groups were perceived by teachers as not having 'independent thought' and hence learning was slow and boring. Teachers of low ability groups also described students as having 'behavioural problems' and attitudes (Macintyre & Ireson, 2002).

Student identities

Research argues that students who are placed in low ability groups develop stigmatised identities (McManus, 2010) and these identities have an impact on how students perceive themselves as learners and how they then interact in the classroom environment. McManus (2010) suggests that effects of ability grouping are caused by students developing stigmatised identities, resulting in them having reduced motivation to learn and exhibiting behaviour issues. This elicits different teaching and learning approaches used by teachers.

Research rationale

There are a small number of studies that have attempted to explore the underlying reasons for the effects of ability grouping. However there remains a lack of understanding regarding the mechanisms and processes that may cause both the positive and negative effects of ability grouping. There is little research that has attempted to provide a detailed examination of the teaching and learning practices in

classes grouped by ability with regards to: the student-teacher interactions; the amount of teacher talk; whether children work independently, in pairs or in a group; what the nature of the tasks given to students is; and what type of questioning teachers use. This research will aim to provide a detailed description of the teaching and learning practices in high, low and middle ability maths classrooms and will consider how these experiences may lead to the observed consequences of ability grouping.

As there is an existing evidence base that has focused on maths classes, this research will seek to build on these findings by focusing on lessons taught in this subject. In addition the researcher is an ex maths teacher and is therefore able to understand the maths concepts and learning taking place during the lessons.

The intention is not to undertake a study that will provide generalisable research findings, but rather to provide a snapshot description of classroom practices and the nature of teacher and student experiences in a small sample of classrooms, and stimulate further thinking in this area. Furthermore, the research will reflect on how Educational Psychologists (EPs) can support and advise schools on both a systemic and individual level to promote best practice regarding ability grouping.

Researcher's background in relation to the current research

The researcher is an ex maths teacher who taught in an inner city comprehensive school in London for three years. The school that the researcher taught in grouped students by ability for maths at the start of Year 8 until the end of Key Stage 4. Year 7 maths classes were taught as mixed ability. It is important to recognise that as a result of this she brings her own views and experiences of teaching classes grouped by ability.

The researcher learnt to teach through an apprenticeship model where she simultaneously trained and worked as a teacher. The researcher has experience of teaching both mixed ability and ability-grouped maths classes. Throughout her teaching career it became increasingly apparent that there were a number of positives and negatives regarding the use of ability grouping. Her view was developed through discussions with teaching colleagues (from all subjects) and her

experience of teaching. The teacher's experience of ability grouping involved teaching high, middle, low and mixed ability classes in addition to Year 12 maths retake class. It is important to note that the researcher does not come from a perspective of favouring any type of ability grouping system. Instead the researcher considers that there are many unknowns regarding ability grouping and feels that understanding the mechanisms in detail will contribute to how ability grouping is perceived and used.

Chapter 2. Literature review

2.1. Literature review introduction

This literature review will critically evaluate research produced in the United Kingdom (UK) that assesses the teaching and learning practices and experiences of students and teachers of ability grouping. The term 'ability grouping' can include a range of methods used to organise students into classes, for example setting and streaming. It will start by considering what is meant by the term 'ability' and will examine the mechanisms and processes of placing students in ability groups. It will then go on to reflect on the positive and negative effects of ability grouping in the UK. Following this it will discuss: how teaching and learning practices differ between ability groups; student and teacher experiences of ability grouping; the development of stigmatised identities; and developing maths understanding.

Research produced in the United States of America (USA) will not be included as the predominant method for allocating students to classes is streaming (or 'tracking' as it is known in the USA). This approach sees students separated by their general academic ability for all classes, and often follows a curriculum designed for their particular level. This may involve students undertaking a significantly different curriculum to their peers (Baines, 2012). The term 'setting' is used when students are placed in classes for different subjects based on having similar attainment in that specific subject. This means that a student could be in top set for maths and the lower set for English. This literature review focuses on setting, as opposed to tracking or streaming. As setting is currently the most common form of 'ability' grouping used in the UK (OFSTED, 2013; Benn & Chitty, 1996). The terms, 'setting' and 'ability grouping' are used interchangeably throughout previous research. In order to provide clarity, the term 'ability grouping' will be used throughout the current study when referring to setting practices and approaches.

In 2013 the Office for Standards in Education (OFSTED) released a paper that reviewed under achievement in the most able students. The report stated that two thirds of schools used setting by ability to allocate students to groups in Key Stage Three (KS3) for maths, English and science. However, there was variation regarding what stage students were initially allocated to ability groups. Where setting by ability occurred at an early stage (Year 7), this was usually only for maths, whereas sets

were introduced at a later stage in KS3 (Year 8 and 9) for English and science.

2.2. What is ability?

The concept of 'ability' has historically been highly contested. There is not one clear definition of the term and as a result it is difficult to measure. Indeed the term is frequently used interchangeably with terms such as attainment and achievement and hence may be seen to suggest an innate cognitive capacity. The lack of linguistic clarity regarding what the term 'ability' means and when it should be used in both practice and policy has led to a range of misunderstandings and disagreements. Generally the term 'ability' seems to capture elements of both attainment and the learning potential of students. A student's perceived 'ability' is often based on judgements made by teachers regarding a student's current attainment combined with their perceived 'teachability' (i.e. capacity to be taught and willingness to learn).

Evans and Davies (2004) suggest that the term 'ability' is understood by policy makers, politicians and practitioners as a 'proxy for common sense notions of intelligence' (p.10). Dunne, Humphreys, Sebba, Dyson, Gallannaugh, and Muijs (2007) claims that the term 'ability' is commonly used to indicate personal attributes and potential, and argues that it is not an objective term.

For the purpose of this research the term 'attainment' will be used to describe key national indicators of student learning and progress, measured by examinations. In this research the term 'ability' will be used only when discussing 'ability grouping'. The current research does not seek to address the debate around ability. For the purpose of this research the term 'ability grouping' will be used to describe the approach used by schools to allocate students to groups that are seemingly of the same 'ability' in a curriculum area. The term 'attainment grouping' will not be used as research suggests that students are often not allocated to groups purely based on attainment (Dunne, et al., 2007).

2.3. Allocation of students to ability groups

The allocation of students to ability groups has been raised as a key concern in previous research. Previous research (Harlen & Malcolm, 1997; McIntyre & Ireson, 2002) suggests that some students are misallocated to ability groups. This is viewed as a particular concern due to evidence that suggests that there is relatively little

movement between groups, mainly because the allocation is rarely reviewed (Hallam & Ireson, 2007). This apparent lack of movement between groups highlights the importance of students' initial allocation to classes, as this will have an impact on how they are positioned within the school community and the access they have to learning opportunities. Hence, it is important to carefully consider the processes and criteria associated when allocating students to ability groups.

Hamer (2001) suggests that most students are not aware of the criteria for allocating students to ability groups and that many assume behaviour qualities to be a key criterion; for example, if students are poorly behaved they are more likely to be placed in a lower ability group. Macintyre and Ireson's (2002) and Davies, Hallam and Ireson's (2003) research revealed that in many instances students are allocated to ability groups based on arbitrary characteristics, including poor behaviour and their perceived motivation to learn. Studies have revealed that lower ability groups are often overrepresented by boys, students from specific ethnic groups and students from lower social economic groups (Boaler, 1997a; Boaler, Wiliam & Brown, 2000; Wiliam & Bartholomew, 2004).

Dunne et al. (2007) conducted research into the teaching and learning experiences of students in low ability groups. The research involved surveys of schools in 12 Local Authorities (LAs) and in-depth case studies in 13 schools. Dunne et al. (2007) found that class allocation decisions were mainly based on prior attainment and perceived ability. However, this was a relatively poor predictor of allocation to ability groups and Dunne et al., (2007) argued that allocation decisions were not made on this basis alone.

Dunne et al. (2007) also highlighted that social class, Special Educational Need (SEN) and ethnicity were found to be predictors of ability group placement. Social class was also a significant predictor in ability group placement. Students from higher socio-economic status (SES) backgrounds were more likely to be assigned to higher ability groups. This was confirmed by the analysis based on both Free School Meals (FSM) and A Classification of Residential Neighbourhoods (ACORN) categories.

SEN was also found to be a significant predictor of ability group placement with

these students concentrated in low attainment groups. This could suggest that SEN and low attainment are seen as closely related or overlapping and that ability group placement may be confounded by the effect of behaviour, as many different types of SEN are also associated with behavioural difficulties. Dunne et al. (2007), also identified ethnicity as a weaker predictor of ability group placement with Bangladeshi students being slightly less likely to be selected for higher ability groups.

The findings revealed that student characteristics, such as behaviour, were likely to influence ability group placement, however it was not always the case that students with behaviour difficulties were allocated to low ability groups. Some schools allocated students with behavioural difficulties to high ability groups regardless of prior attainment, as they believed that the classroom environment provided positive models of behaviour. In contrast, other schools allocated students with behaviour difficulties to lower ability groups as they were smaller and had a higher staff to student ratio. This demonstrates how the relationship between behaviour and ability group placement is not always clear however it does suggest that behaviour is considered as a factor when allocating students to ability groups.

This research from Dunne et al. (2007) demonstrates that a range of factors may have an influence on which ability group a student is allocated to. It is therefore possible that within any ability grouping system a given group will contain students with a range of variations in attainment, as well as learning style. Hence it is essential that teachers of classes taught in ability groups recognise the range of abilities and needs within a class and differentiate their teaching and learning practices to these.

The work of Macintyre and Ireson (2002) demonstrates the range of ability that can be present within different ability groups. They examined whether a student's placement in within-class ability groups was consistent with their ability, as indicated by standardised test. A sample of 145 primary school children in Year 3 to Year 5, from six classes, were included in the study. The researchers found that the mean maths ability scores, as measured by the standardised National Foundation for Educational Research (NFER) assessment, increased in order of ability group with the high ability groups scoring the highest and the low groups scoring the lowest. However, there was considerable overlap between the groups. The highest

performing students in each group were performing above the mean of the group directly above them. This meant that there were a considerable number of students of the same ability that were placed in different ability groups and therefore exposed to different learning opportunities. In addition there was very limited movement reported between groups by teachers. This is concerning as it means that after children are initially allocated to groups there is little re-evaluation of whether or not the level of work is appropriate for them. Macintyre and Ireson (2002) concluded that the main deciding factors regarding allocation of students to groups were on-going teacher assessment and behavioural compositions of the groups rather than scores of ability.

2.3.1. Movement between ability groups

The importance of having flexibility around ability grouping practices has been highlighted many times (OFSTED, 1998 and Ireson & Hallam 1999). However, despite the importance of flexibility being emphasised, research suggests that once initial groups are established, movement between them is uncommon (Macintyre & Ireson, 2002; Hallam & Ireson, 2006, 2007). Macintyre and Ireson's (2002) research reveals that there is a dearth of systems which facilitate movement between groups and a lack of opportunities for school staff to reconsider whether the group placement is appropriate based on a student's achievement. Findings from Hallam and Ireson's (2007) research suggest that even when teachers were aware of a student's misallocation to an ability group they were rarely moved to another group. The reasons cited by school staff to explain the absence of movement between groups by Macintyre and Ireson's (2002) and Hallam and Ireson's (2007) included variations in content covered in different ability groups, flexibility and timetabling constraints.

Gillborn and Youdell (2000) suggest that there are significant differences between the teaching and learning practices within different ability groups. They indicate that the experience of having a slower learning pace and exposure to different parts of the curriculum results in a widening of the achievement gap between students placed in different ability groups. Movement of children from low ability to a higher ability class is therefore unlikely, as the student moving up will lack knowledge that has been covered in the higher groups. As a result of this Gillborn and Youdell

(2000) note that when movement does occur it is most likely to be movement of a student into a lower ability group.

2.4. What are the positive effects of ability grouping?

Firstly, it is important to consider why ability grouping is so commonly used in schools in the UK. The rise of ability grouping in both primary and secondary schools has been promoted with the assumption that it will have positive effects for all students. The Department for Education and Skills (2005) states that ability grouping can "build motivation, social skills and independence; and most importantly can raise academic standards because students are better engaged in their own learning".

Whilst there is little evidence to suggest this is the case for all students there is evidence, which suggests that more able students are advantaged by being placed in ability groups. Ireson, Hallam, Hack, Clark, and Plewis (2002) found that students attaining higher levels in maths at the end of Year 6 made more progress in ability groups than when placed in mixed ability classes. In contrast students attaining lower levels made more progress in mixed ability groups. This suggests that ability grouping practices are advantageous for more able students.

It has also been proposed that many teachers perceive aspects of ability grouping to be positive (Hallam & Toutounji, 1996; Hallam & Ireson, 2007). Hallam and Ireson (2003) investigated the attitudes and beliefs of teachers regarding ability grouping practices. They found that teachers believed grouping students by ability meant that a student's curriculum needs could be better matched, and that classroom management and teaching was easier. However, there was also evidence to suggest that a teacher's preferences were largely influenced by their previous experiences of either ability grouping or mixed ability teaching.

Furthermore, Cahan, Linchevski, Ygra and Danziger (1996) note that ability grouping can allow teachers to differentiate content, learning outcomes, teaching methods and pace to a level appropriate for the students in a group. This may suggest that teachers adopt the view that an ability group contains students that are all at the same ability level. This may have implications for the teaching and learning that students are exposed to when grouped by ability. By assuming that all students are

the same level it is highly likely that these students will be taught in the same way with regards to the content of the work set and the pace at which they would be expected to complete it.

There is a small evidence base that suggests that students prefer to be taught in ability groups (Hallam & Ireson, 2006). The reason given that students gave was that ability grouping enables work to be at an appropriate level. However, Hallam and Ireson (2006) noted that when students were asked if they would prefer to be taught in ability groups or in mixed ability classes students were more likely to prefer whatever arrangement they had previous experience of. Students in schools where mixed ability teaching was the predominant way of allocating students to classes showed a greater preference for learning in mixed ability classes than students in schools that used ability grouping. In contrast, students in schools where ability grouping was the main method of allocating students to classes expressed a strong preference for ability grouping. This suggests that to some extent students prefer the practices with which they are familiar. However, there were differences between preferences of students at different levels of attainment. Students in low ability groups and low attaining students were more likely to prefer mixed ability groupings. This may be because of the stigmatisation attached to being allocated to a lower ability group and the labels that are associated with this (Boaler, 1997c; Ireson & Hallam 2001).

2.5. What are the negative effects of ability grouping?

Despite the fact that government guidelines encourage the use of ability grouping to raise standards in education (DfEE, 1997; DfES, 2005), there is a wealth of research evidence that disputes the value of grouping students by ability and discusses its negative effects (e.g. Ireson & Hallam 2001; Kulick & Kulick 1982; Slavin, 1990; Wiliam & Bartholomew, 2004).

Research has found that placement in a low ability group can have a negative effect on a student's motivation and self-esteem. Hamer (2001) found that students in lower ability groups were observed to have low self-esteem and low aspirations. Studies by Boaler and colleagues (Boaler, 1997a; Boaler et al., 2000) compared classes taught in ability groups and mixed ability for maths in secondary schools.

They found under-achievement, stigmatisation and anti-school attitudes in low ability groups.

Ireson and Hallam (2009) investigated the effects of ability grouping in schools on students' general and academic self-concept. Self-concept represents students' perceptions of themselves, their competence, interest and enjoyment. The study examined 23 secondary schools that used a range of structured ability grouping to allocate students to classes. Measures of the students' general self-concept, academic self-concept, and achievement were collected from the students in Year 9 and again two years later. The findings suggest that students' academic self-concept was related to the extent of ability grouping in the school attended. Students in the most stratified schools were found to have more negative general academic self-concepts. In contrast students who attended schools with the least amount of ability grouping were found to have the most positive self-concept. This suggests that experiences of ability grouping have an impact on how students view themselves academically. However, this research does not give details of the teaching and learning experiences of students who attend schools that use structured ability grouping to allocate students to classes. Therefore we cannot understand the mechanisms and processes that may underpin these differences.

Although research suggests that grouping students by ability benefits those who are high attaining (Ireson & Hallam, 2001), it is also suggested that it has negative effects on attainment for those in lower ability groups (Ireson & Hallam, 2001). Ireson and Hallam (2001) assessed the effects of structured ability grouping on the attainment and self-concepts of 3,000 Year 9 students. Their findings suggest that students who are of the highest attainment on entry to secondary school may make more academic progress when placed in higher ability groups, however, the lowest attaining students achieve less when placed in low ability groups. This suggests that grouping students by ability may only benefit the highest attaining students who represent a small proportion of children. This research failed to give an explanation as to why different degrees of ability grouping may result in these outcomes; for example, there is no information regarding what the teaching and learning experiences were for these children that may have resulted in the different outcomes.

There is little evidence to suggest that ability grouping delivers a net improvement in attainment for all students (Gillborn & Youdell, 2011). Wiliam and Bartholomew (2004) investigated the maths achievements of students in six different London schools. A total of 955 students were followed over a four-year period until they took their GCSEs. Although all the schools began grouping students by ability in different year groups they were all taught in ability groups by Year 11. The research aimed to evaluate the progress made by the students from KS3 to KS4. Although it was expected that children in high ability groups would achieve higher grades than those in low ability groups there was no reason for them to make greater progress given their prior attainment. Overall, students in high ability groups achieved half a grade higher at GCSE than would be expected from their KS3 results. In comparison, those in the lowest ability groups scored over half a grade lower than would be expected from their KS3 results. In four of the six schools, these effects were consistent with high ability groups making better progress than upper middle ability groups, who in turn made better progress than lower middle ability groups, who made better progress than low ability groups. Interestingly, in two of the schools this pattern was not found. In one school the lower ability group made more progress than the upper ability group and at another school the lowest ability group made more progress than any other group. This suggests that there are other factors that may contribute to the progress a child makes other than simply the group that they are placed in.

The schools where children made best progress were schools where teachers continued to make extensive use of small group and individualised teaching in comparison to traditional, teacher-directed whole class teaching. However, a substantial short coming of this research is that it provides insufficient detail regarding what the teaching and learning experiences were for these groups of students. There is little detail regarding how much small group or individualised work actually took place, whether or not children interacted, what the nature of the work set was and what type of questioning took place. Indeed this research does not describe what is meant by ‘individualised teaching’ in relation to this study. This means that the research has limited uses regarding changing ability grouping practices within schools. This will be discussed later in the section on teaching and learning practices.

2.6. How do teaching and learning practices differ between classes grouped by ability?

There is evidence to argue that teaching and learning practices in high and low ability groups differ with regards to teacher experience (Ireson & Hallam, 2001) and teaching approaches used (Boaler, Wiliam & Brown, 2000).

Evidence indicates that teachers of low ability classes are less qualified, have less subject knowledge and have been teaching for shorter periods of time (Ireson & Hallam, 2001; Slavin, 1990). Sukhnandan and Lee (1998) reported that higher ability groups were found to have more experienced and highly qualified teachers. Furthermore, Boaler et al. (2000) found that low ability classes were less likely to be taught by a subject specialist and were more likely to experience changes of teacher. This is concerning as it suggests that the students who require the most support and intervention are being taught by the least qualified or experienced teachers.

Considering the processes and criteria for allocating students to ability groups, it is highly likely that within any given class there are considerable variations with regards to students' attainment and approaches to learning (Boaler, Wiliam & Brown, 2000). This is not a concern if the range of attainment and learning styles are acknowledged and accounted for by teachers, however it is highly problematic for teachers to assume and treat students grouped by ability as intellectually homogeneous (Ireson, Clark, & Hallam, 2002). This approach will mean that it is likely that there will be some students within the class who find work too easy or who are not able to access learning.

Wiliam and Bartholomew's (2004) research strongly suggests that the negative effects of ability grouping may appear not just as a result of ability grouping, but when teachers use traditional methods of teaching which are often adopted when students are grouped by ability (Boaler, Wiliam & Brown 2000). As part of the same four year longitudinal study, Boaler, Wiliam & Brown (2000) reported on the experiences of students who were placed in ability groups for maths and how these differed from their experiences of being taught in mixed ability groups. This research was developed from themes arising from a study of two schools, one of which taught

maths in mixed ability groups and another which taught maths in classes grouped by ability (Boaler, 1997a, b).

In these studies (Wiliam & Bartholomew, 2004; Boaler, Wiliam & Brown 2000 and Boaler, 1997) evidence was gathered through questionnaires, interviews and participant observations. Boaler (1997 a, b) observed that teachers who taught maths to classes grouped by ability taught in a way that assumed the students were identical with regards to learning style and preferred pace. Boaler (1997 a, b) suggested that teachers in these classes taught lessons to an 'imaginary average student' and embraced the 'one size fits all' approach with regards to content and pace. Boaler, Wiliam and Brown (2000) observed that all students within an ability group were given identical work and were expected to complete it at the same speed regardless of whether they found it difficult or not. Although such qualitative descriptions are useful in giving an impression of what takes place in the classroom, it would be beneficial to have the observation information gathered and presented in a more systematic way. There is no information regarding the research methods used to collect and analyse the qualitative observation data of the classes. The results are presented as narrative, however it is unclear how this narrative was formed and how the researchers made decisions regarding what their focus should be. It is therefore not possible to know if a finding of the research occurred once or many times through the research. The absence of structured evidence means that the findings may not be considered reliable.

Boaler, Wiliam and Brown (2000) reported that teachers of mixed ability classrooms provided work that was differentiated either by task or by outcome. Teachers of mixed ability classes were often found to allow students to work at their own pace. Boaler, Wiliam and Brown (2000) explored how teaching practices changed as teachers moved from teaching mixed ability classes to ability grouped classes. They found teachers adopted a more prescriptive pedagogy and the same teachers who offered worksheets, investigations and practical activities to students in mixed ability classes used whole class teaching methods and textbook work when teaching groups with a narrower attainment range.

The information gathered by Boaler (1997a, b) and Boaler, Wiliam and Brown (2000) was based on questionnaires, interviews and qualitative observation data. These tools yielded both qualitative and quantitative data that represented the beliefs and attitudes of students, teachers, parents and school staff. This is useful information as it allows us to understand the perceptions of these groups of individuals. However, there are many factors that may influence an individual's perceptions of their experience. Reportedly qualitative observation was used in both studies, although it is important to note that there is very limited information presented in either piece of research that outlines the methods and procedures used to collect or analyse this observation data. In both pieces of research the type of observation used is described as participant observation (Eisenhart, 1988) where the observers immerse themselves in the environment, in this case the maths classroom. It is not clear how this observation was used and how the data collected was analysed this makes it hard to replicate the research. It would be important to investigate the same issues with the use of a systematic observation in order to develop a detailed account of the differences between teaching and learning experiences of high, low and mixed ability classrooms and enable direct comparisons.

2.7. What are the experiences of students taught in ability groups?

There have been various explanations suggested for the effects of ability grouping (Slavin, 1990; Nystrand 1975; Pallas et al., 1994). These include the consequences of having varying educational experiences, such as different pedagogy and quality of teaching in addition to self-fulfilling prophecies of students' expectations and teacher expectations. It is important to acknowledge that these factors continuously interact and do not occur in isolation from one another.

The continuous interaction of teaching and learning behaviours in classes grouped by ability means that it has historically been challenging to establish any one underlying cause of the observed effects. In order to understand what may be impacting the outcomes for students taught in ability groups it is important to first understand the day-to-day experiences that students in different ability groups may have.

This section of the literature review will focus on the following experiences of students grouped by ability: classroom interactions and classroom environment.

2.7.1. Classroom interactions

This section of the literature review will discuss research regarding the range of interactions which take place in ability groups in relation to how students interact with their: learning; peers; and teachers. There has been little research that has examined the nature of interactions that take place in ability groups. It is important to consider how students interact within the classroom both with other students and teachers in order to understand how they learn and how they engage with learning. The findings from studies which focused on the teaching and learning experiences of students in ability groups (Wiliam & Bartholomew, 2004; Boaler, Wiliam & Brown 2000 and Boaler, 1997) would suggest that students in low ability groups mainly interact with the teacher and have limited opportunities to interact with peers. Furthermore William and Bartholomew (2004) suggest that grouping students by ability leads to teachers using a transmission style of teaching. This would suggest that the teacher would spend most time interacting with students as a whole class across all ability groups as opposed to providing opportunities for interactions between peers.

Solomon's (2007) research focused on the importance of classroom discourse and the development of participatory and marginalised identities in high and low ability maths classes. Solomon's (2007) research was based on the importance of classroom discourse on the guided construction of knowledge and views education as a communicative process. Solomon (2007) used neo-Vygotskian theory to understand the importance of language and interactions within the classroom in order for students to develop knowledge within their zone of proximal development. Vygotsyky (1978) proposed that language and thought operate together, they are combined to make a cognitive tool which enables children to solve practical tasks with the help of their speech. Vygotsky argued that children undergo quite 'profound' changes in their understanding by engaging in joint activity and conversation with other people. The role of language in development of understanding is characterised in two ways:

- Providing a medium for teaching and learning

- Language is used by children to construct a way of thinking

Edwards and Mercer (1987) suggest that there is an imbalance of power within classrooms where teachers control the topic of discussion and how it should be talked about. They suggest that this results in teachers determining the language and meanings that are of target to the lesson as opposed to students developing meanings and language themselves. Edwards and Mercer (1987) present a detailed analysis of how classroom discourse operates to develop an understanding of new concepts via a collection of linguistic interactions used by the teacher including: responses which confirm, reject, repeat, elaborate, reformulate, paraphrase or reconstruct students' contributions. These detailed interactions have not yet been explored in relation to ability grouping with regards to how teachers use language to teach children. Producing an account of the linguistic interactions that take place within classrooms grouped by ability would give a greater insight into the learning experiences of students.

Solomon's (2007) research consisted of rich interviews with 13-15 year-old British students focusing on their accounts of learning and 'doing' maths in high and low ability groups. He found that there was a difference in the perceptions of the type of maths that they were engaging with and their mathematic identities. The analysis highlighted contrasting understanding of maths and experiences of teaching and learning between the high and low ability groups. The learning of high ability groups was characterised by a prescribed mix of opportunities for engagement, imagination and alignment as students not only learn the basics, but how to manipulate these in negotiated and reflective maths.

Students in higher ability groups described the importance of understanding how the maths works in order to then apply it to problems and investigations. They described understanding as developing through discussions with others. Students also described having to experiment with different methods in a creative manner, such as learning through investigations. Interactions between teachers and students in higher ability groups were reported to be reciprocal and there was a high level of engagement between students and teachers. Teachers were seen as a resource that could be used by students if needed and interactions between teachers and

students were described as sustained reciprocal conversations. Hence students in high ability groups recount teaching and learning relationships which foster, or stem from, participative identities.

In contrast, students in low ability groups reported a very different experience of learning maths. Students from lower ability groups describe lessons as being dominated by memorising facts and formulas, and an accompanying identity of marginalisation. Students described maths as something that was 'done to them' as opposed to something they were participating in and were engaged with. There was a strong focus on performance for students in lower ability groups, students were aware of exactly what their results had been and how many marks were needed to move to the next grade. Students in low ability groups discussed needing to learn maths for their future jobs and everyday life skills. This suggests that maths for low ability students is a means to an end in order for them to be able to function in life. Teachers of low ability maths classes were described as an authority and suggestions were made that students struggle to learn through negotiation with teachers. Students also described finding work boring and pointless and that they were not challenged by it. These findings support studies that have found that students in low ability groups find the level of work too easy (Hallam & Ireson, 2007). There is little detail in this research to demonstrate why students perceived their learning to be too easy. Was it a case that work was below the students level or was it the case that teachers put in place a high level of scaffolding to support students which meant that they were not using problem solving skills to answer questions?

Solomon's (2007) research suggests that there are marked differences between the interactions that take place between low and high ability classrooms which impact on the student's ability to be involved with maths. However, Solomon's research consisted only of interviews with students and failed to use any observational methods to help understand the reality of what was happening in the classrooms. It is possible that Solomon's results could be related to other factors such as student motivation and self-concept which impact on how they perceive themselves as learners. It may be that high ability classes are exposed to more participatory learning activities or that high ability students are more interested and engaged with

their learning. However from this research the mechanism and processes that underlie these identities are not clear.

Further research by Kutnick et al. (2006) suggests that students in high ability groups work more in groups. Kutnick et al. (2006) conducted 24 integrated, comparative case studies (12 primary and 12 secondary schools) to investigate the nature and impact of different grouping strategies on the quality of teaching and learning in schools. Kutnick et al. (2006) used interviews with school management, teachers and students in addition to observations and mapping of classrooms. They found that students in secondary schools reported a preference for paired work but were rarely given paired work assignments. Kutnick et al. (2006) found that students in high ability groups worked more frequently with peers than those in low ability groups. They argued that the classroom organisation and working experience of low ability groups was different from other groups and mixed ability groups. Low ability students were rarely offered the opportunity to interact with peers in pairs or small groups. This may be because the challenging behaviour associated with lower ability groups is perceived to be easier to control when they are being taught as a whole class and are not given opportunities to interact with one another. It may also be related to the student's expressive and receptive language skills. It is not clear from this research if peer interactions were controlled by teachers or if interactions were more natural between peers for example do students in high ability groups choose to interact with peers more frequently. It is important to identify whether it is the case that teachers give high ability students more opportunities for peer work or if this happens in an unstructured way.

2.7.2. Classroom environment

Research suggests that there are different learning environments in classes grouped by ability. These differences have been linked to teachers' expectations of students, behaviour and motivation (Boaler, Wiliam & Brown, 2000)

There is evidence that suggests teachers' expectations of students taught in ability groups are distorted by perceptions of 'ability', behaviour and attitudes. These perceptions may have an impact on the students' attainment and self-concept. Research by Ireson and Hallam (2005) indicates that teachers held the view that

students in high ability groups were bright, hardworking and interested in contrast to those in lower ability groups who were described as having behaviour problems (Macintyre & Ireson 2002), being lazy and lacking appropriate work ethic (Ireson & Hallam 2005). These perceptions are likely to have an impact on how teachers approach teaching and interacting with different groups of students. These observed differences may be linked to lack of motivation, limitations to students' learning or even as a result of misallocation to groups. There is no research that currently attempts to explain this.

Boaler, Wiliam and Brown (2000) used qualitative observations and in-depth student interviews to explore how ability grouping affected teachers' expectations and teaching practices across the ability spectrum. Grouping students by ability was found to lead to teachers having fixed and stereotypical expectations of students with regards to their learning capacities. They found that high ability group students were seen as a group who did not experience mistakes and did not need help or time to think. The environments of high ability classes were found to be stressful for some students and affected their ability to engage with work (Boaler, 1997b). The high ability classrooms were characterised by a fast pace where students were expected to rush through work without understanding the meaning instead of having opportunities to deepen their knowledge and understanding of concepts. Hallam and Ireson (2006) found that students in high ability classes can find this experience anxiety provoking and confusing.

In contrast, teachers of low ability groups had limited expectations for students (Boaler 1997b; Boaler, Wiliam & Brown 2000). Students in low ability groups were considered to be unable to have 'independent thought'. They were expected to copy from the board and work from text books. The pace of the lessons was fixed and slow which meant that children would finish work and be left sitting with nothing to do. This undifferentiated approach had consequences for students across the ability spectrum.

In their study of 13 schools Dunne et al. (2007) highlight the importance of interpersonal relationships in low ability groups. Teacher-student relationships were perceived as being significant to the effective learning of low attaining students.

Teachers of low ability groups described using practical and fun activities with students as rewards for behaviour and task completion. Students in low ability groups reported a more relaxed disciplinary environment in addition to difficulties maintaining order. Many teachers described creating a positive learning environment for students in low ability groups where they encouraged participation. This was achieved through the use of praise, careful questioning and treating mistakes as part of learning.

Again there is little explanation of the methodology used to reach these conclusions. This area of research is lacking the use of a systematic description of the nature of teaching, learning and engagement experiences in classrooms.

2.8. The development of stigmatised identities

This section of the literature review will focus on the development of social identities formed by the process of being placed in a given ability group. It will consider how stigmatised identities may lead to anti-school attitudes, challenging behaviour and the reduced academic progress of students in low ability groups. McManus (2010) develops and tests a theory which suggests that social identities are formed as a result of placement in a given ability group and are not caused by differential treatment. She argues that the social context within ability grouped systems results in groups of students defining their own identities which then impacts on their presenting social and learning behaviours. McManus (2010) argues that these different identities then evoke different teaching practices from teachers.

McManus conducted a longitudinal case study of a single secondary school which was changing from a banded to a mixed ability system. Students' identities and experiences were assessed through questionnaires, interviews, qualitative observations, and school performance and pastoral data.

As part of the study McManus conducted interviews with ‘borderline’ students during the first term of Year 7 between whom there were no significant differences, educational or otherwise, and were therefore assigned at random to a higher or lower band. Regardless of the lack of differences between these students they described their social group identities very differently. Students placed in high ability

groups described positive identities whereas middle band students described negative identities.

McManus (2010) argues that student placement in a low or middle ability group is perceived as having limited advantages for the individual, and is often viewed negatively both by students within the group and those in other groups. Students in these groups are identified by themselves and the school community as having intellectual limitations. Therefore students in low ability groups are perceived as having attributes that convey a devalued identity and hence develop a stigmatised identity. Stigmatised identities have been linked to having negative effects on academic achievement (Crocker, Major & Steele, 1998). Crocker, Major and Steele (1998) suggest that the stereotype of being intellectually limited presents a threat to the individual who may respond in ways that aggravate the situation. However it is important to note that this is not in the context of ability grouping.

McManus (2010) suggests that the development of stigmatised identities may result in lower ability students presenting maladaptive behaviour which impacts on their learning behaviours. She found that students who had experienced ability grouping were more likely to subscribe to an entity theory of intelligence where they believed that intelligence is fixed and unchangeable. She suggested that this is due to the level of assessment used to measure ability and attainment that occurs in schools. She adds that this also emphasises the importance of performance goals where the aim is to gain positive judgements or avoid negative judgements of competence as opposed to learning goals where the aim is to increase competence. In maths this may relate to answering questions correctly or incorrectly as opposed to learning to develop understanding.

Dweck (1986) suggests that once students have adopted the entity theory of intelligence and are operating with performance goals their behaviour is determined by their confidence in their ability. McManus (2010) suggests that when students adopt a stigmatised identity where they believe that they are ‘not good at academic work’ their confidence in their work will be low. According to Dweck’s (1986) research this would suggest that they would be likely to adopt maladaptive patterns of behaviour, which would involve avoiding negative judgments, avoiding challenge

and having low persistence. This would be likely to present itself in classrooms as students having low motivation. However, the reality may be that students make little effort in order that any failure may be attributed to a lack of effort, as opposed to a lack of ability. McManus (2010) suggests that avoiding challenge and having low persistence could present as students opting for closed rote tasks and giving up easily.

McManus (2010) conducted qualitative observations of classroom behaviours of high, middle and low ability classes and found that when faced with challenges students in middle ability classes were more likely to present with negative body language, deploy avoidance strategies and were more likely to respond by being reluctant to commit to answers. McManus (2010) suggests that such low level behaviours were seen to seen to hinder the communication between teachers and students. It is not clear why students react to challenge in this way. It may be that these students are not able to complete challenging tasks and what is 'challenging' for a middle and low ability group feels different for a student in a high ability group. For example, is it a question of a student completing an A* level question or is it a case of a student applying their knowledge to a maths problem that requires them to use problem-solving skills?

2.9. Developing mathematics understanding

Here, in order to fully understand the teaching and learning practices within maths classrooms, the researcher considers how mathematical understanding is developed through childhood.

Fredickson, Miller and Cline (2009) argue that mathematical thinking is fundamental to other subjects both in science and humanities. They suggest that each element in mathematical knowledge is related to every other element and they suggest that maths concepts can only be understood by understanding the sequence of assumptions behind them. The language of mathematics involves symbols and diagrams that can only be interpreted by those who understand the conventions that govern them. When the symbols and conventions are fully understood together with the concepts that underpin them, information can be manipulated and communicated in a form that is concise, simple and transparent. However Fredrickson, Miller and Cline (2009) argue that pupils often learn the symbols that are used in mathematics

and the procedures for manipulating them but do not develop an understanding of what the symbols mean or why the procedures work.

A child who has simply learnt procedures and rules may be able to successfully answer the question 792/4 by knowing how to 'carry over' or use the 'bus stop method' without understanding the mathematics behind this method. The effect of this lack of understanding may be seen in various ways including: making uncorrected errors that highlight there lack of conceptual understanding and difficulty with retaining information in addition to not being able to apply their learning to different problems (e.g. with decimal numbers or worded problems).

Fredrickson, Miller and Cline (2009) distinguish between procedural knowledge and conceptual understanding. Procedural knowledge (knowing how) involves knowing the written language of mathematics and also the step-by-step prescriptions for manipulating numbers. Conceptual understanding (knowing why) involves such processes as insight, discovery and the integration of different pieces of information (Baroody and Dowker, 2003). This distinction between 'procedural knowledge' and 'conceptual understanding' has been very important in mathematics education, and the terminology used to describe this difference has frequently changed. For example Skemp (1976) outlined the differences he saw between relational understanding (knowing both what happens and why) and instrumental understanding (which involves applying rules without reason). Skemp (1976) argues that learners construct schemata to link what they already know with new learning. According to Skemp (1976), mathematics involves an extensive hierarchy of concepts and he suggests that learners cannot form any particular concept until they have formed all the subsidiary ones upon which it is depends.

2.10. Research problem

Previous research has not provided a systematic multi-dimensional description of the nature of teaching and learning, the type of tasks and the nature of interactions in ability grouped classes.

There are only a small number of studies that have attempted to explore the teaching and learning practices and experiences of students and teachers in classes

grouped by ability. The previous research that has been conducted in this area fails to give a detailed account of the types of tasks given to students, the nature and extent of questioning used, students' level of engagement in tasks, and the opportunities made available for students to discuss strategies and work in groups.

Previous research has suggested that the effects of ability grouping are not necessarily caused only by the process of placing students in ability groups (Boaler, William and Brown, 2000). Instead, it suggests that students of all abilities may be able to make good progress in ability groups, but this is dependent on the teaching and learning experiences they have. However, we know very little about the nature of teaching and learning practices used in classes grouped by ability that may result in positive or negative outcomes. It is important that research provides a more detailed description of what takes place in ability-grouped classes in order to unpick the complex factors that exist in these contexts.

The current research aims to provide a detailed description of the nature of activities and teaching and learning interactions that take place within maths classrooms grouped by ability. The intention is not to undertake a study that will provide generalisable research findings, but rather to provide a snapshot of classroom practices and an in-depth description of the nature of teacher and student experiences in a small sample of classrooms.

The study does not aim to suggest that grouping students by ability is either good or bad practice. Instead it aims to develop a more in-depth understanding of what takes place in ability groups and hypothesise as to why these differences may exist. This research is exploratory in nature, seeking to pose questions. The research will focus in detail on the interactions between students with their peers and adults in the classroom. Through structured observation, qualitative observation, audio recordings, semi-structured interviews and questionnaires, the research will provide insights into the teaching and learning practices and the experiences that students and teachers have of ability grouping.

The research will aim to explore the following research questions:

RQ1: What is the nature of teaching and learning practices and interactions that take place in Year 10 maths classes that are taught in different ability groups (high, middle and low) and how do they vary?

- *To what extent do students in different ability groups work as a whole class, individually, in groups, or in pairs?*
- *To what extent are students in different ability groups provided with structured opportunities to discuss learning with peers in a group or in pairs?*
- *To what extent are students in different ability groups engaged with their learning? Are they more engaged with their learning when working with peers or when working independently?*
- *To what extent do students work with and socialise with peers or work alone?*
- *How do maths tasks set by teachers vary between different ability groups? With regards to the type and complexity of task, for example number of possible answers, possible methods, having a clear or an ill-defined goal, written in books/worksheets, whiteboards or verbal.*
- *What is the nature of the discourse in classes grouped by ability?*
- *What is the content of teacher interactions with students, for example are the interactions focused on mathematic concepts, explaining tasks, asking questions, giving feedback, addressing behaviour or responding to students?*

RQ2: How do teachers and students perceive the nature of the learning and teaching and the social environment in their classroom?

- *How do teachers and students perceive the types of tasks that students engage with in lessons?*
- *To what extent do students and teachers perceive students as working together during lessons?*
- *What helps and hinders students' learning in lessons?*
- *How do students and teachers perceive the behaviour of students in lessons?*
- *To what extent are students supportive of one another during lessons?*

RQ3: How do students from different ability groups perceive themselves as general learners and maths learners?

- *Do students in high ability groups perceive themselves to be more competent maths and general learners than students in middle and low ability groups?*
- *Do students in low ability groups perceive themselves to be less competent maths and general learners than students in high and middle ability groups?*

Chapter 3. Methodology

3.1. Research Design

The current research adopted a mixed-methods design to explore and describe the experiences of ability grouping for young people in classes designated as of high, middle and low ability across two schools. Three classes, one from each ability level, from each school participated in the research. This approach was chosen to provide a detailed understanding of the nature of the teaching and learning in classes grouped by ability and the perceptions of pupils and their teachers.

The research involved the collection of both quantitative and qualitative data to capture a detailed description of the teaching and learning practices and experiences of students in different classes. The following data instruments were used to collect data: student questionnaires, structured lesson observations, qualitative lesson observations, teacher audio recordings, student interviews and teacher interviews.

The data collection took place over the last half of the 2016 autumn term. This point in the school year was chosen as by this time of year it was thought that students would be settled in their classes (for example if they had changed groups at the start of the year). The summer term was not chosen to avoid the exam season at school where school timetables are often disrupted by exams and revision classes. The research aims to make comparisons between the experiences of students and teachers in high, middle and low ability classrooms.

3.2. Research Paradigm

The current research adopts a pragmatic perspective. The use of the pragmatic perspective is promoted by Biesta and Burbules (2003) to conduct research in education. The pragmatic perspective holds the view that reality is constantly renegotiated, debated, interpreted in light of its usefulness in new unpredictable situations. Pragmatism is described as making use of both quantitative and qualitative approaches (Johnson & Christensen, 2004). The pragmatic approach focuses on the best way of trying to answer the research questions using the most appropriate research tools to do so.

3.3. Sample

3.3.1. Schools

The research focused on two comprehensive schools in inner city London. The schools were sent a letter (Appendix 1) inviting them to take part in the research in September 2016. Follow up phone-calls were made to the schools to discuss the research in more detail and next steps.

The aim was to identify two similar schools so the data from the high, middle and low ability grouped classes could be combined across schools. The criteria for the schools to be selected included the following: comprehensive school, grouping by ability in maths at Key Stage 4 (KS4), schools being academies, having a good or outstanding OFSTED rating.

School A was a large school with a total of 1970 students enrolled; of this number 700 students were enrolled in the sixth form. Over a quarter of the students attending the school spoke English as an Additional Language (EAL) with over 50 different languages spoken. Just below one quarter of the students are eligible for pupil premium funding. This is additional funding provided by the government for disadvantaged students. This is broadly in line with national average. The most recent Key Stage Four (KS4) results for the school showed that 87% of students achieved a C grade or higher in both English and Maths (above the national average). School A's Progress 8[1] score was 0.34. The duration of the lessons in school A was 1 hour.

School B was a smaller school with 1275 students on roll 275 of who attend the sixth form provision. Just less than three quarters of the students in the school spoke EAL with over 50 different languages spoken. The most recent Key Stage Four (KS4) results for the school showed that 78% of students achieved a C grade or higher in English and maths (above the national average). School B's Progress 8 score was 0.74. The duration of the lessons in school B was 1 hour and 40 minutes.

[1] This score shows how much progress pupils at this school made between the end of Key Stage 2 and the end of Key Stage 4, compared to pupils across England who got similar results at the end of Key Stage 2. The average score for mainstream schools in England is 0.

3.3.2. Selecting classes

Year 10 maths classes were focused on as, by this stage, both schools used ability grouping to allocate students to maths classes. When allocating students to ability groups both schools used a combination of attainment, classroom dynamics and perceived ability. Schools allocated students to ability groups in the following ways:

- School A allocated students to ability groups from the start of Year 8 in maths. In Year 10 the students were separated into two bands (A and B) for timetabling reasons. Classes within each band were taught maths at the same time. There were five maths groups in band A and four maths groups in band B. The lowest of the ability groups (Set 5, band A) was comprised of children with very low attainment and were considered a 'nurture group' and was therefore not included. Please see Table 1 for an outline of the structure of classes and ability groups.

Table 1: The structure of classes in school A

Band A	**Band B**
Set 1- High Ability*	Set 1- High Ability
Set 2- Middle/high	Set 2- Middle/high
Set 3- Middle/low	Set 3- Middle/low*
Set 4- Low*	Set 4- Low
Set 5 - Nurture	

*The classes selected for the research

- School B used a higher and lower banding system to allocate students to their maths classes in KS3. In KS3 there was a total of eight classes within each year group. Four classes were considered to be 'mixed higher' and four were 'mixed lower'. The school then started grouping students into higher, middle/high, middle/low and low ability groups in Year 10. School B separated students in two bands (band A and B). Classes within each band were taught maths at the same time. There were 4 classes in each band high ability (set 1) middle/high (set 2) middle/low (set 3) and low (set 4). Please see Table 2 for an outline of the structure of classes.

Table 2: The structure of classes in school A

Band A	Band B
Set 1- High Ability	Set 1- High Ability*
Set 2- Middle/high	Set 2- Middle/high
Set 3- Middle/low*	Set 3- Middle/low
Set 4- Low	Set 4- Low*

*The classes selected for the research

Within each school one high, one middle (set 3) and one low ability year ten maths class was selected. The classes that were selected are indicated in the tables above. Classes were selected from each band to enable the researcher to timetable the observations to avoid lessons clashing.

When discussing which classes should be included in the research the high ability groups were described as being comprised of students aiming for new GCSE grades 9, 8 and 7 (old GCSE grades A* and A) hence the highest achieving class in the Year group.

One criterion for the low ability classes was that the students in the class were able to access an age appropriate maths curriculum. For that reason 'nurture groups' and 'remedial classes' were not included. Therefore the lowest ability groups selected were working towards taking GCSEs. This was set 4 in both schools. Students within these groups had target grades between 2 and 4 (old GCSE grades E-C).

There was a discussion with schools regarding which middle ability class should be selected for the research. It was agreed that students in the middle ability class selected would be working towards achieving a grade 4 or 5 (old GCSE grade C/lower B). Please see Table 3 for descriptive details of the classes selected.

Table 3: Descriptive information for classes

School	Teacher	Teacher Gender	Ability Group	Set within school	Target grades end of KS4	Female students (N)	Male students (N)
A	1	Male	High	1 of 4	7-9	17	16
	2	Male	Middle	3 of 5	4-6	10	8
	3	Female	Low	4 of 4	2-4	8	8
B	4	Female	High	1 of 4	7-9	11	15
	5	Male	Middle	3 of 4	4-6	10	8
	6	Female	Low	4 of 4	2-4	6	5

3.3.3. Selection of students for observations

Within each class six students were selected to be the focus of the structured observations. Class teachers were asked to identify the six students, two high two middle and two low attaining students. The teachers were asked to select students from the highest attaining third, middle attaining third and lowest attaining third. Where possible the teachers were asked to use the most recent attainment information to select students. The teachers were instructed to avoid choosing students based on other variables such as 'good behaviour'.

3.3.4. Selection of students for interviews

One male and one female student were interviewed from each of the observed classes to obtain an in-depth view of their experiences. The students selected to be interviewed were different from the students observed for the structured observation. The teachers were asked to select two students of average attainment for that class. Teachers were asked to randomly select a male and female student from the middle 50% of students, based on their attainment. This meant that students were not selected from the highest attaining (25%) and the lowest attaining (25%) of students. Students of average ability were selected as opposed to selecting a high and low student because of the differences highlighted by Boaler (1997) regarding how girls and boys experience ability grouping. Boaler (1997) found that girls in high ability groups reported higher levels of anxiety when they were struggling to 'keep up' with learning. Choosing male and female students of different abilities would mean adding an additional variable.

The student interviews were conducted during tutor time in both schools so as not to cause any unnecessary disruption to the student's school day and to prevent having to withdraw them from their lessons. The students were selected by their class teacher to be interviewed and efforts were made to select two students from the same tutor group to keep disruption to a minimum. A total of 12 student interviews were completed.

Each class teacher was interviewed about their experiences and views on the particular class and how they approach teaching that class.

3.3.5. Selection of students for questionnaire

All students from each class completed the questionnaire. In total 122 students completed the questionnaire from the high (N=59), middle (N=36) and low (N=27) ability groups across both schools.

3.3.6. Ethical considerations

The current research followed the British Psychological Society Code of Ethics and Conduct (2006). Ethical approval was granted by the Department of Psychology and Human Development, Ethics Committee, UCL Institute of Education, University of London (Appendix 2). The following ethical considerations, which related to this study and how they were addressed, are discussed below.

Informed consent: Letters were sent to the parents of children in the classes to gain consent (Appendix 3). The letters outlined the purpose of the research and assured confidentiality for all students participating. Schools were consulted with regards to whether opt-in or opt-out consent would be appropriate to use when gaining parental consent. Both schools chose to use opt-out consent. This meant that the parents needed to reply to the letter to state that their child could not participate in the research. No parents replied to the school to request that their child did not take part in the research.

Teachers were sent a letter outlining the study and inviting them to participate in the research.

Finally consent was obtained from the students. Students were given a questionnaire to complete about how they viewed themselves as learners and as maths learners. At the top of the questionnaire there was a paragraph explaining the purpose of the study, which stated that by completing the questionnaire they were consenting to take part. It was made clear that they could choose to withdraw themselves from the research at any time. The teachers of the classes were also asked to support the students with the questionnaire if needed (Appendix 4). In this questionnaire the students were given the opportunity to not be observed or interviewed for the research.

Confidentiality: All participants were told that any information included was confidential and that responses would be anonymous in the final report. The names of all students, teachers and schools were anonymised.

3.4. Research tools

A number of research tools were used to collect data including: student questionnaires, structured lesson observations, qualitative lesson observations, teacher audio recordings, student interviews and teacher interviews. The following will describe the research tools.

3.4.1. Development work

Development work was completed in the summer of 2015 as part of an earlier research project on this topic. This research aimed to observe the reality of what occurs in high and low ability mathematics classes. Three schools were recruited, three high and three low ability Year 10 maths classes were selected. The schools selected were different from the schools included in the current study. Structured observations were conducted to observe the interactions taking place in the classroom in addition to the maths tasks. This developmental work was an opportunity to develop and trial a systematic observation schedule which observed students and teachers to collect data on the nature of interactions that take place in the classroom, student engagement with learning, task type and opportunities for pair and group work.

The part of the observation schedule which focused on the task type, has been developed into a qualitative observation for the current research. This was because it

was not possible to objectively observe the task type in a short period of time and determine the exact nature of the task for a specific student.

3.4.3. Student Questionnaire

A questionnaire was developed using items from the Burnette Self-Scale (Burnett, 1994). This scale was developed from Marsh's (1990) Self-Description Questionnaire One (SDQ1). The Burnette (1994) scale was chosen because it includes both descriptive and evaluative beliefs regarding different characteristics. In contrast the Marsh (1990) scale focuses on how competent students perceive themselves to be in a given area. The Burnette (1994) scale combines the student's self-evaluations with descriptions regarding their enjoyment and liking in a given area.

The Burnette (1994) questionnaire consists of eight subscales, each consisting of five items measuring both descriptive and evaluative beliefs about specific characteristics of the self: physical appearance, physical ability, peer relations, relations with mother, relations with father, reading self-concept, maths self-concept and learning self-concept. For the purpose of the current study the items relating to maths self-concept and learning self-concept were selected.

The questionnaire (Appendix 4) consisted of eight scales. Scales 1, 3, 5 and 7 measured maths self-concept. Scales 1 and 5 measured descriptive beliefs (e.g. I like/enjoy maths and sums) and scales 3 and 7 measured evaluative beliefs (e.g. I'm good at maths and sums). Scales 2, 4, 6 and 8 measured learning self-concept. Scales 2 and 6 measured descriptive beliefs (e.g. I like learning new things) and 4 and 8 measured evaluative beliefs (e.g I'm good at learning new things).

For each scale the student was required to read five sets of statements relating to how they think and feel about maths and learning. The student was then asked to decide which of the statements best described them. Scores were allocated to each item on the basis on 1 (most negative) to 5 (most positive). Below is an example of item 1 from the questionnaire.

Please tick the one statement that you think best describes you

	I really like maths and sums
	I like maths and sums
	I sometimes like maths and sums
	I do not like maths and sums
	I really do not like maths and sums

3.4.4. Structured Observation

Two observation schedules were used, one that focused on the teacher (Appendix 5) and one that focused on the students (Appendix 6). The observation schedules were used for alternating 2 minute and 30 second periods. The observation schedules were used one after the other beginning with the student observation and then the teacher observation. Each class was observed on two separate occasions for one hour. The researcher was the only observer involved in collecting the observation data for the current study no additional observer was used.

The observations involved a time sampling approach whereby behaviour was observed for five seconds in every 15 second period. The observation periods for each target (e.g. student or teacher) consisted of 10 x 15 second periods.

The 15 second period consisted of the following:

- A five second tuning in period where the target was located and focused on.
- A five second observation period where the behaviour of the target was observed.
- A five second coding period where the behaviour was recorded in the observation schedule.

Through the development work completed the researcher was able to become familiarised and competent in using this research tool before using it for the current study.

The observation schedule was trialled with a second observer using video recordings of lessons to test for inter-rater reliability. The second observer was given training in how to use the schedule. The researcher and the second observer watched the video recording for a five second period, the video was then paused and the coding took place for that period of time. The second observer practiced using the observation schedule with the researcher for 100 scans to become skilled in using the tool. In total 200 observation scans were completed and used to measure the inter-rater reliability.

Calculation of Cohen's Kappa to establish a measure of inter-rater reliability after a further 200 observation scans was completed. The results suggested that there was acceptable agreement (Field, 2013) between the observers, as shown in Table 4 below.

Table 4: Cohen's Kappa calculation of inter-rater reliability

Observation schedule category	**K**	**Number of observations**
Work Setting	0.980	200
Student Not interacting	0.828	200
Interacting	0.874	200
Adult Identity	0.969	200
Adult Audience	0.969	200
Interaction Type	0.864	200
Target Activity	0.864	200

3.4.4.1. Student coding framework

The coding framework is designed to capture student interaction and on and off task behaviour. It is important to note that when observing on and off task behaviours the observer was only able to base her classification on the presenting behaviours and what they appeared to indicate (e.g. On task – child writing in book, looking at the board and performing calculations. Off task – doodling in book, playing on phone and not completing work.). However it is possible that these judgments were not always valid for example a student could be doodling in their book but still be thinking about a maths problem.

The student interaction and on and off task behaviour sections of the framework were adapted from the School Lunch and Behaviour Study (Baines et al 2009). A

detailed outline of the coding framework can be found in Appendix 7. The coding framework includes the following categories:

Section 1: Work Setting

This section is to be completed in every observation. The observer is to note down what pupils should be doing as intended or expected by the teacher regardless of whether they are doing it or not. This captures whether the work setting is *individual*, *pupil-pupil interaction*, *adult led group*, *whole Class* and *other.*

Section 2: Target not interacting

This section is to be completed when the target student is not interacting with others and is either working or not working on his or her own. This section should not be completed in conjunction with Target-pupil interactions or Adult-target interaction. This section captures whether the student is on or off task and whether they are engaging with a procedural or routine activity. This category also captures whether students are on task intermittent or sustained.

Section 3: Target- pupil interaction

This section should be completed only when the target is interacting with one or more other pupils in the class. This section can be used in conjunction the section for adult interaction. This section captures whether the student is on or off task when working with another student and whether they are engaging with a procedural or routine activity. This category also captures whether students are on task intermittent or sustained.

Section 4: Adult-target interaction

This section should be coded no matter how briefly the adult – target interaction occurs. All blocks should be completed.

4a) Adult Identity- The person identified here should be the adult interacting with the target, if 2 or more adults are interacting with the target then the teacher takes priority. This captures the role of the adult interacting with the student e.g. teacher, teaching assistant etc.

4b) Adult's Audience- This block of categories shows whether the pupil is the focus of the adult's attention or if he/she is one of several or if the entire class is being addressed.

4c) Target to Adult Interaction

This section identifies the nature of the interaction between the target and the adult. Does the student begin the interaction with the adult, respond to the adult, engage in a sustained interaction, listen to the adult or not attend?

4d) *Target's Activity*

This section is used to identify the activity of the student during the interactions with the adult. Is the student on task (intermitted or sustained), engaging with a procedural or routine task, off task or engaging in a social interaction?

3.4.4.2. Teacher coding framework

The items from the teacher observation schedule are an adapted version of the schedule used to observe students. A detailed description of the observation schedule is given in Appendix 8.

Section 1: Target Interaction

This section captures the targets interaction. Whether they are interacting with an individual, a small group, whole class or a member of staff.

Section 2: Interaction theme

This section captures what type of interaction was taking place between the target and others. Is the interaction work based, social, routine or other?

Section 3: Teacher to student Interaction

This section identifies the nature of the interaction between the target and the adult. Does the teacher begin, respond, sustain, attend or not attend to the interaction.

3.4.6. Qualitative observation of task type

Qualitative notes were taken during the student observation periods to capture the type of tasks that students were engaging with. The notes were taken at the end of

each student observation period to summarise the learning taking place over the 2 minute and 30 second period.

Yeo's (2007) classification of maths tasks was used to identify different characteristics of each task. Yeo (2007) distinguishes between a number of different types of task and does this by discussing them in relation to whether they have a clear goal to achieve, have one or multiple answers, have only one method to be used, are set in real life and are abstract. Using these clarification characteristics we can develop an impression of the type of thinking that is being cultivated by teachers within the different classrooms.

For example, if a task has an ill-defined goal and multiple answers, such as, 'investigate powers of 3'. Students are required to pose problems and goals for themselves, justify their answers and choose appropriate methods. Whereas a task such as 'find the last digit of 3^{2007}' does not require them to create their own problems or evaluate the best answers, however they can choose which method is best to use. These two examples demonstrate the difference between an investigation and problem. In addition to this the research will aim to capture whether students in the class are given a clear method to follow for each problem or they are able to choose their own method. If students are applying one method to a number of questions this would indicate that the task is procedural in nature.

The aim of this research tool is to capture the task type as intended by the teacher as opposed to the type of task for individual students. This is because the student's prior knowledge of the maths tasks is likely to be different. This will mean that what would be considered a 'problem' for some students would not be a 'problem' for others. For example if students were given a question such as $^1/_3 + {}^3/_4$, this would only be a 'problem' for students that did not know or had a very early understanding of the method used for adding fractions. Whereas, for students who know the method it would be much more of a procedural task.

Qualitative notes were taken to capture the following characteristics of the task:

- General task- what was the task generally about e.g. finding percentages of amounts?

- Goal- did the task have a well-defined or ill-defined goal?
- Answer- was there one correct answer for the task or were there multiple possible answers?
- Method- was there one method for the students to use or were there multiple methods that students could use?
- Differentiation– was there differentiation present for the task? Is the differentiation through outcome or task e.g. are students of different ability given different tasks to complete or are they expected to complete different amounts of the task set?
- Task type- was the task a pure maths task that has no real life context e.g. 'factorise $2x^2 + 6x$'. Or was the question a task with a real life context e.g. how many pots of paint will be needed to paint a $25m^2$ wall.
- Scaffolding- was there scaffolding present? If what so what was the nature of the scaffolding.

3.4.5. Lesson audio recordings

Audio recordings of the teachers were made during one of the two observations across all six classes. The audio recordings were obtained in order to develop a detailed description of the language used by the teacher when interacting with students during lessons.

The first 30 minutes of each lesson were recorded and analysed. The first 30 minutes were chosen to ensure that the comparisons could be made between school A and B due to the different lesson lengths. Across the classes the first 30 minutes of the lesson normally consisted of the teacher introducing learning followed by a period of students completing independent work. After the 30-minute period there were variations with regards to what was taking place in the lessons. In the 1-hour lessons students tended to finish the activity they were working on followed by a plenary whereas in the 1 hour and 40 minute lessons new learning was often introduced. Therefore we would expect to observe different types of interactions and language being used as the type of learning was different.

In total six recordings were made providing three hours of teacher voice recording. The recordings were made using a lapel microphone which was attached to the teachers clothing.

The audio recordings were analysed using a structured coding system from Rubie-Davies, Blatchford, Webster, Koutsoubou, and Bassett (2010) and developed to analyse the differences between teachers and teaching assistants in terms of the nature of their interactions with students in the classroom. On playback, every 20 seconds (90 coding periods per audio recording) of teacher talk was coded using the following categories:

Organisation

The observer could code either or both categories if they occurred once or more during the 20-second period.

- *Student organisation.* This was coded when the teacher was organising where the students were and what they were doing in the classroom. Examples include: starting and finishing tasks; writing the date and title; instructing them to sit in seats; getting ready for learning and taking the register.
- *Materials organisation.* This was coded when the teacher was organising materials in the classroom. Examples include: handing books out, distributing calculators and giving out worksheets.

Language use concepts

The observer could code either or both categories if they occurred one or more time during the 20-second period.

- *Explaining a concept.* This was coded when the teacher was explaining a maths concept to students. For example if the teacher was talking a student through a question step by step.
- *Statements as prompts.* This was coded when a teacher said a statement about a maths concept to prompt a student's thinking.

Teacher asking question

This category was used to capture the type of questions asked by the teacher. The observer could code any categories if they occurred one or more time during the 20-second period.

- *Questions with a right or wrong answer.* This was coded when the teacher asked a question that had a right or wrong answer.
- *Questions requiring an explanation.* This was coded when a question asked by the teacher required an explanation or justification.
- *Open ended question.* This was coded when the question asked by the teacher had many possible answers.
- *Checking understanding.* This was coded when the teacher checked the students understanding of their learning.

Teacher responding to student answer

This category was used to capture how the teacher responded to student's answers. The observer could code any categories if they occurred one or more time during the 20-second period.

- *Confirming or rejecting student response.* This was coded when the teacher indicated if the student's response was correct or incorrect.
- *Repeating student response.* This was coded when the teacher repeated the student's response.
- *Asking for elaboration.* This was coded when the teacher asked the student to elaborate on his/her response and give more of an explanation.

Feedback

This category captures the feedback given to students about their learning. The observer could code any categories if they occurred one or more time during the 20-second period.

- *Feedback about learning.* This was coded when the teacher gave some form of feedback regarding their learning. This could be regarding their written or verbal learning.
- *Praise or criticism.* This was coded when the teacher gave praise or criticism regarding learning.

Initiating peer interactions

This category was coded when the teacher initiated an interaction between students. For example, suggesting that students should work together.

Teacher addressing behaviour

This category was coded when the teacher addressed a student's behaviour. This category was coded when both positive and negative behaviour was addressed.

Promoting engagement and/or motivation

This category captures how teachers motivate and engage the students with learning

- *Promoting cognitive engagement.* This was coded when the teacher encouraged the students to use thinking skills to help them with their learning. For example the teacher would say "I want you to look at the other questions and think about whether that answer is correct or not".
- *Task focus. This was coded when the teacher spoke about the logistics of the task that the students were completing. E.g "I'd like you to practice question 3 and then go on to 5".*

No utterances

This was coded when the teacher did not speak during the 20 second period.

3.4.7. Semi Structured Interviews

Semi structured interviews were chosen as a research tool in order to collect information regarding the student and teacher experiences of their maths classes. This research method was chosen as opposed to collecting information from all students using a questionnaire, as the researcher wanted more detailed perspectives than would practically be provided by short or structured questionnaires. Using semi structured interviews also allowed for a more personal approach where students and teachers where able engage more with the questions and open up when responding. Finally using semi-structured interviews meant that the students were able to engage regardless of their literacy skills and abilities. This was important as it may have had a particular impact on students taught in lower ability groups where research has suggested that there are more children with SEN (Dunne et al., 2007).

Focus groups were considered in order to achieve a greater breadth of information. However it was considered that focus groups would not be suitable as they are practically difficult to set up and to analyses. In addition focus groups would not provide individual perspectives or descriptive information regarding the areas that the research aimed to investigate. Focus groups were also not considered as appropriate given the complex nature of young people's peer relationships and how this may impact on the validity of the accounts given.

3.4.7.1. Student Interviews

One male and one female student were selected from each class to be interviewed about their experiences of being in their maths class (six male and six female). The interviews took place during tutor time for each student. The interviews were semi structured and lasted around 15 minutes. Time was included at the start of the interview for rapport building and to seek informed verbal consent from students.

The interviews took place in a quiet room during tutor time in each school to ensure the students were not removed from their lessons. In school A tutor time was the first lesson of the school day. In school B tutor time was in the middle of the school day. In school B the Senior Leadership staff requested that a Teaching Assistant to be present in the room during the interviews due to the school's safe guarding procedures. The interviews were recorded using a digital voice recorder.

The student interview schedule contained questions designed to gather information about the following areas (Please see Appendix 9 for interview schedule):

- Perception of the type of tasks completed in lessons.
- The extent to which students work together during lessons.
- What helps and hinders student's learning.
- The behaviour of students in the class generally.
- How supportive students are of one another?
- What did students talk to their teacher about?

3.4.7.2. Teacher Interviews

Each class teacher (six in total) was interviewed about their experiences of teaching their maths class. The interviews were semi structured and lasted between 15 and 20 minutes. The teachers were asked to identify a time when they would be available

to be interviewed. The interviews took place in a quiet room and were recorded using a digital voice recorder.

The teacher interview schedule contained questions designed to capture the following areas (Please see Appendix 10 for interview schedule):

- The type of tasks set by teachers in lessons.
- The extent to which students work together during lessons.
- What helps and hinders student's learning?
- The students' ability to verbally express themselves.
- The behaviour of students in the class generally.
- How supportive students are of one another?
- What did teachers talk to the students about?

3.5. Data Analyses

This section will describe the methods of data analyses used to examine the data generated by each research instrument.

3.5.1. Questionnaire data

The data from the student questionnaires were input into Statistical Package for the Social Sciences (SPSS). Cronbach's alpha was calculated as a measure of internal consistency between the items measuring maths and learning self-concept. Descriptive statistics and analysis of variance (ANOVA) were calculated to compare the responses made by high, middle and low ability groups. Further analysis was completed to compare different ability groups using independent groups t-tests.

3.5.2. Structured observation data

The data from the teacher and student observation schedules were analysed using SPSS. Descriptive statistics were generated including frequency tables and cross tabulations.

3.5.3. Lesson audio recordings

The audio recordings provided descriptive data which was analysed on a class-by-class basis. It was not considered appropriate to combine the results from both ability groups, as there were variations in the type of talk used in both high and both low ability groups.

3.5.4. Qualitative observation of task type

The field notes from the qualitative lesson observations were synthesised in order to capture the type of tasks set for students in their lessons. The analysis of the field notes discussed the tasks in relation to the nature of the goal; if the task had one or many correct answers; if there was one or many methods; if the tasks were set in real life or were pure maths tasks and if there was scaffolding present. The analysis also discussed what prior knowledge the students in the class have of the type of tasks set in the lesson.

The researcher's maths subject knowledge and experience of teaching maths was used in order to interpret the observation of the task type.

The descriptions of the task type were described in relation to the characteristics of the task as opposed to mathematical details and content. This is to enable the reader to understand the type of thinking that students are engaging with without the need for in-depth mathematical knowledge.

Yeo's (2007) maths task classification system was used to categorise the different type of tasks that were set by the teachers in the maths lessons. The information regarding goals, answers, methods, task type, scaffolding and the student's prior knowledge were used to categorise the different tasks. The following criteria were used:

Investigations- Investigations are divergent activities where students set their own goals. Investigative tasks involve both problem solving and problem posing.

Guided discovery learning- Guided discovery learning is when students are guided by a teacher to explore a mathematical idea in order to discover a formula, a procedure or some mathematical fact which the teacher has in mind. It is important to note that the teacher leads this process.

Problems- Yeo (2007) defines a problem from a pedagogical perspective where a student is not able to proceed directly to a solution. Problems have well defined goal. Problems could have many or infinite numbers of answers.

Procedural tasks- Procedural tasks require the student to apply a procedure directly to a task in order to achieve an answer. This does not involve problem solving skills as the student is aware of the steps they need to take to reach the correct answer to the question.

Semi-real tasks- These are tasks that have been created to give a storyline to a maths task. Skovsmose (2002) called this sort of storyline a reference to a semi reality: “not a reality that we actually observe, but a reality constructed by, for instance, an author of a mathematical textbook”.

Academic/pure maths tasks- Academic or pure maths tasks give no real life context to the tasks.

3.5.5. Interview

The interview data were analysed using thematic analysis. This method of analysis was chosen to interpret the qualitative data as it permitted information to be understood in a detailed and flexible way. Grounded Theory was considered as a possible alternative approach to the analysis of this data but was rejected as the research aimed to provide a descriptive account of the experiences of students and teachers as opposed to deriving a theory to explain the data experiences.

An inductive approach was adopted to analyse the data as outlined by Braun and Clarke (2006). This means that the themes identified are strongly related to the data itself (Patton, 1990).

The following steps were taken to analyse the data as defined by Braun and Clarke (2006):

1. *Familiarisation of data*- Transcribing, reading and listening to the data.
2. *Generating initial codes*- Coding the data.
3. *Searching for themes*- Organising codes into possible themes.
4. *Reviewing themes*- Inspection of the themes to ensure they are representative of the coded extracts.

5. *Defining and naming themes*- Refining each theme and generating clear definitions and names.

Please see Appendix 6.11 for evidence of the thematic analysis process.

The analysis of the data was completed manually as opposed to using a program such as N-Vivo. This was chosen as the researcher wanted to physically engage with the data and be able to visualise the themes. The kinaesthetic quality of physically arranging and rearranging codes into sub-themes and subthemes into themes facilitated the exploration of alternative interpretations of the data.

During each phase of data collection the original interview transcripts were discussed within supervision. In addition to this inter-coder reflection and discussion was also conducted with a fellow Trainee Educational Psychologist (TEP) who read and coded a sample of transcripts. At the end of this process, differences and similarities were discussed between the perceptions of the two readers. This discussion lead to some adjustments and elaborations to the themes and subthemes developed. The purpose of discussing themes within supervision and with a fellow TEP was to listen to alternative interpretations of the data and further reflect upon emerging themes and subthemes. This provided a more in-depth consideration of the themes.

Chapter 4. Results

4.1. Overview of results

This chapter presents the results from analyses of the quantitative and qualitative data. The results are presented in four parts: quantitative results, qualitative interview results, qualitative lesson observations and audio recording analyses.

4.2 Quantitative Results

4.2.1. Assumptions for quantitative results

All data were examined for errors and to understand whether data met the assumptions that underlie inferential statistics to be used. This section will outline the assumptions made for the statistical analysis completed.

Self-concept questionnaire data – Homogeneity of variance was assessed using the Levene's test which was not significant.

4.2.2. Self-concept questionnaire (RQ3)

Reliability analysis was undertaken using Cronbach's Alpha to assess internal consistency for the four items of the questionnaire measuring maths self-concept ($\alpha = 0.84, N = 4$) and general self-concept ($\alpha = 0.807, N = 4$).

Maths Self-Concept

There was a significant difference between the students in high, middle and low ability groups with regards to their maths self-concept, $F(2,119) = 3.98$, $p = 0.021$, partial $n^2 = 0.63$.

The mean scores presented in Table 6 are based on the total scores for the four scales from the questionnaire which measure maths self concept. The highest possible score is 20 (positive maths self-concept) and the lowest possible score is 4 (negative maths self-concept).

The results are shown in Table 6.

Table 6: Means and standard deviations for maths self-concept.

	Mean	Standard Deviation	N
High	14.22	3.21	59
Middle	14.19	2.80	36
Low	12.41	2.39	27

Further analysis using independent t tests revealed that there was no significant difference between the high and middle ability group with regards to maths self-concept $t(93) = 0.4$, $p = 0.687$, $d<0.01$.

There was a significant difference between the high and low ability group, $t(84) = 2.62$, $p = 0.011$, $d = 0.64$, and the middle and low ability group, $t(61) = 2.66$, $p = 0.01$, $d = 0.69$.

General Learning Self-Concept

There was a significant difference between the students in high, middle and low ability groups with regards to their maths self-concept, $F(2,119) = 3.26$, $p = 0.04$, partial $n^2 = 0.63$). The results are shown in Table 7.

The mean scores presented in Table 7 are based on the total scores for the four scales which measure general learning self concept. The highest possible score is 20 (positive self-concept) and the lowest possible score is 4 (negative self-concept).

Table 7: Means and standard deviations for general self-concept.

	Mean	Standard Deviation	N
High	15.53	2.56	59
Middle	15.00	2.45	36
Low	14.07	2.2	27

Further analysis using independent t tests revealed that there was no significant difference between the high and middle, $t(93) = 0.99$, $p = 0.326$, $d = 0.21$, and middle and low, $t(61) = 1.55$, $p = 0.13$, $d = 0.4$, ability groups with regards to general self-concept.

There was a significant difference between the high and low ability group in relation to their general self-concept, $t(84) = 2.55$, $p = 0.013$, $d = 0.61$.

4.2.3. Student structured observation (RQ1)

A total of 510 15-second observation periods of students in high ability classes were completed, 500 observation periods of students in middle ability classes were completed and 480 observation periods of students in low ability classes.

Understanding the figures in the tables:

Counts (C) – This is the number of times a particular behaviour was observed across high, middle and low ability lessons.

Percentages (%) – The percentages presented in the tables show the percentage of the total number of 15-second observation periods that a particular behaviour was observed in for each ability group.

Student work context

The most common work context set by teachers of all groups was individual work, which was followed by whole class teaching. The middle ability groups were more frequently asked to work in pairs (11.4%) or give a pupil plenary (7%).

Table 8: Counts (C) and percentages within ability group (%)of work context for high, middle and low ability groups.

		Individual	**Pupil-Pupil**	**Whole Class**	**Pupil Plenary**	**Other**	**Total**
High	C	330	8	160	12	0	510
	%	64.7%	1.6%	31.4%	2.4%	0%	100%
Middle	C	222	57	181	35	5	500
	%	44.3%	11.4%	36.3%	7%	1%	100%
Low	C	334	0	140	3	3	480
	%	69.6%	0%	29.2%	0.6%	0.6%	100%
Total	C	886	65	481	50	8	1490
	%	59.5%	4.4%	32.3%	3.4%	0.5%	100%

Interaction type

Analysis of the types of interactions that took place in the classroom were conducted. The results are shown in Table 9.

Students in high ability groups spent more time than middle and low ability groups interacting with a peer. Students in low ability groups spent more time than middle and high ability groups not interacting.

Table 9: Counts (C) and percentages within ability group (%) of interaction type of students in high, middle and low ability groups.

		Target Not Interacting	**Target Interacting With Peer**	**Target Interacting with Adult**	**Total**
High	C	162	189	159	510
	%	31.8%	37.1%	31.2%	100%
Middle	C	199	109	189	497
	%	40%	21.9%	38.0%	100%
Low	C	297	29	154	480
	%	61.9%	6%	32.1%	100%
Total	C	658	327	502	1487
	%	44.3%	22%	33.8%	100%

Interaction and work context

Further analysis was completed to assess the types of interactions taking place given the work context. This analysis was completed to explore how students interacted given a particular work context set by the teacher. For example do students interact with peers during individual work? The results are shown in Table 10.

Individual work context: When the work context was individual students in high ability groups were observed to spend a greater proportion of time working with peers (52.7%) and worked individually for smaller proportion of time (46.1%). When the work context was individual the students in middle ability groups spent the greatest proportion of time not interacting (77.5%) and least time interacting with peers (22.5%). Lower ability groups spent the majority of time (88.9%) not interacting when the work context was individual.

Pupil-pupil: When the work context was pupil-pupil interaction students in high ability groups did not interact. Whereas students in middle ability groups spent the majority of the time interacting (66.7%).

Whole class: Students in all of the ability groups observed spent the majority of the observation interacting with an adult during whole class teaching.

Pupil plenary: Observations of students in all ability groups showed that they were mostly interacting with a peer during pupil plenaries. In middle ability groups there were a small percentage of observations when they were not interacting (34.3%) during pupil plenaries.

Table 10: Cross tabulation of counts and percentages of student interaction given work setting.

Work context			Target Not Interacting	Target Interacting With a Peer	Target-Adult Interaction	Total
Individual	High	C	152	174	4	330
		%	46.1%	52.7%	1.2%	100%
	Middle	C	172	50	0	222
		%	77.5%	22.5%	0%	100%
	Low	C	297	24	13	334
		%	88.9%	7.2%	3.9%	100%
	Total	C	621	248	17	886
		%	70.1%	28%	1.9%	100%
Pupil-pupil	High	C	8	0	0	8
		%	100%	0%	0%	100%
	Middle	C	10	36	8	54
		%	18.5%	66.7%	14.8%	100%
	Low	C	-	-	-	-
		%	-	-	-	-
	Total	C	18	36	8	62
		%	29%	58.1%	12.9%	100%
Whole Class	High	C	2	3	155	160
		%	1.3%	1.9%	96.9%	100%
	Middle	C	0	0	181	181
		%	0%	0%	100%	100%
	Low	C	0	2	138	140
		%	0%	1.4%	98.6%	100%
	Total	C	2	5	474	481
		%	0.4%	1.0%	98.5%	100%
Pupil-Plenary	High	C	0	12	-	12
		%	0%	100%	-	100%
	Middle	C	12	23	-	35
		%	34.3%	65.7%	-	100%
	Low	C	0	3	-	3
		%	0.0%	100%	-	100%
	Total	C	12	38	-	50
		%	24%	76%	-	100%

Task Engagement

The counts for not interacting, pupil-pupil interaction and adult interaction were combined to give an overall count for on-task, off-task and other. Overall students in

all ability groups spent the majority of the time on task. Students in middle ability groups spent the greatest percentage of time off-task (15.7%) however this was still significantly less time than students spent on-task. Results are presented in Table 11.

For this analysis the 'other' and 'procedural' categories were combined to enable the assumptions for the statistical analysis to be met.

Table 11: Counts (C) and percentages within ability group (%) of student engagement in task in high, middle and low ability groups.

		On-task	**Off-task**	**Other**	**Total**
High	C	466	19	25	510
	%	91.4%	3.7%	4.9%	100%
Middle	C	403	77	11	491
	%	82.1%	15.7%	2.2%	100%
Low	C	441	37	2	480
	%	91.9%	7.7%	0.4%	100%
Total	C	1310	133	38	1481
	%	88.5%	9%	2.6%	100%

Engagement and interaction

Further analysis was completed for the levels of engagement given the interaction type. Please see Table 12 for results.

Target not interacting: Overall students in all groups spent the majority of time on task when not interacting with other students or adults. Students in middle ability groups were off task for a greater percentage of time (14.6%) than any other group when not interacting. Students in low ability groups spent less time off task than expected (3.7%).

Student-student interaction: In high ability groups when students were interacting they spent the greatest amount of time on-task (95.2%). In middle ability groups when students were interacting there was a smaller difference between the percentage of time on task (62%) and off task (38%). In low ability groups when students were interacting they spent most time off task (69%).

Table 12: Counts (C) and percentages within ability group (%) of student engagement given student interaction type for high, middle and low ability groups.

Interaction type			On-task	Off-task	Other	Total
Student not interacting	High	C	141	8	13	162
		%	87%	4.9%	8%	100%
	Middle	C	167	29	3	199
		%	83.9%	14.6%	1.5%	100%
	Low	C	284	11	2	297
		%	95.6%	3.7%	0.1%	100%
	Total	C	592	48	18	658
		%	90%	7.3%	2.7%	100%
Student-student interacting	High	C	180	9	-	189
		%	95.2%	4.8%	-	100%
	Middle	C	67	41	-	108
		%	62%	38%	-	100%
	Low	C	9	20	-	29
		%	31%	69%	-	100%
	Total	C	256	70	-	326
		%	78.5%	21.5%	-	100%
Student interacting with adult	High	C	145	2	12	159
		%	91.2%	1.3%	7.5%	100%
	Middle	C	169	7	8	184
		%	91.8%	3.8%	4.3%	100%
	Low	C	148	6	0	154
		%	96.1	3.9%	0%	100%
	Total	C	462	15	20	497
		%	93%	3%	4%	100%

4.2.4. Structured observation of teachers (RQ1)

A total of 500 15-minute observation periods were completed of teachers in high ability classes, 520 observation periods were completed of teachers in low ability classes and 48 observations of teachers in low ability classes.

Teacher Interaction

In both middle and low ability groups the teachers spent approximately half their time interacting with the whole class and approximately 40% of their time interacting with individual students. The results show that teachers of high ability groups spend much less time on whole class instruction. Teachers of high ability groups spent more time than any other group not interacting (23%). The results are presented in Table 13.

Table 13: Counts (C) and percentages within ability group (%) of interaction types of teachers in high, middle and low ability groups.

		Individual	Small Group	Whole Class	Staff Interaction	Not Interacting	Total
High	C	199	6	180	0	115	500
	%	39.8%	1.2%	36%	0%	23%	100%
Middle	C	210	6	260	0	44	520
	%	40.4%	1.2%	50%	0%	8.5%	100%
Low	C	179	3	229	4	65	480
	%	37.3%	0.6%	47.7%	0.8%	13.5%	100%
Totals	C	588	15	669	4	224	1500
	%	39.2%	1%	44.%	0.3%	14.9%	100%

Interaction theme

The main interaction theme across high, middle and low ability groups was work based. Teachers of low ability classes spent a slightly greater proportion of time focusing interactions on behaviour (8.5%). The results are shown in Table 14.

Table 14: Counts (C) and percentages within ability group (%) of interaction theme of teachers in high, middle and low ability groups.

		Work	Social	Behaviour	Routine	Other	Total
High	C	334	0	24	51	24	433
	%	77.1%	0%	5.5%	11.8%	5.5%	100%
Middle	C	412	2	30	33	14	491
	%	83.9%	0.4%	6.1%	6.7%	2.9%	100%
Low	C	358	6	40	53	15	472
	%	75.8%	1.3%	8.5%	11.2%	3.2%	100%
Totals	C	1104	8	94	137	53	1396
	%	79.1%	0.6%	6.7%	9.8%	3.8%	100%

Interaction type

There was a greater amount of sustained interaction in high ability classrooms than middle and low. Teachers of low ability classes spent a smaller percentage of time than would be expected listening to students (5.1%).

Table 15: Counts (C) and percentages within ability group (%) of interaction type between student and teacher.

		Begins	Responds	Sustains	Attends/Listens	Total
High	C	49	52	63	35	199

	%	24.6%	26.1%	31.7%	17.6%	100%
Middle	C	68	55	25	37	185
	%	36.8%	29.7%	13.5%	20%	100%
Low	C	67	50	33	8	158
	%	42.4%	31.6%	20.9%	5.1%	100%
Totals	C	184	157	121	80	542
	%	33.9%	29%	22.3%	14.8	100%

4.3. Qualitative lesson observations (RQ1)

The field notes from the qualitative lesson observations have been synthesised in order to capture the type of tasks set for students in high middle and low ability groups. Please refer to Appendix 12 for a rich description of the qualitative observations for each class.

Yeo's (2007) maths task classification system was used to categorise the different types of tasks that were set by the teachers over the two maths lessons observed for each class. The information regarding goals, answers, methods, task type, scaffolding and the student's prior knowledge were combined to consider what type of tasks and thinking the students were engaging with.

The table below (Table 16) indicates if the type of task was present in either or both of the lessons observed. It is important to note that not all students will have accessed some of the tasks in the lessons as these were either extension activities or were present towards the end of an activity. These tasks have been marked in the table with a star (*).

Summary of qualitative lesson observations

The main type of tasks set for all ability groups would be described as procedural in nature where the students apply a given method directly to a task in order to reach one correct answer. All lessons also had pure maths tasks where tasks were set in a real life context and were abstract in nature. Generally maths tasks that involved a real life context tended to be focused towards the end of the lessons. There was differentiation present within the lessons however this was through outcome as opposed to task.

High ability- In high ability groups there were tasks that required problem solving skills however these were set as either extensions or were at the end of activities therefore not all students will have completed or been aware of these tasks. These problem solving tasks had infinite numbers of answers and the students were required to consider appropriate methods to use to reach their answer.

Middle ability- In middle ability groups there was a mixture of activities observed. Problem solving tasks were built into the lessons that were presented to all students. The problem solving tasks required students to work out an appropriate method to use to answer the problem. In one middle ability lesson a guided discovery learning approach was used to introduce a new topic to the students. In this lesson the teacher guided the learning of the students with a series of short tasks that lead to them discovering a mathematical fact that the teacher had in mind.

Low ability- The low ability group classes where accessing learning that would be considered as being above their attainment level please see the detailed analysis in the Appendix 11 for more information regarding this. Tasks in both low ability groups were all pure maths tasks that required students to apply a method directly to a problem. There were no problem solving or real life tasks in low ability lessons. There was often a high level of instruction given for tasks where the methods for performing calculations were broken down with each step made explicit. Tasks were mostly repetitive in nature requiring a small number of processing steps. Students in low ability groups were also observed to use methods, such as moving the decimal point when dividing numbers by powers of ten, which may demonstrate their lack of relational understanding of the maths that they were doing.

Table 16: A breakdown of task type in lessons for students

	Investigations	**Guided Discovery learning**	**Problems**	**Procedural tasks**	**Semi-real tasks**	**Pure maths tasks**
High Ability						
School A			Lesson 1*	Lesson 1	Lesson 1	Lesson 1
			Lesson 2*	Lesson 2	Lesson 2	Lesson 2
School B			Lesson 2*	Lesson 1		Lesson 1
				Lesson 2		Lesson 2
Middle Ability						
School A		Lesson 1	Lesson 1	Lesson 1	Lesson 2	Lesson 1
				Lesson 2		Lesson 2
School B			Lesson 1	Lesson 1	Lesson 1	Lesson 1
			Lesson 2	Lesson 2	Lesson 2	Lesson 2
Low Ability						
School A				Lesson 1		Lesson 1
				Lesson 2		Lesson 2
School B				Lesson 1		Lesson 1
				Lesson 2		Lesson 2

*= Not all students in the lesson will have completed these tasks

4.4. Lesson audio recordings (RQ1)

The 30-minute audio recordings were analysed using predefined codes from Rubie-Davies et al. (2010). The 30-minute recordings were broken down into 90 20-second recording periods. The data is shown as the percentage of the 90 observations that the given utterance occurred in.

The coding categories were combined for the following to give overall counts for:

- Organisation- Student organisation and materials organisation
- Language use concepts- Explaining a concept and statements as prompts
- Teacher asking questions- Questions with a wrong or right answer, questions requiring an explanation, open ended questions and checking understanding
- Teacher responding to student- Confirming or rejecting response, repeating student response and asking for elaboration.
- Feedback- feedback about learning and praise or criticism

There was variation between the types of talk taking place in the different classrooms. The research design did not include statistical analyses of lesson audio recordings because only one recording was carried out for each class and multiple

category sets could be coded simultaneously thus breaching the assumptions of independence that many statistical tests require.

The percentages for each category are presented for each individual class in addition to the mean percentages (Table 17) in order to allow for comparisons between categories and classes. On inspection of the data it was not considered appropriate to combine data from the same ability groups as there were some differences between classes. Overall trends in relation to the different codes will be discussed in addition to any anomalies across the different classes. Please see Appendix 13 for a fuller analysis of the lesson audio recordings.

Summary of lesson audio recording

Overall the most common types of talk across all classes were organising students and materials, explaining maths concepts, asking questions and responding to students. The questions asked by all teachers mostly had one correct answer. Teachers responded to student's answers by either confirming or rejecting the answers and frequently repeated student answers.

There was variation between the talk used by teachers in individual lessons. It is likely that the type of talk used by teachers in lessons will vary with regards to a number of factors such as teaching style, the topic being taught, whether a topic is being started or if students are consolidating their learning at the end of a topic.

The greatest degree of variation was between the two high ability classes with regards to the amount of time they spent organising and the amount that they spent explaining concepts. The teacher of the high ability group in school A spent the vast majority of the observation (55.6%) explaining maths concepts; this was higher than any other class. In comparison the teacher of the high ability group in school B spent the smallest percentage of time (15.6%) explaining maths concepts. The teacher of the high ability group in school B spent the greatest percentage of time (42.2%) organising students and materials whereas the teacher of school A spent the least amount of time organising materials (8.9%).

The two middle ability groups presented with the most similar profiles and spent exactly the same amount of time explaining maths concepts (33.3%). The two middle

ability teachers asked questions in approximately 40% of audio recording periods. This was the highest percentage of all classes. The middle ability teachers prompted the students' thinking in the greatest percentage of observations. Teachers of the middle ability classes initiated interactions between students most frequently (7.8%).

The teacher talk in the low ability groups was relatively evenly spread across organising, explaining, questioning and responding. Both teachers responded to students more frequently than asking them questions (school A=34.4% and school B=27.8%). This difference was more prominent in school A than school B. This may have been due to there being a number of occasions when students were sharing answers to work sheet questions with the class.

Table 17: Percentages, mean percentages (standard deviations) of audio recording periods where different utterances were used.

	School	Organisation	Language use concepts	Teacher asking a questions	Teacher responding to a student	Feedback	Initiating peer interactions	Teacher addressing behaviour	Task focus	Promoting engagement/thinking	No Utterances	Other
High	A	8.9%	55.6%	27.8%	22.2%	7.8%	0.0%	5.6%	17.8%	2.2%	11.1%	3.3%
High	B	42.2%	15.6%	20.0%	27.8%	6.7%	0.0%	22.2%	13.3%	6.7%	7.8%	0.0%
Middle	A	24.4%	33.3%	38.9%	25.6%	7.8%	7.8%	7.8%	22.2%	13.3%	4.4%	3.3%
Middle	B	31.1%	33.3%	40%	22.2%	10%	7.8%	14.4%	12.2%	14.4%	5.6%	2.2%
Low	A	26.7%	24.4%	17.8%	34.4%	15.6%	0.0%	25.6%	8.9%	2.2%	2.2%	10.0%
Low	B	35.6%	18.9%	25.6%	27.8%	13.3%	1.1%	15.6%	15.6%	6.7%	4.4%	4.4%
Overall Mean percentage		**28.1% (11.4)**	**30.2% (14.4)**	**28.3% (9.3)**	**26.7% (4.5)**	**10.9% (3.5)**	**2.8% (3.9)**	**15.2% (7.80)**	**15% (4.6)**	**7.6% (5.3)**	**5.9% (3.1)**	**3.9% (3.4)**

4.5. Qualitative data analysis (RQ2)

The qualitative interviews for teachers and students were analysed together for high, middle and low ability groups. Three key themes emerged across the different ability groups: Peer Interactions, Teaching and Learning and Classroom Environment. These themes were similar across the ability groups however there were some subtle differences between the groups.

Frequency analysis has been presented for each subtheme and individual code in order to show how the frequency varies over the high, middle and low ability groups. This approach was chosen to show the extent to which there were similarities and differences across the ability groups to allow for comparisons to be made. There are two frequencies presented in the tables (a(b), a=number of interviews b=the overall frequency of the codes).

It is important to note that this thematic analysis is based on data from short interviews with students (approximately 15 minutes) and teachers (approximately 20 minutes). This was due to availability of students and teachers. Therefore the findings provide a limited insight into the experiences of teachers and students from different ability groups.

When presenting quotes participants have been assigned a unique identification code.
The first letter of the code corresponds to their ability group (1-high ability, 2-middle ability and 3-low ability). The second letter of the code relates to whether they are a teacher (T) or student (S). The third letter of the code relates to the participant's gender (M or F).

4.5.1. Theme 1: Peer Interactions

This theme captures the interactions that take place within the classroom between students. The subthemes include: Students working together and Student support. Please see Table 18 for a breakdown of the subthemes and codes and how these vary across ability groups.

Table 18: This table presents the subthemes and codes for the theme peer interactions.

Theme 1: PEER INTERACTIONS			
	High Ability	Middle Ability	Low Ability
Subtheme 1: Students working together	**6(28)**	**6(22)**	**6(25)**
Teachers and students describing students as not working together	1(1)	2(3)	5(12)
Students working together to help each other with learning	6(15)	4(8)	3(7)
Students work together to compare answers		4(4)	1(1)
The teacher prompts students to work together		1(4)	2(3)
Working together is the students natural way of working	2(3)		
Teachers named specific students that are able to work together		2(2)	1(1)
Students have access to many peers who can help them if needed	2(5)		
Working together makes learning easier to understand	3(4)	1(1)	1(1)
Subtheme 2: Student support of one another	**6 (8)**	**6 (11)**	**6(15)**
Students are supportive	6 (7)	4 (4)	3(6)
Students are not supportive	1(1)	3 (7)	5(9)

Two frequencies are presented in the table (a(b), a=number of interviews b=the overall frequency of the codes)

Subtheme 1: Students working together

All teachers and students spoke about how students worked together in the classroom. Students and teachers across all ability groups described students seeking help from one another when they were stuck with their learning. The main form of peer interactions described were informal as opposed to structured peer or

group work activities set by the teacher. Teachers and students reported that when students worked together their ability to understand their learning was enhanced.

1SM- 'For me personally the thing that helps the most is isn't like the questions or how miss explains it it's like how I interact with other people and like when we like work together we find it easier to like understand the topic.'

However, there were some subtle differences in the way that students and teachers described working together across the ability groups.

Teachers and students in high ability groups described students as continuously working in collaboration with one another to solve problems and answer questions. The students also spoke about the wide access they had to peers who could help them and who they in turn could help.

1SF- "you can just ask your neighbour or you can ask people in front of you and normally there's like if nobody knows then there's always that one person who kind of knows everything so we just kind of ask them and they normally will explain it in brief to someone who may be. So say there's a person on my right who's really really good and there's this person on my left who is quite good but he's not as good. So he'll probably explain it to him and then he'll go back to me or something like that so it kind of works like that."

1SM "everyone's more talkative and it's just something that feels natural to them cause they just want to talk they like don't want to be silent they don't want to be like kept down if you know what I mean."

Students and teachers of middle ability groups suggested that peer work often consisted of students working together to check and compare answers as opposed to having more in-depth discussions and explanation around learning. This may suggest that some interactions are limited in middle ability groups. The teachers of middle ability groups spoke about the importance of managing how students interacted with one another in the class by setting clear expectations regarding the volume levels, movement around the classroom and the time that students would be allocated for talking with one another.

2SM " well sir gets like two people to go up when we're doing answers and stuff like that which I guess is interactive but he won't get anyone to like try and explain to the class"

2TM " what I'll say is that you're allowed to speak but only with the people next to you or in front or behind you and only about the work…and keep the volume down"

Students and teachers in low ability groups spoke about the importance of independent work and how students often relied heavily on others for support. One teacher explained that the students behaviour in lessons can make peer work difficult as they become easily distracted when working together which makes peer work challenging. Teachers and students reported that students are often prompted by teachers to seek help from their peers when they become 'stuck' with learning. Similarly to the middle ability group peer work seemed to focus on getting the 'right' answer where possible. One student suggested that the teacher was aware that the students were easily distracted and that this had an impact on the type of work that they were set in lessons.

3SF "and I find even with myself if I were to work with like my friend or in a group I'd just get really easily distracted and not be on task and then like yeah and our teacher knows that which is why we normally work individually and then we're really focused on what we're doing"

3TF "Some of them who are struggling in there and they will kind of lean over and say oh how do you do this again. They don't even normally phrase it like that they'll say oh 'what did you get for that one?'."

3SF "sometimes she'll say try asking X cause she sits next to me and sometimes that really helps as well. Because if they get it then they can explain."

One teacher spoke about how she gives students a high level of instruction for their learning, which meant that they were able to get on with learning activities independently without support from others.

3TF "the way I teach I do try and have everything so explicit and clear so that they should be able to get on by themselves so there isn't much group work we don't even really do peer assessment in there."

Subtheme 2: Student support

Students and teachers from all ability groups spoke about how students support one another within the classroom. Teachers and students described students as being supportive of one another with their learning. The majority of talk regarding students

not being supportive to each other related to students laughing at one another when peers answered questions incorrectly.

Students and teachers in high ability groups described the students as being highly supportive of one another in relation to their learning. There was an impression that students were able to ask a number of peers for help and support when needed.

> *1SM "um quite supportive I'd say they would generally help anyone if they needed the help um they're very supportive actually."*

Students and teachers in middle ability groups gave examples of when students were supportive and when they were not. There were a number of examples of students laughing at one another when peers gave incorrect answers but this was generally viewed as joking as opposed to being unkind. One teacher suggested that the student's lack of supportive behaviour was a result of them having low self-esteem.

> *2TM "often the weaker they are the lower self-esteem and oddly rather than being supportive they'll laugh when someone else gets something wrong"*

> *2SF "overall I'd say they are supportive but obviously if someone says an answer that's incorrect some people might laugh from time to time but everyone in the class is quite nice"*

Students and teachers in low ability groups described the level of support between students as being variable. They explained that students will try to help others if they are stuck and will sometimes offer alternative methods. They reported that there was a selection of students who would not be considered as supportive and who could be actively unsupportive and unkind to other students.

> *3TF "Um I think they are generally very supportive of each other but occasionally you get students like one of them gets something wrong and they'll be like 'oh you're stupid'"*

4.5.2. Theme 2: Teaching and learning

This theme captures the teaching and learning that takes place in the classroom. Subthemes include: Developing understanding, Classroom talk and Teaching. Please see Table 19 for a breakdown of the subthemes and codes and how these vary across ability groups.

Table 19: This table presents the subthemes and codes for the theme teaching and learning.

THEME 2: TEACHING AND LEARNING			
	High Ability	Middle Ability	Low Ability
Subtheme 1: Developing mathematical understanding	**4(14)**	**3(9)**	**4(17)**
Students being described as having difficulty retaining learning			4(4)
Focus on the conceptual understanding of maths	3(10)	2(2)	4(8)
Students lack basic numeracy skills which effects their understanding			2(4)
Students lack motivation to understand learning		1(3)	
Students are not aware of what they do and don't understand		2(4)	1(1)
Descriptions of maths as a creative subject	2(4)		
Subtheme 2: Talk in the classroom	**3(10)**	**2(8)**	**4(12)**
Teachers using questioning to support students	2(3)	1(3)	
Value of teacher explanations	1(2)	1(1)	3(5)
Students having a good verbal ability	2(5)	1(1)	
Students having a poor verbal ability		2(3)	3(7)
Subtheme 3: Teaching	**6(24)**	**6(14)**	**6(13)**
Use of traditional teaching methods	6(17)	5(7)	5(6)
IT support programs as being helpful			2(4)
Time controlled activities		3(4)	
Importance of repetition for learning	2(2)		1(3)
Teachers using rich tasks	2(5)	2(3)	

Two frequencies are presented in the table (a(b), a=number of interviews b=the overall frequency of the codes)

Subtheme 1: Developing understanding in maths

Students and teachers across ability groups spoke about the importance of developing the students understanding of maths. Teachers explained that it was important for student's to understand the maths behind their learning before applying their knowledge to tasks. Although this was highlighted as being an important part of learning across ability groups there were some slight differences with regards to how the teachers and students spoke about developing understanding across the groups.

Teachers and students in high ability groups spoke about the importance of developing conceptual understanding in order for students to be able to interpret and apply their mathematical knowledge. One teacher considered that the aim of lessons was to move beyond procedural tasks to tasks requiring interpretation. One teacher spoke about how she often challenged students when they described 'quicker' methods for solving maths problems (e.g. moving the decimal point when multiplying by ten) as these methods stopped students from fully understanding their learning. One student and one teacher spoke about the importance of seeing 'the link' for learning. One student spoke about enjoying learning when she understood it but was still challenged by it.

> *1TF "I very much like them to think about their conceptual understanding so rather than just repeating stuff I want them to understand it first so they* can see the link.
>
> *1SF "those kind of tasks when you find it kind of difficult but then you kind of know it at the same time so in a way it kind of challenges you"*
>
> *1TM "the objective is always to move beyond those [procedural] tasks into tasks that require interpretation and understanding."*

Teachers of the middle ability classes spoke about how students struggled to identify what it was that they did not understand about a task or activity. They described students asking for help with a question and saying that they didn't understand 'anything' that the question was asking them. One teacher linked this to the students lacking motivation to try. One teacher spoke about the students not having a conceptual understanding of maths and suggested that the students would struggle to identify if an answer is wrong or right.

2TM "you want to get them to the point where they go I know that I don't understand this very specific task and they can ask you that question. Most of the time if you just said what don't you know they would say algebra or something vague"

2TM "these guys see maths quite often as here are some numbers put it in and you get a number out the end. So they have no contextual idea of even if it's right what kind of ball park it would be"

The teachers and students of low ability groups spoke about understanding being important and making sure that the students feel confident with the mathematical tasks. One teacher described how students found quicker methods for mathematical tasks e.g. moving the decimal point when multiplying by ten. The teacher explained that although this is not technically correct this gives them a method that they feel confident with.

3TF " when I was teaching them about negative indices I showed them that pattern to help it make sense to them rather than just saying oh it's a decimal so therefore it's to the power minus one at least they can see the pattern so they kind of thought that they understood"

The teachers of low ability groups spoke about students poor numeracy skills as a barrier to them being able to develop an understanding in maths. They explained that some students lack skills such as multiplying, and adding which can have an impact on their ability to develop understanding.

3TF "sometimes she doesn't know whether she should be adding or multiplying or she's be at a step when she can't for the life of her remember what three times five is"

Students and teachers of low ability groups also spoke about students finding it difficult to remember maths techniques and how to solve maths problems. One student spoke about having activities at the beginning of the lesson to help them remember what they had learnt in the previous lesson.

3TF " their retention is quite low like they'll follow something on the board just fine but when it comes for them to do it themselves they might forget what to do"

3SF "I have a really bad memory"

Subtheme 2: Talk in the classroom

Teachers and students from all ability groups described the type of talk that takes place between students and teachers in the classroom regarding learning conversations. They also spoke about the student's ability to verbally express themselves and how this was important for their learning. Teachers and students also spoke about the importance of having clear explanations from teachers to help them understand their learning.

Teachers and students in high ability classes described how interactions between the teacher and students are structured to help students develop their maths understanding and thinking. Teachers explained that they support students by pointing out key information and asking questions as opposed to always giving explanations.

> *1TM "what I do is um use a technique of focusing their attention on the specific just kind of draw their attention to a specific features of the problem which I know are important to the solution……and then once they see that the penny drops and they can crack on"*

The teachers of the high ability groups spoke about the importance of language and articulation in developing the student's understanding. The teachers explained that the students have a good verbal ability which enables them to talk about the maths at an advanced level.

> *1TM "learning to articulate their own understanding is really important for them so if you know if you can do something without talking about it then you don't really understand it"*

The teachers of both middle ability classes spoke about how they built in opportunities for students to practice their ability to express their understanding verbally. The teachers spoke about how some students found this particularly difficult for example students were not able to say numbers correctly.

> *2TM "So it's trying to. Some of them are better at talking than others so trying to push some to engage a little bit more is important"*

Teachers of middle ability classes spoke about using questioning techniques with students where they ask the students a series of questions in order to help them develop the skills needed to help themselves.

Some students and teachers in low ability classes spoke about the difficulties that students in the class have with expressing themselves to one another and being able to clearly articulate their understanding of maths. One student described herself becoming quite frustrated when having a disagreement with a peer over a maths question. The students in low ability groups spoke about the importance of teacher explanations in developing their understanding. They reported that it was most helpful when teachers explained learning and explained it in different ways if needed.

> *3SF "so basically we just get rude to each other and we're just like, no you're wrong I'm right and this that and we just go really off topic"*

> *3TF "they can't articulate why they think their answer is correct um which is really difficult and it's what they struggle with. So them helping each other or explaining why someone else's answer is incorrect is difficult for them."*

Subtheme 3: Teaching

The majority of teachers and students in all ability groups described a traditional method of teaching that took place in the classroom which started with the teacher introducing the learning, giving an example, students recording the examples in their books and then trying activities independently. Teachers and students reported working predominantly from text books and worksheets.

One teacher of a high ability class described the aim of learning for the class being to always move on to creative tasks that require interpretation and problem solving skills, sometimes with an infinite number of answers.

> *1TM "another example of a question…..come up with some inequalities that define a right angle triangle…so that's kind of turning it on its head and saying lets be a bit more creative with it"*

Teachers in high ability groups spoke about the importance of repetition in learning. However explained that repetition has 'its place' and described this as being in homework.

1TF "repetition comes in their homework as opposed to classwork. Um and it's I don't give them too long actually to practice the maths tasks once they've got their conceptual understanding."

Teachers and students in middle ability classes spoke about different tasks designed to help students to develop their understanding. The teacher of one class spoke about how he would often introduce new topics with a 'rich' task that helped develop the students' conceptual understanding. A student in one class gave a description of how topics were introduced in a way that made students have to work out the topic.

2SF "normally when we are starting a new subject um sir will tell us briefly about what we are going to do but he won't tell us the full thing so first he'll show us an example of what we're going to do and then he'll see if we can guess the name of the lesson"

Teachers in middle ability groups spoke about the importance of time managed activities that maintained the momentum of the lesson.

2TM "I say ok you have twelve ,minutes to do this task first six minutes are paired next six minutes are independent"

One low ability teacher spoke about the importance of repetition and having short tasks that required only one or two steps of processing. Both female students from each low ability group spoke about using maths IT programs that could be accessed from their home to support them. They explained that the programs explained the learning to them and gave them examples to attempt.

3SF "And also like maths watch like we have this website that we can go on for homework or just we're able to log onto it and it's like there's this ladies voice and she just talks through anything…..you click on a bit of maths and she's like step by step talk you through it."

4.5.3. Theme 3: Classroom Environment

This theme captures the environment within the classroom. The subthemes include: Classroom Culture and Behaviour. Please see Table 20 for a breakdown of the subthemes and codes and how these vary across ability groups

Table 20: This table presents the subthemes and codes for the theme teaching and learning.

THEME 3: CLASSROOM ENVIRNOMENT			
	High Ability	Middle Ability	Low ability
Subtheme 1: Culture within the classroom	**4(13)**	**4(12)**	**4(16)**
Description of a 'banter' environment		3(4)	
Social conversations between teachers and students during the lesson		4(4)	3(3)
Students are shy about making mistakes	2(4)	1(2)	3(5)
Description of a positive relationship with teacher		2(2)	4(8)
Students are competitive with one another	3(7)		
Learning moves at a fast pace	2(2)		
Subtheme 2: Classroom behaviour	**6(17)**	**6(26)**	**6(43)**
Generally behaviour is good during lessons	5(6)	4(5)	4(4)
Descriptions of disruptive behaviour during lessons	1(1)		5(15)
Off task behaviours and talking	4(6)	5(12)	3(4)
The teacher has control of behaviour	3(3)	3(4)	5(11)
Behaviour is worst in the afternoon lessons	1(1)	1(1)	1(1)
Factors outside the classroom have an impact on behaviour		1(2)	2(2)
Students lack self-control		2(2)	3(6)

Two frequencies are presented in the table (a(b), a=number of interviews b=the overall frequency of the codes).

Subtheme 1: Culture within the classroom

Students and teachers described the culture within their classrooms. One of main commonalities between the ability groups was the importance of creating an environment where students felt it was ok to make mistakes. They spoke about mistakes as an important part of learning. Some subtle qualitative differences between the ability groups emerged from the analysis.

The culture within the high ability groups was described by some students and teachers as being fast paced, competitive and students were concerned about making mistakes.

1SM "The learning is often very fast and we move on to new topics quickly"

A 'banter' environment was described in middle ability groups. The relationship between the students and teacher was highlighted as being important in order to help engage students with learning. Students and teachers reported having social conversations between them to develop a rapport.

2TM "So I don't know how you'd describe it. I suppose I try to have banter with them so they can see I'm a real person"

Teachers of low ability groups spoke about the importance of creating a safe environment for students where they felt comfortable to attempt tasks and potentially make mistakes. They explained that having some social conversations is important but it was also important that these were at appropriate times and did not disrupt learning. Students spoke about their teachers as being there to support them when they needed them.

3TF "it's really important that they have a safe environment where they can make mistakes"

Subtheme 2: Classroom behaviour

Teachers and students of all ability groups spoke about behaviour being mostly good. Poor behaviour across the ability groups often related to 'off task' behaviours such as talking about what happened at break time. Teachers also spoke about the differences in behaviour given the time of day with behaviour during afternoon lessons being more challenging. There were some differences across the ability groups in relation to the severity of behaviours and the self-control that the students had.

Teachers and students of high ability groups spoke about the behaviour as being mostly good and reported that any poor behaviour consisted of students talking when they were not supposed to.

> *1SM " behaviour is good it's just that people like we're all used to talking a lot so we're like for example when we're discussing and we're working in groups we always like talk a lot about everything"*

Students and teachers in middle ability groups spoke about students getting easily distracted by one another. Students and teachers spoke about students lacking in self-control behaviours. The students spoke about the teacher being in control of the behaviour in the class.

> *2SF "to be honest I just get distracted really easily so I find it hard to concentrate for a long time"*

Teachers and students in low ability groups spoke about there being a selection of students in the class who had 'behavioural difficulties' which had an impact on the rest of the students. The teachers spoke about how some of the students had difficult home lives and this had an impact on their behaviour in lessons.

> *3SF "we're all quite hyper and like we've got certain people in our class that are just like really out there and they'll get distracted really easily"*

4.6. Summary of findings

The following gives a summary of the key findings of the current study

Self-concept questionnaire (RQ3)

- Students in both high and middle ability groups had a significantly higher maths self-concept in comparison to those in lower ability groups. There was not a significant difference between the students' maths self-concept in high and middle ability groups.
- There was a significant difference between the general/learning self- concept of students in low ability and high ability classes. There was not a significant difference between the high and middle, and middle and low.

Structured observation (RQ1)

- Overall the most common work context in all ability groups set by the class teacher was individual work. This was closely followed by whole class teaching. Generally there were limited structured opportunities as set by the teacher for students to work with their peers in pairs or groups. Teachers of middle ability groups provided the greatest number of opportunities for students to work in pairs.
- There was less individual work set in middle ability groups than would be expected and more individual work set in low ability groups. Teachers of middle ability groups set the work context as pupil plenary most frequently.
- The structured observation findings suggests that students in high ability groups spent more time interacting with a peer than in any other ability group. Although teachers of high ability groups did not set up peer learning opportunities, in these classes there appeared to be an informal understanding that students could informally work together. Students in high ability groups also spent more time interacting with a peer than not interacting or interacting with an adult. When students were interacting with a peer they were on-task for the vast majority of the time.
- In middle ability groups students spent the most time not interacting or interacting with an adult. Students did interact with peers, however on closer inspection when students in middle ability groups were interacting with their peers there was a higher than expected number of occasions where they were off-task.
- Students in low ability groups spent the majority of time not interacting, which was higher than expected. Students in low ability classes spent the least amount of time of all ability groups interacting with a peer. There were no structured opportunities, as set by the teacher, for students to work together. On the small number of occasions when the students were interacting with peers they were mostly off task.
- The teachers mostly interacted with students at an individual and whole class level. There was less whole class teaching than expected in high ability groups. Teachers of high ability groups spent more time than expected not

interacting. Teachers of low ability groups spent less time not interacting than would be expected.

- The main interaction theme between teachers and students was work based across all ability groups. There was very little social talk between students and teachers across the ability groups. The interactions themed around behaviour were low across the ability groups. There was a slightly higher frequency of interactions that were focused on behaviour in the low ability groups.
- When teachers were interacting with students on an individual level the teachers were most likely to either begin the interaction or respond to the interaction. There was a higher than expected frequency of teachers and students having a sustained interaction in high ability groups and lower than expected in middle ability groups. Teachers of low ability groups listened less frequently than in other groups.
- Overall there was a high level of student engagement with students being on task for the vast majority of the time. There was a higher level of off task behaviours in middle ability groups than expected although this was still significantly less than on task behaviours. When students were not interacting they were mostly on task. When students were interacting with an adult there was a high level of on task behaviours.

Qualitative observations (RQ1)

- The qualitative observation data suggested the main type of tasks set for all ability groups would be classified as procedural in nature where the students apply a method directly to a task in order to reach one correct solution. There was a mixture of academic and semi-real life tasks set for students in the lessons. Every lesson involved an academic task, however only some lessons incorporated semi-real life tasks.
- There were tasks that required problem solving skills in the high ability lesson, however these were set as either extensions or were at the end of activities therefore not all students will have completed or been aware of these tasks.
- There was a mixture of activities in the middle ability and lessons there were problem-solving activities built into the lessons that all students accessed. In

one middle ability lesson, a guided discovery approach was used to introduce a new topic to the students.

- Tasks in both low ability groups were all academic/pure maths tasks that required students to apply a method directly to a problem. Tasks were mostly repetitive in nature and were supported by a high level of instruction, hence tasks often required only a small number of processing steps. Students in low ability groups also used methods, such as moving the decimal point, which demonstrated their lack of relational understanding of the maths that they were doing.

Lesson audio recordings (RQ1)

- Overall the most common types of talk across all classes were organising students and materials, explaining maths concepts, asking questions and responding to students.
- The greatest degree of variation was between the two high ability classes with regards to the amount of time they spent organising and explaining concepts.
- The two middle ability groups presented with the most similar profiles. The two middle ability teachers asked questions in the highest percentage of recording periods. The middle ability teachers prompted the students' thinking and initiated interactions between students in the greatest percentage of recording periods.
- The teacher talk in the low ability groups was relatively evenly spread across organising, explaining, questioning and responding.

Qualitative Interviews (RQ2)

- Teachers and students from all classes described a traditional method of teaching which mainly consisted of the teacher introducing a topic to students, giving a worked example for all students and then the students having the opportunity to practice this skill either by completing questions presented on the whiteboard, worksheet or from a text book.
- All teachers and students spoke about how students worked together to help and support one another with learning. Students and teachers across all ability groups described students seeking help from one another when they

were stuck with their learning. Interactions between students were perceived as being valuable by teachers and students. Across all groups teachers and students spoke about self-control and how this was important for students to be able to work together.

- The teachers and students in high ability groups described students working together continuously and explained that they had wide access to students who were able to support them. Students and teachers of middle and low ability groups spoke about how students often compared answers with one another. They added that students are mostly supportive, however there was a tendency for students to laugh at one another when incorrect answers were given. There was an example in low ability classes of students being more actively unkind.
- Teachers and students across ability groups described a traditional method of teaching maths. This was a transmission style of teaching where all learning was controlled and determined by the teacher. Teachers of high ability classes spoke about extending students' knowledge with tasks that required a higher degree of interpretation and creativity. The teachers of middle ability classes seemed to describe tasks that often focused on developing students engagement and thinking skills. The low ability teachers described tasks where students' had a limited number of steps of processing to reach an answer. One teacher linked this approach to helping students to feel confident with their learning.
- Teachers across the ability groups spoke about the importance of developing the students' conceptual understanding of maths and how this was crucial for the students' success. The teachers of the low ability groups explained that this can often be difficult for low ability students as some of them lack the basic numeracy skills needed to understand, hence students resort to using procedural methods in order to achieve the correct answer. One teacher said that she tended not to challenge students when they used these methods as they enabled students to feel confident.
- The researcher considers that there was a difference between the students' perceptions of what 'mathematical understanding' meant in high and low ability groups. Students in low ability groups perceived understanding as

being able to get a correct answer and high ability groups viewed 'understanding' as having knowledge of the maths mechanisms needed to reach the answer.

- Teachers and students from all ability groups explained that having clear verbal explanations was important for students' learning. Students across all ability groups spoke about teacher explanations being very valuable. Teachers across ability groups spoke about the importance of asking students questions, as opposed to telling students the answers.
- There was some variation regarding the teachers' perceptions of the students' ability to express themselves verbally. Teachers of low ability groups spoke about how students often find it hard to verbally express themselves whereas high ability teachers described students as being verbally very able. This may have an impact on the students' ability to work together and explain maths concepts to one another.
- The teachers and students described slightly different classroom environments across the ability groups. One of main commonalities between the ability groups was the importance of creating an environment where students felt it was OK to make mistakes. Behaviour across ability groups was described as being mostly good. The students' level of self-control was highlighted as a factor across the ability groups in relation to their behaviour, ability to work with peers and engagement. Students in high ability groups were described as having more self-control than those in lower ability groups.
- Poor behaviour was generally described as students becoming distracted and not being on task as opposed to students being actively disruptive. Teachers and students in low ability groups explained that there were a selection of students with 'behavioural difficulties' that had an impact on other students in the class.
- The culture within the high ability groups was described by some students and teachers as being fast paced and competitive. A 'banter' environment was described in middle ability groups where the relationship between the students and teachers was an important part of student engagement. Teachers of low ability groups spoke about the importance of creating a safe

environment for students where they felt comfortable to attempt tasks and potentially make mistakes.

Chapter 5. Discussion

The current research aimed to provide a detailed description of the nature of teaching and learning practices within classes grouped by ability in addition to exploring the experiences that teachers and students have of this context. The qualitative and quantitative results from the research have provided an in-depth account of the experiences that both students and teachers have of high, middle and low ability groups.

The discussion will begin by considering how the findings of the study relate to, and build on, current research in the area regarding:

- Classroom interactions (RQ1 and RQ2);
- Classroom environment (RQ2);
- Teaching and learning (RQ1 and RQ2); and
- Student self-concept (RQ3).

The findings from research questions one and two will be discussed together in relation to the classroom interactions and teaching and learning practices within classes grouped by ability. Considering these questions together enables the researcher to combine the experiences of teachers and students with the findings from the observations regarding what takes place within the classrooms.

Following a discussion of the findings, the researcher will then go on to consider the strengths and limitations of the current research and possible areas for future research. Finally, the researcher will conclude by considering this study's wider implications for EPs, education policy makers and schools.

It is important to note that the findings of the current study are correlational in nature and should be understood and interpreted in this context. It is therefore only possible to hypothesise as to why some of the observed differences may exists.

5.1 Discussion of results in relation to previous research

5.1.1 Classroom interactions (RQ1 and RQ2)

Both the quantitative and qualitative results from the current study have provided a rich account of the interactions that take place in classrooms grouped by ability. This section will discuss the different interactions that were observed across the three ability groups and will consider how these may link to the different types of learning and thinking taking place within the different groups.

5.1.1.1. Peer interactions

The results from the structured observation produced some interesting findings and revealed that there were some differences between the students' perceptions of how they interacted with peers and the observed reality.

There was little difference between the high, middle and low ability groups with regards to the work context as set by the teacher. The most common form of work context was whole class teaching and individual work. There were few structured opportunities, created by teachers, for students to work with peers across all ability grouped classes. Teachers of middle ability groups created opportunities for students to interact with peers most frequently. This contradicts previous research by (Kutnick et al., 2006) that suggest teachers in high ability groups give students more opportunities to work with peers.

Interestingly there was a difference between the interaction type, as set by the teacher, and the reality of the types of interaction that were observed during the lessons. Students in high ability groups spent significantly more time than any other group (37.1%) interacting with peers, despite the teacher only instructing the students to work together in 1.6% of the observations. This suggests that there may be factors other than the opportunities for peer work provided by the teacher that influence how students interact with their peers during lessons. Furthermore when students in high ability groups were interacting with peers they were mostly on task (95%) this demonstrates that the students were able to work with peers and remain focused and engaged with their learning. There was an inverse relationship across the high, middle and low ability groups with regards to on and off task behaviours

when students were interacting with peers. This relationship was consistent with high ability groups being on task the most (95%) and off task the least (4.8%), students in middle ability groups who were on task for 62% of the time and off task for 38% of the time and students in low ability groups who were on task the least (31%) and were off task (69%) for the greatest amount of time. This is a significant finding for the research and it is important to consider why these differences in peer interactions were observed across ability groups. The researcher considers five different hypotheses to explain and understand this finding:

1. The differences regarding the students' interactions with peers may be explained by the low levels of self-control that students were described, by teachers and students, as having in middle and low ability groups. The lack of self-control may result in students in middle and low ability groups struggling to remain on task when working with peers. The evidence suggests that students in low ability groups had difficulty interacting with peers and remaining on task. This pattern of behaviour may lead to teachers actively preventing informal peer work in low ability lessons as the interactions often lead to off task behaviours. This may also explain the high level of instruction given by teachers of middle ability classes regarding volume, movement of students and timing when setting up peer work interactions in lessons.
2. It may be that the different interactions are related to students' engagement, interest and motivation with their learning and, as a result, their desire to discuss their learning with peers as opposed to discussing other topics. Previous research has suggested that students in low ability groups are less motivated (Saleh, 2005) to learn. This could also be linked with the first point regarding the student's self-control behaviours.
3. This finding could also be linked to the high level of scaffolding and instruction observed and reported in low ability lessons where students are required to follow fewer steps of processing and therefore may have less need to seek help from other students or discuss learning. Indeed one low ability teacher was explicit about taking this approach to teaching students so it was not possible for them to 'get stuck' and need to seek support from adults or peers.

4. This finding could be related to reports that students in high ability groups are more able to use language to express themselves and explain mathematical concepts more effectively.
5. It is important to note that there was a class size difference between high middle and low ability groups with the low ability groups being much smaller than the high ability groups. This may have had an impact on the interactions that took place within the classroom, as there were fewer students in the lower ability groups. Therefore there were fewer students to interact with and the adult to student ratio was higher. A learning environment with a higher adult to student ratio may lend itself to a different approach to teaching.

The findings from the interviews suggest that the nature of the dialogue between students varies subtly between different ability groups. The talk in low and middle ability groups was often reported to be focused on checking and comparing answers, whereas talk in high ability groups seemed to focus more on the process of getting to the answers. This may be linked to how success and understanding of maths is perceived in high, middle and low ability groups. With students in low and middle ability groups potentially perceiving success as 'being correct' and students in high ability groups perceiving success as understanding why it is correct and being able to see 'the link'. This suggests that students may be engaging in different types of maths learning across ability groups. This will be reflected on in more detail when discussing the findings in relation to teaching and learning.

5.1.1.2. Interactions between teacher and students

The evidence from the structured observations indicated that teachers across ability groups interacted predominantly with the class as a whole and with individual students. The focus of interactions between teachers and students was mostly work related. Teachers of high ability groups spent the greatest proportion of time not interacting (23%) and spent less time than any other group teaching the whole class. This may indicate that students in high ability groups are more independent learners. This could also be explained by the wide access that students have to peer support in high ability groups, which may mean there is less need for students to rely on

support from the teacher when stuck. When the students in high ability groups interacted with the teacher individually there was a greater percentage of sustained interactions than in any other group. This may suggest that there was a greater balance of teacher/student talk in high ability groups. This supports Solomon's (2007) research that found that there was a higher level of reciprocal interactions between teachers and students in high ability groups.

Teachers of high and middle ability groups were also observed to listen to students more frequently when interacting with students individually (17.6% and 20%) in comparison to teachers of low ability groups who listened less frequently (5.1%). This supports the view that there may be an imbalance of power in low ability lessons in relation to teacher and student talk. This also may suggest that students participate less with their learning supporting Solomon's (2007) view the students taught in low ability groups develop marginalised identities. The evidence from the student interviews emphasised the importance and value of teacher explanations for students across ability groups, with many students describing teacher explanations as being most helpful for their learning.

Detailed analysis of the teacher talk in the lessons revealed that teachers used a collection of linguistic interactions including: giving detailed explanations; asking questions; responding to students; organising students; managing behaviour; and promoting cognitive engagement. There was variation with regards to the type of talk in different lessons with the two high ability groups representing the most varied profiles. This may have been related to the differences in behaviour in the two high ability groups and also the fact that one high ability group was introducing new knowledge and the other was not.

Interestingly, the teachers of the two middle ability groups asked students the most questions, promoted cognitive engagement most frequently and initiated interactions between students. This may indicate that middle ability teachers were continuously attempting to actively engage and motivate students with their learning by promoting participation and creating opportunities for engagement. Solomon (2007) suggested that this trend exists in high ability groups, although his research did not include students in middle ability groups. This approach to engaging and interacting with

students may suggest that the teachers of these groups are attempting to scaffold the students thinking to help them develop a more in-depth understanding of their learning.

5.1.2. Classroom environment

5.1.2.1. Students' behavior

The results from the teacher and student interviews suggest that overall the behaviour of the majority of students across the classes was good. Concerns reported regarding behaviour were mainly related to students lacking self-control and becoming easily distracted. These behaviours were reported to be more prominent in the low and middle ability groups. The structured observations showed that teachers of low ability groups addressed behaviour more than in any other group, however this was still relatively infrequent (8.5%). The low levels of behaviour issues observed may be related to the overall high levels of on task behaviour observed across the ability groups, with students being on task in 88.5% of the overall observations. It is also important to note that previous research (Dunne et al., 2007) has suggested that teachers of low ability groups have a more lenient approach to behaviour management. If levels of leniency are higher in lower ability groups, then the low levels of behaviour issues identified in these groups may be a reflection of this leniency rather than the actual behaviour taking place in the lesson. Furthermore the behaviour of students in low ability groups may be easier to manage due to the smaller class sizes.

The interviews with students and teachers support the view suggested by Macintyre and Ireson (2002) that there were a selection of students in the low ability classes that were described as having 'behaviour difficulties'. It was suggested that the behaviour of these specific students could have an impact on the class as a whole.

The students' lack of self-control in lessons was raised as a key factor regarding students being able to work effectively with peers and general behaviour management within the classroom. Interestingly poor behaviour was not described as students being unkind to either students or adults instead it was frequently attributed to the students ability to control themselves and inhibit their actions. This

may be reflective of the level of interest and engagement that students have with maths as a subject. This may also be related to why engagement with learning is encouraged through other means such as questioning, having banter, teachers driving learning, playing games etc. These differences may also relate to intrinsic and extrinsic motivation.

5.1.2.2. Classroom environment

The research identified a range of classroom environments across the ability groups with student and teacher interviews highlighting key differences in classroom culture. Environments included: competitive; nurturing; and good-humoured banter. The main commonality highlighted in the groups was the importance of recognising that mistakes are a good thing and a part of learning. Overall teachers and students reported that students were generally supportive of one another.

Students and teachers in high ability groups described a competitive and fast-paced environment. They spoke about competition in both a positive and negative manner. Some students described it as helping to motivate them with their learning and others described it as anxiety provoking. Overall students were described as being highly supportive of one another in the high ability groups. This supports research by Boaler (1997) and Hallam and Ireson (2006) who described a similar environment in high ability groups. However, a competitive environment may undermine engagement for some students in high ability groups as students do not feel safe.

Teachers and students in middle ability groups described a ‘banter’ environment where the relationship between the students and teacher was important for engagement. Students and teachers did describe students laughing at one another when incorrect answers were given, this was understood as ‘joking’ by many students as opposed to being nasty. However this may not be reflective of how all students perceive this behaviour.

The environment described in low ability classrooms was nurturing and placed an emphasis on the importance of students feeling safe and being able to build their

confidence with learning. As with middle ability groups, any unsupportive behaviour was described in low ability groups as students laughing at one another when they gave incorrect answers to a question. There could be a range of hypotheses to understand why these behaviours are prevalent in these groups including: low self-concept; anxiety; and competitiveness. One teacher reported that students felt more able to contribute to lessons as they felt safe. Another teacher spoke about the impact that some of the students' lives outside of school can have on their ability to engage and learn in school, and that it is important to recognise this. The teachers were viewed as being important by students, and as being in charge of the class and dealing with any issues as they arose. This again emphasises the view that students in lower ability groups have less control over their behaviours and therefore the teacher has an important role in control and management within the classroom. This supports research from Solomon (2007). This finding may also be linked to the small class sizes of lower ability groups that may lend themselves more to a nurturing environment.

5.1.3. Teaching and learning

Both the quantitative and qualitative results of the research support the view that teachers of ability-grouped classes predominantly use traditional transmission style methods of teaching where teachers impart knowledge directly to students. This supports research by Boaler et al. (2000) and William and Bartholomew (2004) who suggest that ability grouping allows teachers to teach to an 'imaginary average', as opposed to using different teaching methods in order to address the different needs that may be found within a given class. In the lessons observed, the students were all presented with the same work to complete.

Differentiation was present in the lessons, however this was through outcome as opposed to task, where the higher ability students within the classes were accessing extension work and more challenging material towards the end of activities, by contrast lower ability students within the class were not expected to complete the whole activity. It is important to note that these expectations were rarely made explicit by the teachers. This finding supports the view to an extent that when teachers teach ability-grouped classes they teach them as a homogenous group

(Boaler, 1997). However, in contrast to previous research the evidence does indicate that there was some form of differentiation present to stretch the most able and accommodate for the least able. The results regarding the high level of student engagement across the ability groups may also further suggest that students were engaged and accessing work as opposed to the boredom or disengagement that might be expected from lessons developed for an 'imaginary average'.

The results from the qualitative observations and interviews suggested that there were subtle differences regarding the different types of tasks that were set by teachers across the ability groups and importantly the level of instruction and scaffolding that was given to students. In contrast to the view suggested by Solomon (2007), there were not marked differences between the high, middle and low ability classes with regards to the types of maths tasks that students were engaging with as set by the teacher, with the majority of the classes working from worksheets and text books. However, the evidence from interviews and qualitative observations suggests that there was a difference in the type of thinking that students were engaging with when completing the different tasks.

The low ability groups were observed to be engaging with pure maths topics that would be viewed as being academically above their attainment level, however they were supported with a high level of scaffolding and instruction. This meant that students were predominantly applying a prescribed method directly to a number of similar pure maths questions. Students in low ability groups were not observed to apply their maths knowledge, use problem-solving skills or answer questions that required interpretation. Teachers of low ability groups spoke about students having limited numeracy skills and considered that this may have an impact on their ability to achieve the depth of understanding that is required when tasks require interpretation. Skemp (1978) describes the type of maths learning that the lower ability group students were engaging with as developing an instrumental understanding of maths. Instrumental maths is when students apply a known mathematical rule or procedure to a question in order to achieve the correct answer. He states that students are able to do this without having an understanding of the maths mechanism that underlie the procedure. For example, a child would be able to multiply fractions together and achieve a correct answer without understanding what

they are actually doing to achieve this answer. Indeed they would be able to answer the question without knowing what a fraction is.

According to Skemp (1978) the benefits of developing an instrumental understanding include:

- *Instrumental mathematics as being easier to understand.* Some topics (e.g dividing fractions or multiplying two negative numbers) are significantly easier to learn and understand instrumentally.
- *The rewards are more immediate and more apparent.* Students are able to achieve a page of correct answers more easily using an instrumental method.
- *Students can often get the correct answer more quickly*. Instrumental understanding often results in quick solutions to maths questions.

The benefits of learning maths instrumentally can be related directly to low ability groups. Developing an instrumental understanding of maths will mean that students are able to 'do' the maths and be able to achieve correct answers without the need for the secure numeracy skills and deeper understanding that may be hard for them to achieve. Students will also be more motivated by being able to achieve the immediate reward of a correct answer.

In contrast to low ability groups, the students in high ability groups were given less scaffolding and instruction for tasks. They were given examples of how to solve questions and were then expected and to be able to apply that knowledge to a range of different questions independently. In order for students to be able to apply their knowledge to different questions Skemp (1978) claims that they have developed a relational understanding of maths where they understand the mechanisms that underlie a procedure. An understanding of these mechanisms will have been built up over many years of being able to successfully learn and understand mathematics. Skemp (1978) argues that this type of learning develops a relational understanding of maths. The advantages of having a relational understanding include:

- *It is more adaptable to new tasks.* Having a relational understanding of maths allows students to apply their knowledge to different tasks and problems.

- *It is easier to remember.* Relational understanding is considered significantly harder to learn than instrumental understanding but when learnt is easier to remember. For example, it is easier to learn the formula for calculating the area of a triangle as $^1/_2$ x(base x height) than to learn why it is this formula. However a student then needs to learn and retain different formula to calculate the area of rectangles, parallelograms, trapeziums; whereas the relational understanding of this consists partly of understanding all of these in relation to the area of a rectangle. Knowing how these are interrelated allows students to remember these as a whole as opposed to remembering multiple formulas. It is therefore less of a load on students' memory.
- *Relational knowledge can be effective as a goal*. When developing relational understanding the focus is not on being right or wrong it is instead about developing the understanding, which can be motivational in its self.

Therefore students in high ability groups may be more able to access problem solving tasks as they have the level of understanding needed to do so. This may also indicate the students in high ability classes are engaging with maths in a very different way to those in low ability classes.

The teachers of middle ability groups appeared to approach teaching and learning in a slightly different way where there was a focus on engaging students and promoting maths thinking through questioning, guided discovery learning and embedding maths problems into learning. One maths teacher used guided discovery learning to teach the students about trigonometry. This lesson was an example of the teacher attempting to build the students' relational understanding of the topic. The relational understanding of the topic then led to the development of formulae that could be used to answer trigonometry questions. When the students were introduced to the formulae they then used and applied these in an instrumental way. This is interesting as it demonstrates how relational and instrumental understanding often co-exists. The desire to reach answers quickly and efficiently appears to be highly motivating for students and therefore students often opt for using instrumental methods.

It is important to ask why students develop such different understanding of maths. Is it that teachers believe that students in low ability groups are not able to develop a relational understanding of maths due to their limited numeracy skills? Is it that the focus of maths learning is on being correct and not on understanding as it is not always possible to validly measure understanding? Is it because teachers are teaching students to pass exams instead of to understand their learning? Skemp (1978) claims that there are a number of situational factors that result in students being taught to understand maths instrumentally including: the impact of examinations; an over-burdened syllabus; and difficulty of assessment. A fundamental aim for KS4 maths teachers is to help students to answer as many questions as possible correctly on an exam. It is important to recognise that this is different from teaching students to understand maths and that understanding maths and answering questions correctly do not necessarily have to co-exist. It could be argued that this focus on being correct dominates the education system in the UK and due to the nature of examinations means that understanding is sometimes sacrificed for being correct.

This potential difference in understanding that exists between ability groups may be why previous research has found that there are high levels of repetition and overlearning in low ability groups (Solomon, 2007 and Boaler, 1997). As a result of students not fully understanding their learning there is an increased pressure on them to retain and remember a range of formulae and maths facts, which is potentially a heavy burden on students' memory. This may also link to the reports that teachers of low ability groups gave regarding students having poor ability to retain learning. Is this because students have a poor memory or do not fully understand their learning when initially learnt?

This different type of learning is also likely to have an impact on how students interact with each other and how motivated and interested they are in their learning. This may, in part, explain the different interactions that were observed between high, middle and low ability groups. Is it the case that actually students in high ability groups have more to talk about as a result of how they understand and cognitively engage with maths as a subject? Whereas students in low ability groups have less to

cognitively engage with as their learning is focused on being able to retain information?

The research suggests that there is a function in how teachers approach the teaching and learning of students in different ability groups, particularly with regards to the teaching of low ability groups. These approaches may be influenced in part by exams pressures. It is not surprising that helping students pass exams is the focus for teachers and students as success in exams has a significant impact on students' futures. However, previous research (Gillborn & Youdell, 2001) suggests that ability grouping does not improve the net attainment for all children. Could this be related to the fact that students are not exposed to different teaching approaches when taught in low sets? Could it be that students in low sets do not have the same access to other students who are able to support them and who have the level of self-control needed to do so? Would we see different teaching and learning practices, interactions and understanding if students in low ability groups were accessing learning at a level where they were able to develop a relational understanding of maths?

5.1.4. Students' self-concepts

The evidence from the research suggests that students taught in low ability groups were found to have a less positive view of themselves as learners generally and as maths learners than students in high ability groups. This finding links to Ireson and Hallam's (2009) research that found that setting practices had an impact on student's self-concept. It builds on this research by suggesting that the process of being placed in a low ability group has a negative impact on how students perceive themselves as maths and general learners. As the current research used the Burnett (1994) scale, which includes the student's enjoyment of maths, the results also indicate that students enjoy maths less when placed in a low set. This may impact on their motivation and engagement with learning. It is likely that this relates to their sense of their own ability regarding the subject.

5.1.5. Summary of discussion of results

Interactions

The research suggests that students in high ability groups spend more time interacting with their peers. It is important to note that these interactions are informal and are not organised or by teachers. Students in high ability groups were also found to engage in more sustained interaction with their teachers. This suggests that there is a more collaborative approach to teaching and learning in high ability groups. Students in low and middle ability groups also identified interacting with peers as being useful for their learning. The researcher suggests that this could be linked to the following factors:

- This could be linked to the fact that students in high, middle and low ability groups engage with different types of maths learning. As students in high ability groups are able to develop more of a relational understanding they interact with their learning in a different way, which may then have an impact on how they interact with teachers and peers.
- This could be linked to the reports regarding students in high ability groups being perceived as having a greater level of self-control in comparison to those in low ability groups. Therefore, they are able to talk without being distracted or going off topic.
- This may be linked to students in high ability groups being more able to use language to express themselves and explain mathematical concepts more effectively.

Classroom environment

The results of the research suggested that different environments are fostered in high, middle and low ability groups. The researcher considers that these differences may be related to the teachers of the classes using different strategies to promote engagement for students at all levels. In middle ability groups there was a 'banter environment' where the relationship with the teacher was important, this may encourage student's intrinsic motivation to please the teacher of the class. High ability groups were characterised by competition and challenge, which may be used as a motivational tool for some students, however this could be considered to be anxiety provoking for others. Teachers of low ability groups tended to create a nurturing environment that focused on developing confidence.

Behaviour across the ability groups was described predominantly as being good. Poor behaviour was described as students becoming distracted and having poor self-control. Some students in low ability groups were described as having 'behaviour difficulties'.

Teaching and learning

The research suggests that students in different ability groups engage in different forms of maths understanding and thinking. The researcher suggests that this could be linked to two key factors:

- The use of summative assessments as a measure of success for both students and schools. This process feeds into an education system where the aim of learning is to be correct. This in turn develops teaching practices that place more value on a student being able to get a correct answer than being able to understand how they got their answer. It seems that the difference between understanding and 'doing' is more prominent in low ability groups as the difference between what the students understand and what they can do is greater. This could explain why there is more instrumental teaching of maths observed and described in low ability groups.
- Students in low ability groups were not reported to have a solid numeracy foundation from which an in-depth understanding of maths could be developed. This potentially leads to teachers compensating for students lack of numeracy skills by developing teaching methods that help students access the curriculum and be successful with their learning, by answering questions correctly.

Self-concept

Students in low ability groups had a less positive view of themselves as general learners, and maths learners, than those in high ability groups. This indicates that students do not enjoy learning maths as much as those in high ability groups. This is likely to impact on student's motivation for learning.

5.2. Strengths of the research

This study has investigated the teaching practices and experiences of students and teachers in high, middle and low ability groups using a clear replicable methodology. In particular the use of structured observation has provided a much-needed detailed account of the subtle differences between high, middle and low ability groups.

The research has provided a more holistic view of the experiences through a combination of both qualitative and quantitative research methods that give an account of the perspectives of students and teachers combined with observations. This has resulted in a rich picture of the reality of what happens in maths classes taught by ability and has enabled the researcher to consider what may be underlying the differences observed between ability groups.

The current research has included accounts of the experience of students and teachers in middle ability groups. Middle ability groups have been neglected in previous research to focus on the experiences of high and low ability groups.

The researcher's experience and knowledge of teaching maths has enabled her to reflect on the learning taking place within the different classrooms and understand the differences from a maths teaching and learning perspective. This has helped to understand why these teaching and learning differences exist and why students in high and low ability groups interact differently with maths. This has improved the validity of the research.

5.3. Limitations of the research

In order to best understand this research it should be interpreted in light of its methodological limitations.

Small school sample size: The research was conducted in two secondary schools in inner city London and focused on year 10 classes only. It is important to recognise that this research intended to give a detailed and rich account of the experiences of

ability grouping by combining interviews, questionnaires and qualitative and structured observation. The aim of the research was not for the findings to be widely generalisable, but to enable a broader exploration and deeper understanding regarding the mechanisms that may function within ability grouped classes. The research was looking to understand potential processes that may explain the effects identified by previous 'outcome' focused studies. For the results to be considered more generaliseable more observations of lessons and audio recordings would be needed.

Furthermore both the schools selected were considered to be outstanding schools by OFSTED. Therefore the quality of teaching and learning was of a high standard. The results of the study may have been different if conducted in schools that were not considered as outstanding.

Short interviews with teachers and students: The qualitative interview data is based on relatively short interviews with only two students from each class. It is important to recognise that these provide a limited insight into the experiences of students in ability grouped classrooms.

Year 10 classes: The research was conducted on Year 10 classes because the majority of schools grouped students by ability by Key Stage 4 (KS4). However, by KS4 students are beginning preparation for their GCSE's and this has an impact on the content of their lessons as teachers begin to teach students for the purpose of passing exams. This means that by Year 10 lessons become restricted due to exam pressures which is likely to have an impact on the approach to teaching adopted by teachers. The results of the study may be different for KS3 classes where there is less exam pressure. It would be interesting to repeat the research with Year 7 classes where students are new to the school.

Student talk: The research did gain a rich picture of the teacher talk taking place in the lesson but did not collect data to give a detailed analysis of the types of conversations taking place between students. This highlights one area for future research.

5.4. Areas for future research

The current research has highlighted the range of inter relating factors that impact on an ability grouped classroom including: interactions, classroom environment, behaviours and teaching and learning approaches. It will be important for any future research to continue to unpick these in order to fully understand the mechanisms and processes within classes grouped by ability and then go on to link these to outcomes regarding attainment, motivation and self-concept. An extensive piece of research that considers the processes and mechanisms that take place in a number of classrooms grouped by ability would be necessary to gain a deeper understanding of how these then relate to outcomes for students.

The research has highlighted the use of transmission styles of teaching across the ability groups. Previous research (William & Bartholomew 2004) suggests that this style of teaching is more frequently found when classes are taught in ability groups. It would be interesting to repeat the current study and include mixed ability classes to assess whether there are different teaching and learning practices in ability grouped classes of the same year group. In particular it may be useful to consider how the teaching and learning experiences differ for low ability students in mixed ability classrooms. What is different about teaching and learning practices and experiences in mixed ability classes that results in low ability students making better progress? Do these students interact with middle and high ability students in these contexts? Are low ability students exposed to more problem solving and real life tasks? Do students work with other low ability students? Is there more differentiation within mixed ability classrooms? Or is differentiation predominantly separated up into three main groups (high, middle and low)?

The current research was not able to collect detailed analysis of the type of talk taking place between the students in the ability groups with regards to how they supported one another with learning in an informal manner. Findings from such research could contribute to developing advice for supporting interactions between students.

Future research could investigate the impact of summative assessments on the teaching, learning and understanding of students in low ability groups. It may be helpful to do this in collaboration with an examination board to collect information on how students perform nationally on questions that require relational understanding of mathematics as opposed to questions that can be answered with only an instrumental understanding.

5.5. Implications for Educational Psychologists, Schools and Policy Makers

The implications of the findings will be discussed in relation to Educational Psychologists (EPs), schools and education policy.

Educational Psychologists

The current research has highlighted some key differences with regards to how students in low, middle and higher ability groups learn maths and also how students interact with peers. EPs are well placed to support schools in developing an effective approach to the teaching of maths to low ability students. The understanding and assessment of maths/numeracy from an EP perspective is limited. EPs only have access to a small range of numeracy assessments and there is little understanding regarding the mechanisms of how students learn maths. In addition EPs are able to support schools at a systemic level to help consider how best to organise students into classes.

The following recommendations are for EPs:

- EPs should continue to promote the development of numeracy skills in both primary and secondary education to provide a solid foundation, which gives students the tools to develop conceptual understanding of new maths learning.
- EP's should endeavour to improve their skill set in relation to the teaching and learning and assessment of mathematics. It will be important to develop training which makes teachers aware of the differences in maths understanding and help teachers to identify these practices within their

classrooms. For example, when teachers identify that a child cannot retain learning. What factors could underlie this?

- EPs are well placed in schools to promote a focus on student centred learning where students learn new information in the context of what they already know. EP's should continue to challenge support and teaching approaches that provide access to a curriculum that is conceptually beyond students' conceptual understanding.
- EPs should provide training and support to schools regarding how to effectively develop each student's abilities to work in pairs or as a group.

Schools

The researchers view is that some of the differences observed between classes grouped by ability relate to the students engaging with a different type of maths learning which in turn goes on to develop different maths identities. The research also highlights the importance of students engaging in interactions with their peers to develop learning and thinking skills.

Recommendations for schools include:

- Schools should carefully consider how they allocate students to ability groups. Allocation of students to groups should be based purely on prior attainment and not other factors.
- Schools should develop professional development programmes for teachers that emphasise the importance of learning goals and learner-centred teaching approaches. Where there is a focus on an approach to teaching, which recognises an individual student's current level of understanding and builds on that. This approach would have a positive impact for students across the ability range.
- There should be a focus on sharing and emphasising learning goals, which focus on understanding as opposed to doing. Feedback to students should be given in relation to these goals.
- Schools should implement strategies for encouraging self-regulation in learning and positive inter-personal and working relationships with other students.

- Frequent opportunities should be built into lessons for students to interact in a meaningful way with their peers as a part of their learning process as opposed to students interacting on a surface level e.g. peer assessment.

Education Policy

In order for schools to be able to change their practice in relation the teaching and learning within ability groups there will need to be changes made at a policy level to make this possible.

- Education policy makers should carefully consider whether or not to advocate the use of ability grouping. Instead of focusing on ability grouping being good or bad policy should ensure that practitioners are aware of the research regarding ability grouping and it can impact on outcomes for students.
- Education policy should also include extensive guidance for schools regarding best practice and ability grouping.
- Education policy should have a greater focus on the importance of motivation for learning and consider how this can be developed in low ability learners.
- Support should be provided to schools in order to help them find different ways of assessing learning that do not rely purely on summative assessment. And instead provide a more valid measure of understanding.
- It is likely that the use of summative assessments will continue to be used if the end goal for students is to take a nationally recognised qualifications by the end of their school education. It will be important to carefully consider how national standards can be tracked without this e.g. sampling students rather than testing all and use a wider range of test forms and items.
- It may be useful to consider how the findings of the current study relate to the current government initiative regarding grammar school education in the UK.

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Chapter 6. Appendices

6.1. Research letter

Dear Head teacher/Head of Department

I am contacting you regarding an exciting opportunity for your school to take part in a piece of research that I will be conducting this academic year. I am currently in my final year of a doctorate in Educational Psychology at the UCL Institute of Education and am in the process of developing my thesis. Having worked as a maths teacher for three years in an inner city London secondary school I have developed a passion for the teaching of mathematics.

My research will focus on grouping students by attainment and how this may relate to the behaviour, engagement and interactions that take place in year ten mathematics classrooms. The research will provide both qualitative and quantitative evidence that describes how students and teachers in your school experience grouping by attainment and what impact this could be having.

The advantages and disadvantages of grouping students by attainment has been a highly debated topic in education for years. Research has found that grouping students by attainment has negative affects for those in low attaining classrooms including: reduced academic progress, low self-esteem, stigmatisation and challenging behaviour.

A small body of research has attempted to explain how these negative effects are produced. This research has highlighted the different teaching and learning experiences of students in high and low ability groups and suggests that this may be a contributing factor to the effects of grouping students by attainment. The current research aims to give a detailed account of teaching and learning experiences in classrooms taught in attainment groups and to consider how these may impact outcomes for students.

The Study

I am planning to recruit two schools to take part in the research. The research will focus on three year ten mathematics classes in each school. One high ability, middle ability and low ability class will be selected to take part. The research will consist of questionnaires, observations of each class as well as student and teacher interviews.

Questionnaires: All students from each class will be given a questionnaire to complete. This questionnaire will capture how students perceive themselves as mathematics learners and as more general learners in school.

Observations: An observation will be used to examine the nature of the interactions between students, between students and teachers and between other adults, as well as the nature of student engagement and behaviour. The observation will focus on both teachers and students intermittently throughout the lesson. Class teachers will be asked to identify two high, two middle and two low attaining students to be focused on throughout the lesson. Each class will be observed on at least two different occasions.

Interviews: Semi structured interviews will be conducted with two students from each class (one high and one low ability) and the teacher of each class. The interviews will focus on what it is like to be a part of each class and how students work with one another in the

classroom. School staff will be consulted regarding the most suitable time to interview students and teachers in order to have absolute minimal impact on what happens in the school. Interviews have been designed to take roughly 20 minutes each.

All the information gathered in the study will be anonymised and confidential. This means that none of the schools, students or teachers will be named at any point in the study or in the reporting of findings.

Each school will receive a summary of the findings from the observations and interviews for their school. If the school would like I can also return to the school to present the findings from the research.

In addition, the maths department of each school will be offered a one hour training session that will focus on how to approach the teaching of secondary school children with dyscalculia and numeracy difficulties.

Please contact me if you are interested in taking part in the research. I will follow this letter with a phone call in a week's time to discuss the possibility of your school taking part.

Kind Regards,

Polly Warrington

6.2. Ethical approval

Dear Polly
I am pleased to inform you that your research **"A comparison of experiences in high, low and mixed ability Year ten mathematics classes and how these effect outcomes",** for the Doctorate in Professional Educational, child and Adolescent Psychology, has been given ethical approval. If you have any further queries in this regard, please refer the enquirer to your supervisor.

Please note, if your proposed study and methodology changes markedly from what you have outlined in your ethics review application you may need to complete and submit a new or revised application. Should this possibility arise, please discuss with your supervisors in the first instance before you proceed with a new/revised application.

Your ethical approval form has been logged.

Good luck with your data collection.

Best wishes
Lorraine

6.3. Parent consent letter

Dear Parent/Guardian,

Your child's mathematics class has been selected to be part of a research study. The study will investigate the effect of grouping children by attainment on teaching, learning and interaction in their class.

The study will consist of the following:

1. Your child will be asked to complete a questionnaire about how she/he rates their skills and abilities in maths and more generally in school.
2. An observation of the activities and interactions that occur in the class will take place. As a result some children will be observed from time to time undertaking their usual activities. Rest assured the study aims to focus on learning behaviours overall in the class and not on what particular individuals do.
3. Your child may be asked to take part in an interview where he or she will be asked about what it is like to be in their class. This will be audio recorded.

All the information gathered in the study will be anonymised and confidential. This means that neither the school's name nor the child's name will be used at any point in the study or in the reporting of findings. **If you DO NOT wish your child to take part in this research please complete and return the slip below**. However, you can withdraw your child from the study at any time you wish to by contacting me on the details below. If you would like to ask any questions about the study please do not hesitate to contact me by email: polly.warrington.14@ucl.ac.uk

Kind Regards,

Polly Warrington

If you do not wish your child to be involved in this research, please complete the following and return to the school by ??/??/??.

I do not wish my child _____ to take part in this research study taking place at……. school. I understand that I have the right to withdraw my child from the study at any point if I wish.

Printed name:_____

Signature: _____ Date:_____

6.4. Student questionnaire

Student Questionnaire

Hello, I am undertaking research looking at the different experiences of teaching and learning that students have in different maths sets. I would be grateful if you could help me by completing this questionnaire to tell me about your maths and learning skills. I will also be coming into some of your maths lessons to observe what happens. I will be observing some students and this possibly might include you. If you are happy to be observed as a member of the class, then please complete and return this questionnaire. On the other hand, if you would rather I did not observe you when I visit please do not complete and return this questionnaire.

All information collected will be completely anonymous and confidential. This means that I will not tell anyone about the information or views that you have given to me. The findings from my research will be part of a general report where I will write about student's views and the things that go on in classrooms generally. If you have any questions about the research or decide at a later point that you do not want to take part, please tell your teacher or contact me directly: polly.warrington.14@ucl.ac.uk

Please tick the one statement that you think best describes you for each of the eight groups

1.
- ❑ I really like maths and sums
- ❑ I like maths and sums
- ❑ I sometimes like maths and sums
- ❑ I do not like maths and sums
- ❑ I really do not like maths and sums

2.
- ❑ I really like learning new things
- ❑ I like learning new things
- ❑ I sometimes like learning new things
- ❑ I do not like learning new things
- ❑ I really do not like learning new things

3.
- ❑ I am really good at maths
- ❑ I am good at maths
- ❑ I am OK at maths
- ❑ I am not good at maths
- ❑ I really am not good at maths

4.
- ❑ I am really good at learning new things
- ❑ I am good at learning new things
- ❑ I am OK at learning new things
- ❑ I am good at learning new things
- ❑ I really am not good at learning new things

5.
- ❑ I really enjoy maths
- ❑ I enjoy maths
- ❑ I sometimes enjoy maths
- ❑ I do not enjoy maths
- ❑ I really do not enjoy maths

6.
- ❑ I really enjoy learning new things
- ❑ I enjoy learning new things
- ❑ I sometimes enjoy learning new things
- ❑ I do not enjoy learning new things
- ❑ I really do not enjoy learning new things

7.
- ❑ I get really good marks in maths
- ❑ I get good marks in maths
- ❑ I get OK marks in maths
- ❑ I do not get good marks in maths
- ❑ I really do not get good marks in maths

8.
- ❑ I find learning new things really easy
- ❑ I find learning new things easy
- ❑ I sometimes find learning new things easy
- ❑ I find learning new things hard
- ❑ I find learning new things really hard

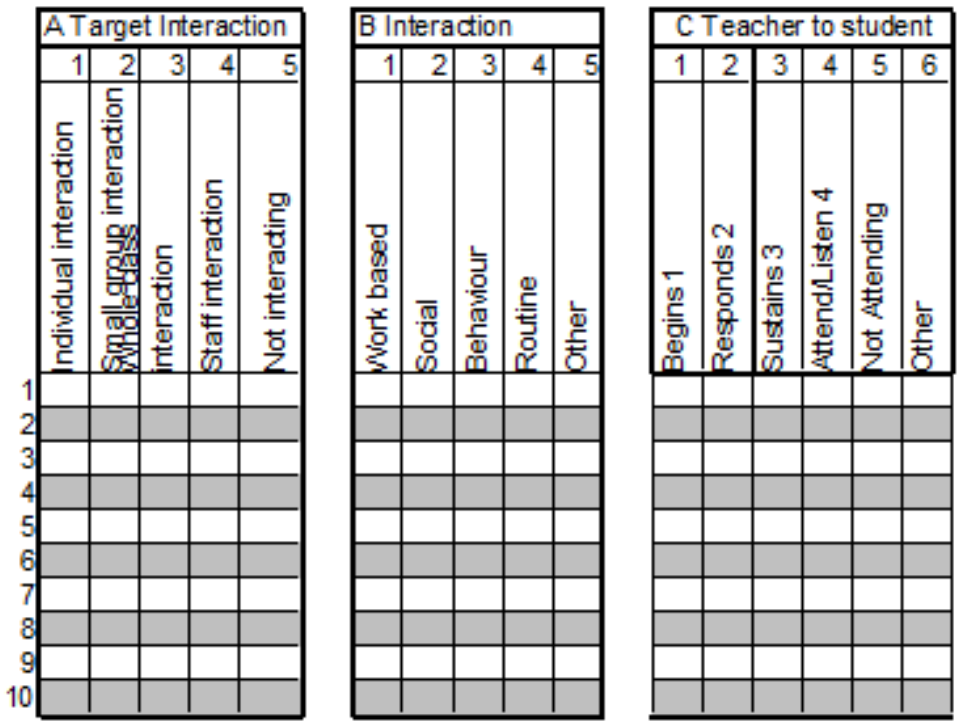
of statements. It is important that you only tick one statement from each group

.

6.5. Teacher observation schedule

School: Class: Set : H / L
Start time: M / F Date:

Targets context 1 Interaction Theme 2



6.6. Student observation schedule

Observer: **School:** **Class:**

Start Time:

Target M / F **Target: H / M / L**

Target's context **1** **Target not interacting** **2** **Target-pupil** **3**

	Work Setting						Not Interacting						Target & Pupil Activity						
	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	5	6	7	
	Individual	Pupil-pupil interaction	Adult led group	Whole Class	Pupil Plenary	Other	On task: Intermittent	On Task: Sustained	Proced./Routine	Off-task Active-Alone	Off-task passive	Other	On task: Intermittent	On Task: Sustained	Proced./Routine	Off-task Active e-Interact	Other	Uncodable	
1																			1
2																			2
3																			3
4																			4
5																			5
6																			6
7																			7
8																			8
9																			9
10																			10

4

	A Adult Identity			B Adult's Audience				C Target to Adult Interaction						D Target's Activity						
	1	2	3	1	2	3	4	1	2	3	4	5	6	1	2	3	5	6	7	8
	Teacher	TA/Support Staff	Other	Focus 1	Group Audience 2	Class Audience 3	Other	Begins 1	Responds 2	Sustains 3	Attend/Listen 4	Not Attending	Other	On task: Intermittent	On Task: Sustained	Proceed/Routine	Off-task Active Alone	Off-task Active interact.	Off-task passive	Other
1																				
2																				
3																				
4																				
5																				
6																				
7																				
8																				
9																				
10																				

Qualitative Analyses of task type		
Brief description of task	Goal - open ended/closed	Methods- multiple or one
Scaffolding present	Answer - one or multiple	Task type abstract/ rael life

6.7. Details of the student-coding framework

Section 1: Work Setting

This section is to be completed in every observation. The observer is to note down what pupils should be doing as intended or expected by the teacher regardless of whether they are doing it or not.

1 *Individual*: Target is supposed to be working on a task alone.
2 *Pupil-pupil interaction*: 2 or more children are expected to work together to produce a joint piece of work or may work together to perform the task.
3 *Adult led group*: An adult leads a group in an activity.
4 *Whole Class*: Teacher/adult talks to the class or individuals within the class whilst expecting the rest of the class to be an audience.
5 *Other:* any other situations not covered by the above

Section 2: Target not interacting

This section is to be completed when the target student is not interacting with others and is either working or not working on his or her own. This section should not be completed in conjunction with Target-pupil interactions or Adult-target interaction.

1 *On-task – Intermittent*: Target is completely engaged in the task for the majority but not the entire 5 second interval.
2 *On-task Sustained*: Target is completely engaged in the task for the full 5 sec interval.
3 *Procedure/routine*: The Target is involved in classroom management and organisation of classroom routine.
4 *Off-task-active-Alone*: Target should be off-task but is actively engaged in something else.
5 *Off-task-passive*: Target should be off-task but is plainly not attending and not interacting with others
6 *Other*: anything else not covered by the above categories.

Section 3: Target- pupil interaction

This section should be completed only when the target is interacting with one or more other pupils in the class. This section can be used in conjunction the section for adult interaction.

1. *On-task – Intermittent*: Target is either only partially engaged in the task or fully engaged in the task for the majority but not the entire 5 second interval.
2. *On-task – Sustained*: As for on-task intermittent but target is completely engaged in the task for the full 5 sec interval.
3. *Procedure/routine*: The target and the child are involved in classroom management and organisation of classroom routine
4. *Off-task-active-Interactive*: Target should be On-task but is actively engaged in something else that is unrelated and interacting with another child, either talking (about something other than the task) or mucking about
5. *Other*. Anything else that does not fit into the above categories.
6. *Uncodeable:* Marked if it is impossible to identify whether a child is on or off task but there is a clear indication that pupils are interacting.

Section 4: Adult-target interaction

This section should be coded no matter how briefly the adult – target interaction occurs. All blocks should be completed.

4a) Adult Identity
The person identified here should be the adult interacting with the target, if 2 or more adults are interacting with the target then the teacher takes priority.

1. *Teacher*: The main or leading teacher within the class. Can include: Class or set teacher, supply teacher, SENCO.
2. *TA/ support staff*: Teaching Assistant or other official classroom support staff.
3. *SENT*: Special Educational Needs Teacher.
4. *Trainee*: Student teachers, nursery nurses or work experience students from school.
5. *Other*: Volunteers, parent or similar.

4b) Adult's Audience
This block of categories shows whether the pupil is the focus of the adult's attention or if he/she is one of several or if the entire class is being addressed.

1. *Focus*: The Target is the direct focus of the adult's attention
2. *Group Audience*: The Target is one of a group of others being addressed by the adult.
3. *Class Audience*: The Target is one of half the class or more being addressed by the adult.
4. *Other*: For example if the teacher ignores a question from the pupil

4c) Target to Adult Interaction
This section identifies the nature of the interaction between the target and the adult.

1 *Begins*: The Target initiates an interaction with the adult, this may be by word or by gesture. Begins takes priority over responds.
2 *Responds*: The Target responds to a new interaction initiated by the adult.
3 *Sustains*: The Target and the adult continue the verbal conversation over the majority of the 10 seconds.
4 *Attend/Listen*: The Target is attending to what the adult says for the majority of the 10 seconds. This is also the default and is marked if nothing else is occurring.
5 *Not attending*: the target is not attending to the adult (is more than likely off task).
6 Other: Anything else not covered by the above categories.

4d) *Target's Activity*
This section is used to identify the activity of the Target during the interactions with the adult.

1 *On-task intermittent*: The Target is partially engaged, or trying to engage, in the task activity but not the entire 10 sec interval.
2 *On-task – Sustained*: Target is completely engaged in the task for the full 10 sec interval.
3 *Procedure/routine*: The Target is involved in classroom management and organisation of classroom routine.
4 *Social*: The interaction between the Target and the adult is concerned with social matters.

5 *Off-task-active-Alone*: Target is actively engaged and on his or her own in some other activity.
6 *Off-task-active-Interactive*: This is similar to off task active-alone but requires the target to also be engaged in social interaction with another pupil.
7 *Off task-passive*: Target is not attending but not interacting with others.
Other: anything else not covered by the above categories.

6.8. Details of the teacher-coding framework

Section 1: Target Interaction

This section captures the targets interaction. Whether they are interacting with an individual, a small group, whole class or a member of staff.

1 *Individual Interaction*- The target is interacting with an individual student
2 *Small group interaction* – The target is interacting with a small group of children
3 *Whole class interaction* – The target is addressing the class as a whole
4 *Staff interaction* – Target is interacting with another member of staff
5 *Not interaction* – Target is not interacting with staff or children

Section 2: Interaction theme

This section captures what type of interaction was taking place between the target and others.

1 *Work based* – The interaction is focused around the work set
2 *Social* – The interaction is social and consists of conversations that do not focus on class work.
3 *Routine* - The Target is involved in classroom management and organisation of classroom routine.
4 *Other* - None of the above interaction types are observed

Section 3: Teacher to student Interaction

This section identifies the nature of the interaction between the target and the adult.

1 Begins: The teacher initiates an interaction with the student, this may be by word or by gesture. Begins takes priority over responds.
2 Responds: The teacher responds to a new interaction initiated by the student.
3 Sustains: The teacher and the student continue the verbal conversation over the majority of the 5 seconds.
4 Attend/Listen: The teacher is attending to what the adult says for the majority of the 5 seconds. This is also the default and is marked if nothing else is occurring.
5 Not attending: the teacher is not attending to the student.
6 Other: Anything else not covered by the above categories.

6.9. Student interview schedule

Research Questions:

How do students perceive the nature of the teaching and learning in their classroom, for example what type of tasks to they complete, do they work with other students, what do they consider supports and hinders their learning in their classroom?

How do students perceive the social environment in their classroom, for example how supportive are students of one another, is there competition and friction between students?

Interview Preamble:

My name is Polly and I am carrying out this research to find out about what it is like for students in different maths classes. In this interview I will ask you questions about what it is like in your maths lessons.

I will use this recorder to record our conversation.
Would it be ok for me to record your responses on the recorder?

Only I will listen to the conversation after this interview and I may include parts of what we have spoken about in my research. Anything that I use from what you have said will remain anonymous which means that I will not say that the information comes from you.

Please feel comfortable to speak about your experiences because it will not be shared with anyone else but if something that you have said means you or someone else is unsafe, I will tell another adult such as your teacher. I will tell you if I need to do this.

Do you have any questions about what I've said?

It will take about 20 minutes. If at any stage you would like a break or you would like to stop the interview completely just say so. It is ok if you ask me to stop.

You do not have to answer any question you do not want to.

Is there anything you would like me to explain?

Interview Questions:

Can you tell me about what it is like to be in your maths lessons?

Can you tell me about the type of work that you do in your maths lessons?

- Prompt- do you work from text books, work sheets, questions on board, card sorts

To what extent do students work together in your maths lessons?

- Prompt- do you work in pairs, groups, on your own

Can you tell me about what helps you to learn in your maths lessons?

- Prompt – Are there any strategies that you find useful?

- Prompt – Is there a particular way of working that helps?

Can you tell me about what makes learning difficult in your maths lessons?

To what extent are students supportive of each other in lessons?
- Prompt- to what extent do students in your lesson ask one another for help with their learning?

Can you tell me about the behaviour in your maths lessons?
- Prompt – can you give an example of what challenging behaviour looks like in your maths class?

How would you describe conversations that students in your class have with your teacher?
- Prompt – What are the conversations about?
- Prompt – How do teachers help students with tasks

6.10. Teacher interview schedule

Research Questions:
How do teachers perceive the nature of the learning and teaching in their classroom, the social environment in the classroom and how does this relate to how they approach the task of instructing the class?

Interview Preamble:
My name is Polly and I am carrying out this research to find out about the experiences of teachers and students in maths classes grouped by ability. In this interview I will ask you questions about the day-to-day experiences of teaching your Year 10 maths class.

I will use this recorder to record our conversation.
Would it be ok for me to record your responses on the recorder?

Only I will listen to the conversation after this interview and I may include parts of what we have spoken about in my research. Anything that I use from what you have said will remain anonymous.

Please feel comfortable to speak about your experiences. Any thing you say will remain confidential. However, if something that you have said means you or someone else is unsafe, I will need to pass that information on to the relevant professional. I will tell you if I need to do this.

Do you have any questions about what I've said?

It will take about 20 minutes. If at any stage you would like a break or you would like to stop the interview completely just say so. It is ok if you ask me to stop.

You do not have to answer any question you do not want to.

Is there anything you would like me to explain?

Interview Questions:

Can you tell me about the type of tasks that you tend to set students in their lesson?
- Prompt –Why you choose these types of task for this class?

Can you tell me about what helps and hinders students learning in your class?
- Prompt- What type of strategies and resources do you use?

To what extent do students work together in your maths lessons?
- Prompt – Pair and group work.
- Prompt – Why do you think this might be?

To what extent are opportunities for students to work together planned and structured?
- Prompt – Do students choose to work together independently?

To what extent are students supportive of each other in lessons?

- Prompt – Do students seek support from one another with their learning?

How would you describe the behaviour of students in lessons?

- Prompt – What are the types of behaviour that you may have to address in your lesson?

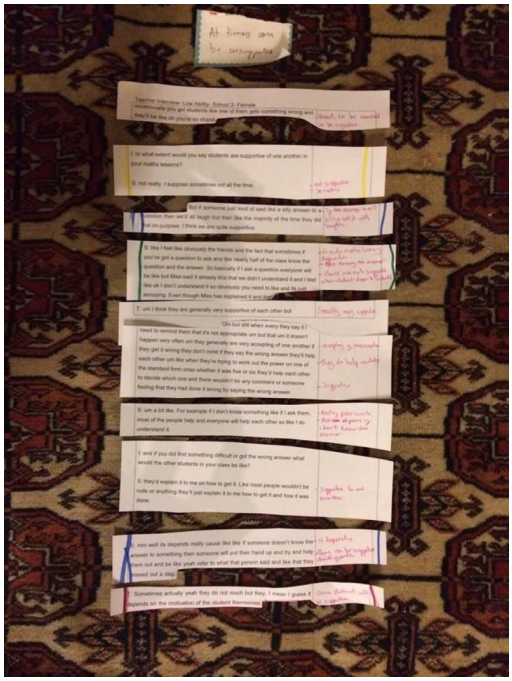
Can you tell me about the conversations you have with students in your lessons?

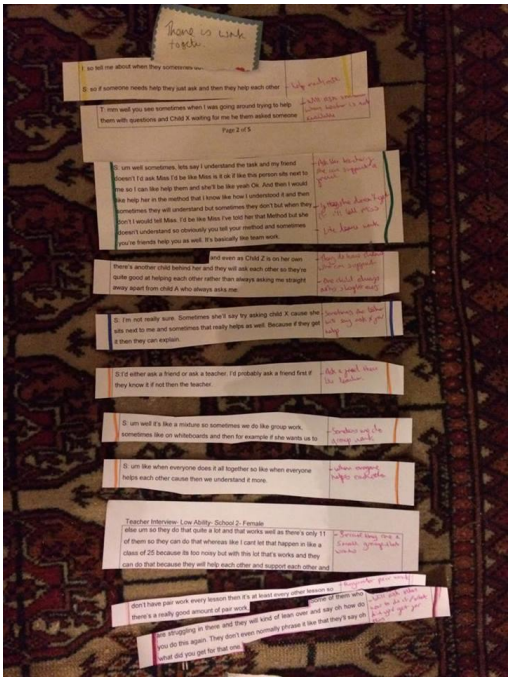
- Prompt – What would you say the conversations focus on?
- Prompt – Are conversations reciprocal (e.g. back and forth)?

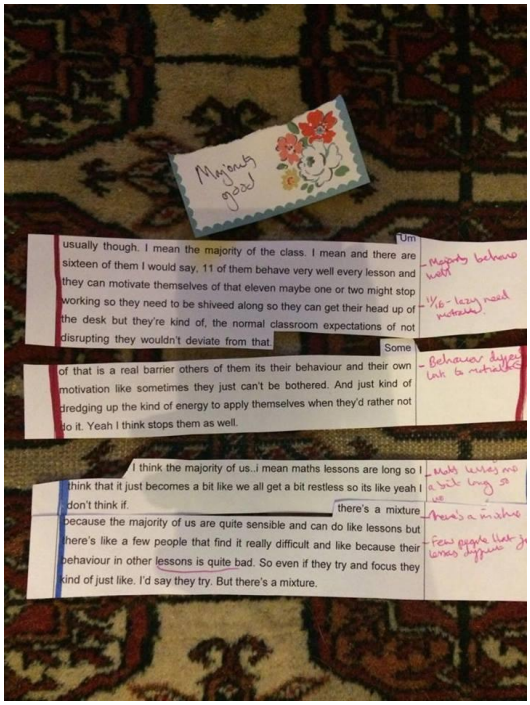
6.11. Evidence of thematic analysis process

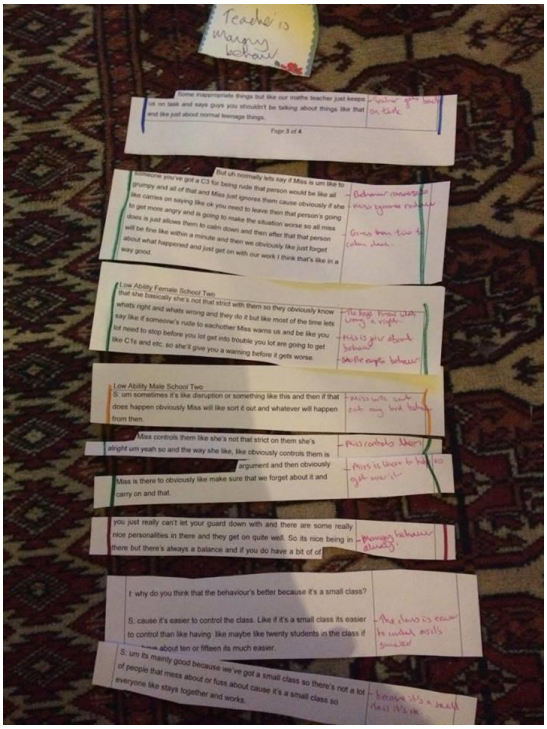
Transcript High Ability Teacher	Code
I: Can you tell me about the type of tasks you tend to set in that maths class?	
T: so I suppose what I set uh is a mixture of tasks I suppose in the two lessons that you observed um the second lesson started with the kind of routine task you know here's here's a technique now just apply the technique in a really simple kind of easy fashion. I chose that task because they struggled with that technique in the previous lesson um but the objective is always to move beyond those tasks those tasks into tasks that require interpretation and understanding. You know the task with regards to applying the technique of inequalities to sandwhiches and cake and that was one that required interpretation and linking the maths back into the real world and in the excersise set in the second lesson we were trying to get towards a question at the end of the excersise where students would have to read a set of texts form inequalities from that and then solve it and then bring their answer back into real life context.	Teacher set a range of tasks Traditional tasks where a technique is demonstrated and then practiced Always move to tasks that require interpretation/understanding Example of a task in the lesson that required interpretation Tasks set in real life
I: So applying maths is something that is key.	
T: Yeah and you know that's something that we know is becoming more of a feature of the GCSE exam itself so its apart from being really important interms of just pedagogy its also important in terms of exam success so its key. Um yeah I mean there's another example of a question at the end of the excersise that I used in the second lesson was uh 'come up with some inequalities that define a right angle triangle' so the student can just come up with their own inequalities so that's	Understanding is important for GCSEs/exams and T&L understanding An example of maths being a creative subject Create inequalities to solve a problem

kind of turning it on its head and saying lets be a bit more creative with it and produce the inequalities yourself. Or another question I use is ‘come up with some inequalities that produce a trapezium’. That’s instead of here’s your question just do the technique its do you really understand the technique. Can you use it to show me something else. I: and also I suppose that with that for example there’s not exactly one answer that you could give.	Showing understanding through applying knowledge.


At times can be unsupportive
Teacher Interview- Low Ability- School 2- Female
I: so what extent would you say students are supportive of one another in your maths lessons?
S: not really. I suppose sometimes not all the time.
I: and if you did find something difficult or got the wrong answer what would the other students in your class be like?
S: they'd explain it to me on how to get it. Like most people wouldn't be rude or anything they'll just explain it to me how to get it and how it was done.
Sometimes actually yeah they do not much but they. I mean I guess it depends on the motivation of the student themselves.


Home is task focus.
I: so tell me about when they sometimes w...
S: so if someone needs help they just ask and then they help each other
T: mm well you see sometimes when I was going around trying to help them with questions and Child X waiting for me, he them asked someone
Page 3 of 5
and even as Child Z is on her own
there's another child behind her and they will ask each other so they're quite good at helping each other rather than always asking me straight away apart from child A who always asks me.
S: I'm not really sure. Sometimes she'll say try asking child X cause she sits next to me and sometimes that really helps as well. Because if they get it then they can explain.
S:I'd either ask a friend or ask a teacher. I'd probably ask a friend first if they know it if not then the teacher.
S: um well it's like a mixture so sometimes we do like group work, sometimes like on whiteboards and then for example if she wants us to
S: um like when everyone does it all together so like when everyone helps each other cause then we understand it more.
Teacher Interview- Low Ability- School 2- Female
else um so they do that quite a lot and that works well as there's only 11 of them so they can do that whereas like I cant let that happen in like a class of 25 because its too noisy but with this lot that's works and they can do that because they will help each other and support each other and
don't have pair work every lesson then it's at least every other lesson so
there's a really good amount of pair work
you do this again. They don't even normally phrase it like that they'll say oh
what did you get for that one


Majority good
Um
I usually though. I mean the majority of the class. I mean and there are sixteen of them I would say, 11 of them behave very well every lesson and they can motivate themselves of that eleven maybe one or two might stop working so they need to be shiveed along so they can get their head up of the desk but they're kind of, the normal classroom expectations of not disrupting they wouldn't deviate from that.
Some
of that is a real barrier others of them its their behaviour and their own motivation like sometimes they just can't be bothered. And just kind of dredging up the kind of energy to apply themselves when they'd rather not do it. Yeah I think stops them as well.
I think the majority of us..i mean maths lessons are long so I think that it just becomes a bit like we all get a bit restless so its like yeah I don't think if.
there's a mixture
because the majority of us are quite sensible and can do like lessons but there's like a few people that find it really difficult and like because their behaviour in other lessons is quite bad. So even if they try and focus they kind of just like. I'd say they try. But there's a mixture.


Teacher is Majority behave
Some inappropriate things but like our maths teacher just keeps on task and says guys you shouldn't be talking about things like that and like just about normal teenage things.
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but uh normally lets say if Miss is um like to someone you've got a C3 for being rude that person would be like all grumpy and all of that and Miss just ignores them cause obviously if she like carries on saying like ok you need to leave them that person's going to get more angry and is going to make the situation worse so all miss does is just allows them to calm down and then after that that person will be fine like within a minute and then we obviously like just forget about what happened and just get on with our work I think that's like in a way good.
I: Low Ability Female School Two
that she basically she's not that strict with them so they obviously know whats right and whats wrong and they do it but like most of the time lets say like if someone's rude to eachother Miss warns us and be like you all need to stop before you lot get into trouble you lot are going to get like C1s and etc. so she'll give you a warning before it gets worse.
I: Low Ability Male School Two
S: um sometimes it's like disruption or something like this and then if that does happen obviously Miss will like sort it out and whatever will happen from then.
Miss controls them like she's not that strict on them she's
alright um yeah so and the way she like, like obviously controls them is
argument and then obviously
Miss is there to obviously like make sure that we forget about it and carry on and that.
you just really can't let your guard down with and there are some really nice personalities in there and they get on quite well. So its nice being in there but there's always a balance and if you do have a bit of
I: why do you think that the behaviour's better because it's a small class?
S: cause it's easier to control the class. Like if it's a small class its easier to control than like having like maybe like twenty students in the class if
about ten or fifteen its much easier.
S: um its mainly good because we've got a small class so there's not a lot of people that mess about or fuss about cause it's a small class so everyone like stays together and works.

6.12. Qualitative lesson observations detailed analyses

The field notes from the qualitative lesson observations have been synthesised in order to capture the type of tasks set for students in their lessons. The analysis of the field notes will discuss the tasks in relation to the nature of the goal; if the task has one or many correct answers; if there is one or many methods; if the tasks are set in real life or are pure maths tasks and if there is scaffolding present. The analysis will also discuss what prior knowledge the class have, in general, of the type of tasks set in the lesson. It is important to note that there will be variation between the students with regards to their prior knowledge of different tasks therefore the researcher will consider the prior knowledge of the class more generally as would be assumed by the teacher. This approach has been chosen in order to capture what type of thinking skills the teacher is attempting to cultivate within the classroom. Similarly when the term 'scaffolding' is used the researcher is referring to the scaffolding available for the whole class as opposed to individual children

The discussion regarding the type of tasks set will aim to give an account of the thinking skills used by the students as opposed to focusing in detail on the mathematics behind the tasks this is in order to make the analyses meaningful for those who are not experts in maths. For a more detailed account of the lessons please see the appendix for the lesson plans.

School A – 2D Inequalities

The high ability lessons in School A were focused around 2D inequalities. The students had prior knowledge of inequalities and in the previous lesson had been learning how to draw inequalities with vertical and horizontal lines. The previous lesson will have given the students the conceptual understanding behind what an inequality is. In the two lessons observed the students were moving on to using their knowledge of inequalities to attempt more complex maths problems that required the students to create inequalities using diagonal lines (this is a more complex maths skill than drawing vertical and horizontal lines) and to start to apply their knowledge of inequalities in different ways. The structure of the lesson consisted of the teacher explaining a concept and then the students working from a text book activity.

- *Goal*- All tasks set in the lesson had a well-defined goal that students were able to work towards.
- *Method*- The majority of tasks set in the lesson required the use of one method that the students had been instructed to use by the teacher and had been demonstrated for them. There were a small number of tasks towards the end of the text book activity that required students to think of their own method to use in order to reach their goal.
- Answers- The majority of the tasks set led to one correct answer. There were a small number of activities (e.g produce a set of inequalities that form the shape of a trapezium) that had an infinite number of possible correct answers.
- Semi- real, real-life or academic tasks - There was a mixture of semi-real and academic tasks in the two lessons. The initial questions in the text book activity consisted of academic pure maths tasks (e.g. write the following inequality $2x + 2y > 4$). Further on in the text book activity there were worded

problems that related to real life situations for example calculating the cost of sandwiches.

- Scaffolding- The general scaffolding in the lesson consisted of the teacher talking through example questions at the start of the lesson and having students record examples in their books to refer to if needed.
- Differentiation- The work was differentiated by outcome as opposed to by task. The students worked through the text book activity at varying speeds hence the more able students completed more of the challenging tasks towards the end of the activity that required more advanced thinking skills.

***School B* – Solving quadratic equations and Drawing straight line graphs**

The high ability lessons in School B focused on different topics. Students had prior knowledge of both topics and the lessons were designed to recap the learning as opposed to introducing new knowledge. The lesson structure consisted of the tasks being presented on the board for students to answer and working through tasks on work sheets.

- *Goal-* All tasks set had a clear goal for students to work towards.
- *Method-* The majority of tasks set in the lesson had one clear method to follow that the students were directly applying to answer the tasks. There was one extension activity (What do you notice about the equations of perpendicular lines?) that required the students to consider different approaches and methods to solve the problem.
- *Answers-* All of the tasks set in the lesson had one correct answer.
- *Semi-real, real-life or academic tasks-* All of the tasks set in the lesson were academic/pure maths tasks.
- *Scaffolding-* There was very little scaffolding during the lesson. The main scaffolding was from teacher explanations and examples at the start of the lesson.
- *Differentiation-* There was little differentiation in the lesson. The main form of differentiation was the extension question that a small number of students reached. Hence it was differentiated by outcome.

Middle ability lessons

School A- Using trigonometry to find the lengths of missing sides of a triangle.

The two middle ability lessons in School A were focused around trigonometry. In their previous lesson students had been learning about Pythagoras theorem. The first lesson was an example of guided discovery learning. Guided discovery learning is when students are guided to explore some mathematical ideas in order to discover a formula, a procedure or some mathematical fact, which the teacher has in mind (Bruner 1961). In the context of this lesson students were being guided by the teacher to explore the relationship between triangle ratios and trigonometry. It is important to note that guided discover learning is different from a mathematical investigation as the students are being led at each individual stage by their teacher. Therefore the students are following step by step instructions to reach a final destination as opposed to posing and solving problems themselves. In the second lesson the students were using their knowledge of trigonometry to find missing lengths of triangles using the formula to do this.

- Goal- In the initial lesson the overall goal of the learning was not well defined. However the students were set individual tasks to complete where there was a well-defined goal at each stage e.g. draw and label a right angle triangle. Therefore although the students were not aware of the goal of their learning as a whole they only needed to be concerned about each individual step. In the second lesson there was a well-defined goal set for all tasks.
- Method- There was one task set at the end of the first lesson where students attempted to work out a method to use to find the missing length of a triangle. All other tasks set in the lessons used one method that had been outlined by the teacher.
- *Answers*- All of the tasks set in the lesson had one correct answer.
- *Semi-real, real-life or academic tasks*- The majority of tasks set were academic tasks. There were a small number of tasks towards the end of the text book activity that were semi-real life tasks e.g 'A ladder 5m long, leaning against a vertical wall makes an angle of 65˚with the ground. How high on the wall does the ladder reach?' With a diagram.'
- *Scaffolding*- There was a high level of scaffolding in the first lesson as students were taken through the activity one step at a time. Therefore students were following step by step instructions from the teacher. In the second lesson the scaffolding consisted of worked examples by the teacher for students to refer to if and when needed.
- *Differentiation*- The differentiation in both lessons was through outcome.

School B- Simple and Compound Interest

The two middle ability lessons in School B were focused on calculating simple and compound interest. In their previous lessons students had been learning about calculating percentages of amounts. The lesson consisted of teacher input, tasks being presented on the whiteboard for students to attempt and students working from work sheets.

- Goal- All tasks set in the lesson had a clear goal for students to work towards.
- Method- Both compound and simple interest were introduced to the students by giving them a question e.g. 'Sally deposits £600 into an account with an interest rate of 5% per year. How much money will Sally have in her account after 2 years?'. The students then attempted to work this out using their own methods and there was a class discussion about what method should be used. The questions following the introductory questions used one method that had been discussed and agreed with the teacher.
- *Answers*- All tasks set in the lessons had one correct answer to work towards.
- *Semi-real, real-life or academic tasks*- There was a combination semi-real and academic tasks in both lessons. The semi-real tasks consisted of worded questions about people investing money.
- *Scaffolding*- The scaffolding in the lesson consisted of teacher explanations and examples for students to work from.
- *Differentiation*- Differentiation was through outcome.

Low ability lessons

School A- Angles in parallel lines and Factorising quadratic equations

The two low ability lessons observed in school A focused on two different topics. In the first lesson students were learning about angles in parallel lines. In their previous lessons the students had been learning about angles in triangles. This lesson consisted of students watching a maths video clip, recording examples in their books and then answering a series of practice questions. The second lesson was a recap lesson on factoring quadratic equations. In this lesson the teacher demonstrated a method to the students and wrote instructions for each step in the method on the white board and the students then followed this.

- *Goal*- Each maths task set by the teacher had a clearly defined goal that students worked towards.
- *Answers*- Each maths task had one correct answer.
- *Method*- The students were given one method to use to complete the tasks set.
- *Semi-real, real-life or academic tasks*- All tasks set were academic/pure maths tasks.
- *Scaffolding*- There was a high level of scaffolding for the tasks set in both lessons with step by step instructions for each stage of the maths procedure.
- Differentiation- Differentiation was by outcome during the lesson.

School B- Standard form

The two low ability lessons in School B focused on standard form. The students had had one previous lesson on standard form in which I understand they were developing their understanding of what standard form is. In the two lessons observed students were practicing the skill of converting numbers to and from standard form for very small and very large numbers. When the teacher introduced the concept of writing very small numbers using standard form she used a visual pattern to show the students negative powers of ten:

$$100=10^{2}$$
$$10=10^{1}$$
$$1=10^{0}$$
$$0.1=10^{-1}$$
$$0.01=10^{-2}$$

I noticed at points during the lesson some students asked questions which highlighted their lack of conceptual understanding of the maths such as 'does it always have to be ten?'. I also noticed that students used the method of moving the decimal point. There were no opportunities in the lesson for the students to apply their knowledge of standard form.e.g. Write down the largest number 8.3×10^{4} , 3.9×10^{5} or 8.36×10^{3}

- Goal- There was a clear well defined goal for all tasks set in the lesson.
- Answer- There was one correct answer for all tasks set in the lesson.
- Method- The students used one method that they applied directly to the task.
- *Semi-real, real-life or academic tasks*- All tasks set were academic/pure maths tasks.
- *Scaffolding*- There was little scaffolding for the learning in the lesson.
- Differentiation- Differentiation was by outcome during the lesson.

6.13. Lesson audio recordings

The 30-minute audio recordings were analysed using predefined codes from Christine et al (2010). The 30-minute recordings were broken down into 90 20-second recording periods. The data is shown as the percentage of the 90 observations that the given utterance occurred in. The coding categories were combined for organising students and materials, use of language to explain maths concepts, asking questions, responding to student, teacher giving feedback and teacher addressing behaviour. These areas are discussed qualitatively.

There was variation between the types of talk taking place in the different classrooms. The percentages are presented for each individual class in addition to the mean percentages. Overall trends in relation to the different codes will be discussed in addition to any anomalies across the different classe Organising students and materials

The overall mean percentage of audio recording periods spent organising students and materials in the classroom was 28.1%. Organising students was the main form of organisation that took place (24.4%).

The two high ability groups represented the lowest (8.9%- School A) and the highest (42.2%- School B) percentage of recording periods organising students and materials. It is important to note that the teacher of the high ability group in school B also addressed behaviour a number of times at the start of the lesson which may have resulted in her giving student more instructions to organise and control them.

B1TF “The instructions are that you need to sit down, your homework book is open so I can come and check it, your class book is open the date and title is in there and you’re doing these questions in complete silence year 10.”

Use of language to explain maths concepts

The overall mean percentage of audio recording periods where teachers explained maths concepts was 30.2% and this was one of the most common types of talk used by teachers across all ability groups.

Again the two high ability groups represented the highest (55.6%- School A) and the lowest (15.6%- School B) percentage of recording periods explaining maths concepts. The teacher of the high ability group in school A gave explanations of maths concepts little and often although these were often relatively short the talk was mostly related purely to maths concepts.

A1TM “so x is two and seven times two is fourteen and y is seven so two times seven is fourteen as well so subtracting two”

The two middle ability groups explained maths concepts in 33.3% of the recording periods.

The two low ability groups explained maths concepts in similar percentages of the audio recordings (24.4%- School A and 18.9%- School B).

Teacher asking questions

The overall mean percentage of audio recording periods in which teachers asked students questions was 28.1%. The majority of questions asked were closed questions with a right and wrong answer (19.3%). In a small percentage of recording periods the teacher asked open-ended questions (1.7%).

The two middle ability groups had the highest number of recording periods where teachers asked questions (38.9%-School A and 40%- School B). The middle ability teachers tended to use student questioning as a way of teaching the class and building explanations.

AMTM "Is there anyone here who could shed some light. What do I mean by label your diagram?"

The low ability group in school A (17.8%) and high ability group in school B (20%) asked questions in the lowest percentage of recording periods.

Teacher responding to student's answers
The overall mean percentage of audio recording periods in which teachers responded to student's answers was 26.7%. When receiving a response from a student the teachers first confirmed or rejected the answer and then often repeated the answer that was given by the student.

In the high ability groups the teachers asked for elaboration from students in 6.7% (School A) and 4.4% (School B) of the recording periods. Teachers of other ability groups did not ask for elaboration in any recording period when receiving answers.

The highest percentage was in the low ability group (school A) where the teacher responded to a student's answers in 34.4% of recording periods. This may have been due to their being a number of occasions where students were giving answers from exercises to the teacher.

Teacher giving feedback on learning
The overall mean percentage of audio recording periods in which teachers gave students feedback regarding their learning was 10.9%.
The low ability groups gave feedback in the greatest percentage of recording periods (15.6%- School A and 13.6%-School B). The feedback for the low ability groups was mostly giving praise to students for their learning.

Initiating student interactions
Teachers of both middle ability groups initiated peer interactions in 7.8% of the recording periods. The teacher of the low ability group in school B initiated a peer interaction in 1.1% of the recording periods. Teachers in other ability groups did not initiate peer interactions.

Addressing behaviour during the lesson
The overall mean percentage of audio recording periods in which teachers spoke about the student's behaviour was 15.2%. When teachers spoke about behaviour this mostly consisted of the teachers reacting to behaviour issues.

There was variation between the different classes with regards to how frequently behaviour was spoken about during the lesson. The highest percentage of recording periods where teachers spoke about behaviour was in the high ability group in school B (22.2%) and the low ability group in school A (25.6). In the low ability group in school A behaviour was addressed throughout the lesson where the teacher was continuously reacting to individual student's poor behaviour. In the high ability group the teacher predominantly addressed the behaviour of the class as a whole and there was a period of 4 minutes where she spoke to the students solely about their behaviour.

Linking to prior knowledge
The overall mean percentage of audio recording periods in which teachers linked the students learning to prior knowledge was 3%. The teachers of the middle ability groups both related the students learning to prior knowledge in 4.4% of the recording periods. Teachers of all other classes linked the students learning to prior knowledge in 2.2% of the recording periods.

Task focus
The overall mean percentage of audio recording periods in which teachers focused student's attention on tasks and what they needed to do was 15%.
The teacher of the middle ability class in school A spoke about task focus for the largest percentage of recording periods (22.2%). The teacher of the low ability class in school A spoke about task focus for the smallest percentage of recording periods (8.9%%).

Promoting cognitive engagement / thinking
The overall mean percentage of audio recording periods in which teachers promoted cognitive engagement and thinking was 7.6%. The two middle ability classes promoted cognitive engagement in the highest percentage of recording periods (13.3%- School A and 14.4%- School B).

No utterances
The overall mean percentage of audio recording periods in which teachers did not talk for the full 20-second period was 5.9%. The classes with the largest percentage of recording periods with no utterances were the high ability classes (11.1%- School A and 7.8%- School B)