An exploration of the ‘cultural script’ for teaching and learning mathematics in English secondary schools and its relationship with teacher change

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Summary

Recent reports on mathematics education in English secondary schools have consistently expressed concern about students' performance and enjoyment as well as their progression into studying mathematics post-16 (Smith, 2004; Ofsted, 2006, 2008a; Royal Society, 2008, 2010; Vorderman et al, 2011). Too often students were expected to follow rules and procedures without mastering underlying concepts and connections, and hence without developing their mathematical understanding (Ofsted 2008a).

Boaler (2008a) provides evidence for the introduction of Complex Instruction (CI) as an effective alternative approach to teaching and learning mathematics. The CI pedagogy combines rich mathematical tasks and instructional strategies that foster collaborative group work and problem solving. The approach emphasises effort over 'ability' and challenges beliefs that only some students can do mathematics and that they should be taught in 'ability' groups.

This thesis explores factors which facilitate or militate against the adoption of such an approach by drawing upon Stigler and Hiebert's (1999) concept of a 'cultural script' and Dweck's (2000) 'theory of self and others'. It aims to build a better understanding of what influences teaching in mathematics classrooms in order to inform teacher development.

The study combines quantitative and qualitative methods through the use of questionnaires, interviews and a reflective research journal over a two year period and includes:

- Secondary analysis of interviews with 20 teachers in schools with high numbers of students studying mathematics post-16;
- Course evaluations from 27 teachers attending a workshop on CI and interviews with a sample who were willing to use the approach;
- Pre and post study interviews with a lead mathematics teacher at two contrasting schools; one using CI with mixed ability groups and the other not.
- Questionnaires completed by 221 Year 7 students and their mathematics teachers at the two contrasting schools.

Open coding analysis of the teacher interviews was used to produce themes. The questionnaires were statistically analysed to explore teachers' and students' frameworks of intelligence and personality in relation to learning and performance goals in mathematics.

The findings support the notion of a 'dominant cultural script' for teaching mathematics in English secondary schools. Teachers refer to 'expected national norms', where the expectations are driven by their understanding of National Strategy/Ofsted guidelines and the judgements upon them are based upon students' exam performance. This performance goal orientated model, coupled with teachers' anxieties about unacceptable behaviour in the classroom together with concerns about finding time to plan and resource a different approach, offers strong reasons for teachers' reluctance to change.

The findings demonstrate that the teachers using CI still adhered, to some extent, to aspects of the 'dominant cultural script'. They felt vulnerable in terms of examination results and inspection. The extent to which they deviated from the 'script' was contingent upon factors such as having a strong supportive department with collaborative sharing of resources; seeing students as actively involved in the learning process and continuing professional development opportunities both within their schools and with university departments of education.

Whilst these teachers, though mindful of exam performance and inspection, held other beliefs and goals for their students, these were not necessarily shared by the students. A high proportion of students, particularly amongst the lowest attaining students and girls, were found to hold fixed frameworks of intelligence and personality coupled with a preference for performance over challenge in mathematics. Dweck (2000) suggests that having such beliefs is unlikely to lead to mastery orientated qualities in students, which are the key to improvement in progress. Hence, given a dominant script for teaching mathematics which also emphasises performance goals, the likelihood of all students achieving their full potential in mathematics in such a climate is jeopardised.

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1 Introduction and rationale

1.1 The journey

My journey as a teacher began in 1976 and I have now worked in each of the primary, secondary, tertiary and higher phases of education. Over the years, I have been privileged to work with hundreds of teachers and thousands of students of mathematics in a variety of settings. I began my interest in mathematics teaching in a large London comprehensive school which grouped the students into ‘sets’ according to their examination performance. I was never comfortable with this way of grouping students. First, because I thought that labelling of students in this way was inequitable; influenced by my initial teacher education and further reading, for example, the seminal work of Rosenthal and Jacobson (1968), and I was concerned that it placed limits on student attainment. Secondly, because of the difficult behaviour that I frequently encountered in the lower mathematics sets and thirdly because, at this same school, I also taught economics and commerce to students in mixed attainment groups without these concerns. This distinction between how students were grouped for mathematics compared with other subjects always puzzled me. I had enjoyed mathematics the most when taught in a collaborative, problem solving and investigative style that encouraged mathematical discussion and so I wanted to teach mathematics that way. Influenced again by my initial teacher education and further reading as a teacher, for example, the Cockcroft Report (DES, 1982), I believed that this would promote engagement and lead to more effective learning. Unfortunately, my early experience of teaching mathematics as a newly qualified teacher was far from this ideal. My head of department expected me to ‘teach from the textbook’, model the rules and procedures to the class and get students to practise plenty of examples.

Over a decade later, in 1992, which included a period as a class teacher in upper primary schools where children were taught in mixed attainment classes, I secured a position as a mathematics teacher at a comprehensive secondary school where students were not placed in sets for mathematics and where the mathematics department had schemes of work which included interesting rich mathematical activities. After several happy years, this was to be brought to an abrupt end. Two things happened in close succession. First there was a challenge to the department’s methods from two more recently qualified colleagues in the mathematics department claiming that it was too difficult to teach mathematics in this way. They found the classroom management required particularly difficult and wanted to return to ‘text-book’ style teaching. Secondly, in March 1997, the school had its first Ofsted inspection. Shortly after the inspectors’ departure, I was asked to meet with the Head Teacher. He told me that, although Ofsted had given me a good report and he was more than happy with my teaching and my students’ progress, unlike me, some of my colleagues in the mathematics department found it too difficult to teach mathematics in these ‘progressive’ ways.

Overall, the mathematics examination results were not good enough and consequently, unlike the rest of the school, the overall report for the mathematics department was not good. Hence, he would be instructing the head of mathematics to group students in all the year groups into sets for their mathematics lessons and use more ‘traditional, text-book’ methods. He said that he knew I would be disappointed so he wanted to speak to me personally and assure me that it was no slight on my personal practice. It was this defining moment that triggered my pursuit of research evidence on student grouping and effective pedagogy in mathematics. Although I, and some of my colleagues, continued to use a range of pedagogical approaches within our classes, now in sets, I wanted to make my case more widely.

It was towards the end of the 1990s that I discovered the research of Jo Boaler (Boaler, 1997) which chimed with my pedagogical preferences and academic interest. Interestingly, one of the teachers she referred to in this study, Jim Cresswell, suffered similarly as a result of an Ofsted inspection. A decade later in 2008, by chance rather than design, I became Boaler’s research assistant. She came to work at the University where I was working in initial teacher education and I was offered the opportunity to work with her.

I have included this summarised autobiography because it foregrounds the following sections through a personal exemplification of the enduring debate, over many decades now, about two key, interrelated discourses for teaching and learning mathematics in this country; that of the most effective pedagogical approach and that of how students should be grouped. I have also included it because I want to be completely transparent from the outset about where I locate myself in relation to this research study. My position affords both opportunities and threats for the research and these will be addressed fully in my research methodology (see Chapter 3).

1.2 The state of mathematics education in English secondary schools

In this section, I will summarise the state of mathematics education in English secondary schools when I embarked upon this thesis.

As a teacher of mathematics and teacher educator, I fully supported the statement from the report ‘Making Mathematics Count’:

> *The Inquiry regards it as vital that society fully recognises the importance of mathematics: its importance for its own sake, as an intellectual discipline; for the knowledge economy; for science, technology and engineering; for the workplace; and for the individual citizen* (Smith, 2004, p3).

However, I had also come to know from both the learner’s and teacher’s perspective that:

> *...the United Kingdom is still one of the few advanced nations where it is socially acceptable – fashionable even – to profess an inability to cope with the subject,* (Williams, 2008, p3).

Performance in mathematics of compulsory age students in England also remained notably wanting. The Department for Children, Schools and Families (DCSF) statistics (2008a; 2008b) showed that students’ performance in the National Curriculum tests for mathematics at the end of Key Stage 2 and 3, whilst improved since 2000, still tended to lag behind that in English and science. The GCSE examination results (DCSF, 2008c) showed that students on average achieved lower grades in mathematics, compared to English and science. The Trends in International Mathematics and Science Study (TIMSS) (Mullis et al, 2007), showed that Year 9 students in English schools still performed less well in mathematics compared to students in many other countries, notably those that Stevenson & Stigler (1992) and Stigler & Hiebert (1999) referred to in their studies of learning mathematics in other cultures (see Chapter 2).

These statistics, coupled with recent reports in England on the teaching and learning of mathematics in schools (Smith, 2004; Ofsted, 2006, 2008a; Williams, 2008; Royal Society, 2008) expressed concern about students' performance, enjoyment and post-16 participation. Ofsted's (2008a) report encapsulated the concerns at the time about the state of mathematics teaching in English schools:

> *The fundamental issue for teachers is how better to develop pupils' mathematical understanding. Too often, pupils are expected to remember methods, rules and facts without grasping the underpinning concepts, making connections with earlier learning and other topics, and making sense of the mathematics so that they can use it independently. The nature of teaching and assessment, as well as the interpretation of the mathematics curriculum, often combine to leave pupils ill equipped to use and apply mathematics. Pupils rarely investigate open-ended problems which might offer them opportunities to choose which approach to adopt or to reason and generalise. Most lessons do not emphasise mathematical talk enough; as a result, pupils struggle to express and develop their thinking,* (Ofsted, 2008a, p5).

Further, in their evaluation of the Primary and Secondary National Strategies 2005-7, Ofsted (2008b) reported that the quality of teaching was good in only just over half the schools visited and teaching was generally less good in mathematics lessons. Each report, with considerable agreement, made recommendations for improvement. Of particular relevance to my study are:

1. Investment in continuing professional development, to develop all teachers subject and pedagogical knowledge, to provide opportunities for reflection on alternative approaches to delivering the mathematics curriculum and to share good practice;
2. Employing teaching approaches which develop students' understanding of mathematics whatever their level of attainment and which encourage collaborative enquiry via problem solving to enhance critical reasoning and thinking and encourage discussion of mathematics rather than simply 'teaching to the test' via instruction in rules and procedures.

1.3 The research focus

In 2008-9, I assisted Professor Boaler in two of her research projects. The first examined inequalities in the progression of students from GCSE to A level in mathematics and science in the UK, with a focus on gender, social class and ethnicity performance and participation patterns, (Boaler et al, 2011). The second investigated the impact upon students' learning of teaching mathematics using Complex Instruction (CI) pedagogy, (Boaler et al, 2010). CI is an approach to teaching and learning mathematics which promotes group work designed with rich tasks appropriate for students with a wide range of prior attainment, instructional strategies that incorporate the use of norms and roles and teacher interventions which hold both individuals and groups accountable for learning (Cohen & Lotan, 1997, see also section 2.2.1). The outcomes claimed of this approach, are that it supports the learning of key mathematical concepts and skills, develops autonomy and independence and raises the status and attainment expectations of all learners. Boaler (2008a) has researched this approach in the US to show that significant gains can be made with its application:

> *At Railside School students learned more, enjoyed mathematics more and progressed to higher mathematics levels* (Boaler & Staples, 2008, p609).

However, Boaler's research findings are not without critics. For example, the Stamford Residents for Excellence in Education (2009) presented a report to the school board claiming that research evidence, in terms of test scores, contradicts heterogeneous grouping, (known as mixed ability grouping in England), and supports ability grouping so long as appropriately differentiated pedagogical approaches are used. They included a paper written by Bishop et al (undated) which, following a detailed analysis of the measures used by Boaler (2008a) to demonstrate the advances made in student attainment at Railside School using the CI approach, suggested that Boaler's claims are grossly exaggerated. Boaler did not use standardised state tests to make comparisons between the attainment of Railside students with those at the other two comparator schools and Bishop et al found the instruments she used to be flawed. It was also subsequently found that the students at the comparator schools performed better than Railside on the state tests. However, the critics do not appear to challenge Boaler's findings in terms of the improvements she found in both the Railside students' attitudes towards mathematics and towards each other:

> *Equity is a concept that is often measured in terms of test scores, with educators looking for equal test scores among students of different cultural groups, social classes or sexes. In this article the term 'relational equity' is proposed to describe equitable relations in classrooms; relations that include students treating each other with respect and responsibility* (Boaler, 2008a, p1).

In June 2008, a group of 27 mathematics teachers from across England were invited to attend a workshop on CI. As a result of this workshop, some of these teachers began to apply this pedagogy in their mathematics lessons. Year 7 and 8 students' attitudes to, and performance in mathematics, with and without the CI approach, in four pairs of comparator schools were evaluated by the project team.

Concurrent with these research projects, Boaler toured the country over the period 2008-2010, presenting her research findings and advocating the adoption of the CI approach to teaching mathematics which, she argued, addressed the issues of achievement in mathematics for all pupils and engaging students in ways that led to higher levels of enjoyment and participation.

Over this period, to assist with the data collection and analysis of the first project, I was invited to listen to interviews that Boaler had conducted with teachers at the 20 schools with high post-16 participation rates in mathematics and science. I then subsequently visited a sample of four of these schools to interview teachers and students and observe lessons. For the second project, I assisted with the workshop and then with the data collection and analysis which again involved interviewing teachers and students and observing lessons. Throughout the duration of these projects I kept notes in my personal research journal. I was struck by the homogeneity of the structure of the mathematics lessons observed and, whilst, in my opinion, there were notable incidences of vibrant lessons involving problem solving and group work, the majority of lessons took the form described by Ofsted (2008a) above. Concurrent with these projects, I was also fortunate to accompany Professor Boaler to her presentations of her research on the CI approach (Boaler, 2008a). It appeared that whilst most teachers, in the first instance, responded with interest and positively to her research findings and her suggested alternative approach to teaching mathematics, questions invariably followed from many, but not all, that expressed concern and doubt about adopting the approach in their schools. By keeping a record of teachers' responses to Boaler's research in my journal, I began to notice some themes emerging in the form of resistance or barriers to pedagogical change which I thought worthy of further research of my own.

Boaler (2008b, p1), states:

> *One of the most important research questions for our time, in mathematics education, concerns teacher change - specifically how teachers may be encouraged to take on more effective approaches.*

However, the adoption of more effective approaches to teaching and learning mathematics as indicated in the authoritative reports previously referenced is not straightforward, not least because the term 'effective' is value-laden. Measurement of the effectiveness of the teaching and learning process is related to its outcomes or product (Muijs & Reynolds, 2011). Therefore, effectiveness may vary according to which outcomes are deemed desirable and which measures are used. Thus the term 'effective' is problematic and this will be developed in Chapter 2.

Hence, in questioning the effectiveness of current and alternative pedagogy, there appear to be challenges in the form of beliefs about the nature and purpose of education generally, mathematics education specifically and the influence that government policy has had on these factors. Previous national (e.g. Smith, 2004; Ofsted 2008a) and international (e.g. Burghes, 2011) reports have arguably failed to recognise the widely held cultural beliefs about the teaching and learning of mathematics. Stigler and Hiebert (1999) state that teaching is a cultural activity that evolves over long periods of time and is consistent with the beliefs and assumptions that are part of our culture. The result of this process for teachers is a shared mental picture of what teaching is like: a '*cultural script'*. This concept will also be developed in Chapter 2. Crucially, Stigler and Hiebert (1999) state that, if teaching is a cultural activity, improving teachers' cultural scripts is the approach needed rather than improving the skills of individual teachers. Thus, if an alternative pedagogy is to be adopted as a more effective approach to improving the performance, the enjoyment and the post-16 participation of students in mathematics in England, which national reviews such as Smith (2004) and Ofsted (2008a) suggest is an urgent need, an understanding of teachers' cultural scripts is required and this is the focus of my study.

2 Literature Review

2.1 Two competing discourses for teaching and learning mathematics

In Chapter 1, I referred to the enduring debate about two key, interrelated discourses for teaching and learning mathematics in England; that of how students should be grouped and that of the most effective pedagogical approach. In the extreme polarities of the debate, mixed ability grouping with ‘progressive’ methods are pitched against setting by ability with ‘traditional’ methods. This can be attributed in some part to relatively recent research that has been carried out into the performance, enjoyment and post-16 participation of students in mathematics which has taken the form of case-study comparisons between schools under these two conditions. For example, Boaler’s two major research studies, (Boaler, 1997, 2008), which are quoted widely in the current debate, and the latter making headline press coverage in The Times newspaper (Frean, 2008), make claims for the advantages of mixed ability groups taught with what she terms ‘progressive’ methods over ability sets taught with what she terms ‘traditional’ methods.

In my experience of observing many hours of mathematics lessons as a PGCE tutor and as a mathematics education researcher over the period 2003 to the present, I have observed lessons where the students are grouped into sets and have been working on engaging process-based problems. I have also observed lessons where students are grouped by mixed ability where the focus has been on remembering rules and facts. Furthermore, I have observed the same teacher using each of the approaches on different occasions. However, I have mostly observed students being taught in sets using pedagogy described by Ofsted (2008a) as limited in the opportunity for students to discuss and develop their mathematical thinking.

Hence the debate is far more complex than that of a choice between two options; rather, there is a spectrum along which teachers position themselves. In the following sections, by way of gaining some understanding of the positions that can be taken on these issues, I will explore the research evidence for each of these discourses.

2.2 Student Grouping

> *Ability and hierarchy appear to be concepts central to the way in which many maths teachers theorise mathematics learning, and their organisational and pedagogical practice* (Ruthven, 1987, p245).

This discourse relates to the arguments about whether or not students should be grouped by some measure of their ‘ability’. Separation of students in this way can operate on three levels: between schools, between classes and within classes. I will show how this practice of ‘ability’ grouping and its subsequent segregation of students are highly problematic.

In 2010, with varying degree of control by local authorities, the state system in England comprised mostly non-selective, secondary schools described as comprehensive schools. Eligibility for entry was largely defined by students living within the school’s catchment area. One hundred and eighteen of England’s 150 local authorities had only comprehensive secondary schools which accounted for approximately 3000 schools (DfE, 2010). Thirty-two local authorities had retained selective state-funded grammar schools accounting for 164 grammar schools (National Grammar Schools Association, 2010). Since the introduction of specialist school status to all maintained secondary schools in 1995, (Yeomans et al, 2000), now held by most comprehensive schools, there is the option for these schools to select 10% of their intake.

However, within this largely non-selective, comprehensive school system, the mix of students within each school may neither represent the full range of student attainment nor socio-economic status (SES). For example, some parents choose to opt out of the state system in favour of private education, some relocate to the catchment area of a preferred state school and some, if their child has attained highly in a subject, can apply to a specialist school outside their neighbourhood.

Thereafter, within these state schools, children are grouped in a variety of ways with the following formations and terms widely used and accepted (Kutnick et al, 2005a), amongst teachers, students, parents and policymakers:

1. Setting – where students in each class are assumed to have a similar ability to each other for a particular subject.
2. Mixed ability – where students are distributed between classes such that each class is assumed to have a similarly wide range of ability.

There are two other formations which are less well known and used:

3. Streaming – where students are classified by their assumed overall ability and stay in the assigned stream for all their subjects.
4. Banding – where all students in a year are classified into two or three broad groups based on assumed ability across subjects with parallel classes in each band. This system assumes that ‘ability’ of students is constant across subjects.

I will continue to use the terms ‘mixed ability’ and ‘ability grouping’ or ‘setting’ in this study, despite the flaws in the notion of ‘ability’, to be discussed later in this chapter, because they are the common parlance amongst teachers and students in schools, parents and policymakers.

There is a long history in the English education system of assigning children to different groups according to some measure of their ability (Curtis & Pettigrew, 2009). Gillard (2008) traces this history back to the late 19th century and argues that the segregation of children was derived initially from a desire by the middle and upper classes to have their children educated separately from the working class when free, state education first became available. This was followed by a regime of state education driven by standards which denied access to education beyond the elementary stage except for the most able children, as measured by passing a scholarship examination.

By the 1920s, influenced by the work of psychologists such as Cyril Burt, the notion of fixed innate intelligence was used to determine a child’s education at eleven and initiated the beginning of grouping students within schools by a measure of ability: the IQ test. As early as the 1930s, the nature/nurture debate in relation to education had also begun and questions were being raised about the relative influence of hereditary and environmental factors on a child’s measured ability (Hadow, 1931), and hence the validity of the IQ tests used. Nevertheless, by the 1944 Education Act, although there was education for all to the age of fourteen, students were separated at every level, both between and within schools, either in preparation for a test of intelligence, the 11-plus, or as a result of it. Galton, Simon and Croll, (1980), refer to the league tables that parents in the 1940s and 50s drew up to see which local primary schools performed well in the 11-plus exam, and the subsequent pressure that this placed upon both teachers and children.

A landmark report from the British Psychological Society in 1957 reopened the nature/nurture debate in relation to the 11-plus (Gillard, 2008). Since it was shown that children could enhance their IQ scores, it was argued that environmental factors must have some bearing on their measured ability. Chitty (2007) suggests that this report was important in developing support for comprehensive secondary education. Supported by the Ministry of Education, the 1960s saw a growing support for comprehensive secondary schools. With a reduction in the selective process at age eleven, streaming in primary schools diminished in favour of more flexible mixed ability groupings. The Plowden Report (1967) gave an extensive summary of the situation in primary schools at that time. Plowden welcomed the ‘unstreaming’ of children commenting that when mixed ability groups were ‘established with conviction’, and ‘put into effect with skill’ the outcome was ‘a happy school and an atmosphere conducive to learning’ (ibid, p819). However, she also stated that the 'forms of organisation are less critical than the underlying differences in teachers' attitudes and practice which are sometimes associated with them'. Hence, the form of organisation could 'reflect and reinforce attitudes', (ibid, p818) and ‘streaming can be wounding to children’, (ibid, p823). In the following year, 1968, Rosenthal and Jacobson published their seminal work on the ‘self-fulfilling prophecy’ in schools which supported the concerns of Plowden and revealed the extent to which teachers’ perceptions, expectations and subsequent attitudes towards a group of children can affect their performance.

Developing the pedagogical approach required, Plowden commended a combination of individual, class work and group work organised flexibly on the basis of children’s needs in mixed ability classes. She argued that group work fostered both social skills: 'children learn to get along together, help one another and realise their own strengths and weaknesses as well as those of others', and pedagogical functions:

‘they make their meaning clearer to themselves by having to explain it to others, and gain some opportunity to teach as well as to learn' (Plowden, 1967, p757).

Arguably, the Plowden Report signalled the notion of what has become termed ‘progressive’ education:

> *Child-centred approaches in general, the concept of "informal" education, flexibility of internal organisation and non-streaming in a general humanist approach - stressing particularly the uniqueness of each individual and the paramount need for individualisation of the teaching-learning process* (Galton, et al, 1980, p40).

However, class teaching was mostly rejected and the most popular option was individualisation combined with within-class ability grouping, which afforded 'a rational means of controlling (or managing) the independent activities of some thirty plus children', (Galton et al, 1980, p5).

The Newsom Report (1963) stated 'the essential point is that all children should have an equal opportunity of acquiring intelligence' (ibid, p iv). Gillard, (2008), argues that the word ‘acquiring’ is the key to opening up the debate more widely about the innateness of intelligence. It gave teachers and educationalists the opportunity to campaign for the abolition of selection and streaming based largely on the premise that children from deprived backgrounds were disadvantaged in the testing system, which measured what they had learned rather than their capability or potential. However this was set against a backdrop of further publications from the eugenicists still claiming that intelligence was innate and that the removal of selection and streaming in favour of comprehensive schooling would hold the most able students back (Chitty, 2007). This gave the ‘traditionalists’, in the form of whole class teaching, to students grouped by some measure of ability, further armoury against the ‘progressives’.

Gillard (2008) argues that just as some positive effects of mixed ability teaching were beginning to emerge in secondary schools in the form of greater student motivation and better behaviour, the CSE was introduced in 1965 as an alternative to the existing secondary school exit qualification, the GCE, and this saw the division of secondary aged students into either academic and non-academic pathways within state schools. Chitty, (2007), notes these pathways as being indicative policies in the form of providing education for the middle and upper classes and training for the working class.

The Conservative government, who were elected in 1979, were keen to reintroduce 11-plus selection to those education authorities across the country that had abandoned grammar schools in favour of comprehensive schools. In this unsuccessful bid to re-introduce selection in all areas, differentiated education was developed by other means such as the Training and Vocational Education Initiative (TVEI). Like the introduction of the CSEs, the introduction of the TVEI scheme led to different educational opportunities being offered to different sections of young people with different ‘types of mind’ (Chitty, 2007, p112).

The arguments against selection and streaming were essentially twofold: one rooted in the validity of the tests used and the other in the harmful, limiting effects of selection or streaming on a substantial proportion of the population. Although the 11-plus and selective secondary schools were disappearing across many parts of the country, there remained low evidence of mixed ability grouping within schools. However, the arguments against selection or streaming are not necessarily arguments for mixed ability. The evidence illustrated thus far suggests that the debate has been largely framed negatively against selection and streaming rather than for the advantages of mixed ability. Furthermore, as Plowden suggested, the shift to mixed ability classes requires a shift in teachers’ pedagogy.

Kelly (1978) suggests that the positive arguments for mixed ability grouping lie with a view of society as egalitarian and the individuals within it as cooperative and social, with commensurate views about the purpose of education, and the nature of values particularly about different kinds of knowledge. Referring to the pace of technological and social change, Kelly argues against the inflexibility of streaming in favour of the flexibility that only mixed ability could afford, 'flexible enough to allow for the creation of different groupings for different purposes and to facilitate continuing development of all kinds', (ibid 1978, p24-25).

Chitty (2007) documents the counter arguments put forward by those who believed that universal educational opportunities were undesirable as it would lead to discontent within society. This was based on the premise that educational opportunities could not be matched by employment opportunities. Hence, education should be rationed and people should ‘know their place’.

Interestingly, the Cockcroft Report (DES,1982) ‘Mathematics Counts’, so often referenced by mathematics educationalists in support of their case for incorporating more progressive pedagogical approaches, expressed concerns about mixed ability teaching in mathematics. These concerns were ventilated in terms of 'problems of ensuring continuity' and 'the quality of the mathematics teaching inevitably depends largely on the strength and interest of the class teacher', (ibid, p348). Acknowledging the difficulty teachers faced of matching levels of work to children in a class with a wide range of ability, they concluded, 'We do not therefore consider that this form of grouping offers any advantages for the teaching of mathematics'. They also alerted teachers with children grouped into sets that 'considerable differences will exist within each group', (ibid, p349-350). The suggestion was that mixed ability grouping for maths was acceptable only if there were suitable teachers, with the warning that standards were liable to suffer 'if mixed ability teaching is imposed upon mathematics departments against their will', (ibid, p496).

Hence the argument for and against having mixed ability groups in schools initially based on egalitarian versus conservative principles begins to switch to arguments for or against mixed ability based upon the ability of the teacher to teach the group effectively. Bailey and Bridges, (1983, p5) state, 'In our experience the teachers most deeply disillusioned with mixed ability grouping are those in schools which have taken the first of these steps without giving proper consideration to the second'. They went on to note that there was 'a *prima facie* conflict ... between the concern for individuality and the concern for equality' (ibid, p24), where the former is associated with variety and divergence and the latter, a common curriculum and provision.

The Elton Report (DES, 1989) found that more than half the classes which teachers described as 'difficult' were grouped by ability in some way (by sets, streams or bands) and that three quarters of these groups were of 'below average attainment level compared with other pupils in the school' (DES, 1989, p.235). It would seem, therefore, that both forms of grouping present the teacher with challenges, though it is difficult to unpack the effect of the grouping strategy from that of the pedagogical approach employed on the resultant disaffection.

The New Labour government, elected in 1997, attacked mixed ability teaching, claiming that it had only been successful in the hands of the best teachers and should only be used in future where there was proof that it could be truly effective. They argued that mixed ability teaching in too many cases had 'failed both to stretch the brightest and to respond to the needs of those who have fallen behind', (DfEE 1997, p38). It recommended the use of setting, particularly for science, mathematics and languages with a targeted programme for gifted and talented students:

> *Unless a school can demonstrate that it is getting better than expected results through a different approach we do make the presumption that setting should be the norm in secondary schools. In some cases it is worth considering in primary schools,* (DfEE, 1997, p38).

In that same year, Boaler's (1997) ethnographic longitudinal study of two English schools was published. The aim of the study was to monitor the learning of students who experienced either 'traditional' or 'progressive' approaches to the teaching of mathematics. She concluded that there was an urgent need for the results of setting research, which showed no links between setting and high achievement, with even some students in the top sets being disadvantaged, to be brought to the attention of schools and policy makers. A research study two years later, conducted by Ireson and Hallam (1999), which analysed the progress of students in 45 secondary schools with good Ofsted reports, demonstrated that there was no academic advantage to students afforded by setting and that mixed ability promoted positive self-esteem amongst students. Venkatakrishnan and Wiliam (2003) showed that placement in mixed ability groups conferred significant advantages for the lower attaining students whilst the disadvantages to the high attaining students was much smaller. The General Teaching Council for England, (2004), suggested that the debate about pupil grouping policy stems from a number of issues and tends to divide opinion between effectiveness in terms of academic achievement and equity in the sense of fairness and the effect upon students' self esteem.

In 2005, Kutnick et al published a systematic review of the literature on the effects of pupil grouping. Their key findings stated that:

> *Pupil grouping is often presented as a polemical debate between setting and mixed-ability teaching. The research evidence suggests that schools show a much wider range of grouping practices that vary with age of pupils (especially*

> *at transition into secondary schools) and curricular area. In addition, consideration of pupil grouping should include a variety of within-class groupings, and organisational and within-class grouping for both social and academic purposes*, (ibid, p5).

They also found that there was no one form of organisational grouping that benefitted all pupils and where setting occurred, students in the lower groups were ‘vulnerable to making less progress, becoming de-motivated and developing anti-school attitudes’ (ibid p5). Furthermore, they found evidence to show that these students experienced, ‘poorer quality of teaching and a limited range of curricular and assessment opportunities’, (ibid, p5). They also noted the over-representation of some groups in the lowest sets: boys, students with SEN and some minority ethnic students. This lends further weight to the difficulty of distinguishing between the effects of the mode of grouping students and the pedagogical approach employed.

Nevertheless, standards in education began to be emphasised by the government on economic grounds over social, egalitarian goals, culminating in the description of students as falling into three groups, ‘the gifted and talented, the struggling and the just average’, (DfES, 2005, p156). In the same document, the advantages of grouping children by ability and attainment were guised under the agenda of personalised learning which 'can help to build motivation, social skills and independence; and most importantly can raise standards because pupils are better engaged in their own learning' (DfES 2005, p58). Arguably, the opposite of what previous research evidence has suggested and continued to suggest thereafter.

Whilst the Primary and Secondary National Strategies (DfES, 2006) guidance document advises grouping students on potential as well as ability in order to avoid compounding prior underachievement, Dunne et al (2007) found that nearly 50% of students were set not on the basis of prior attainment but instead appeared to be influenced by teacher judgements, pupil behaviour and social class. Blatchford et al, (2008, p1), concluded that ability grouping had 'no positive effects on attainment but has detrimental effects on the social and personal outcomes for some children'. Ireson and Hallam’s (2005) research study of over 6000 students in British secondary schools found that, when other variables were controlled, the number of years of setting had virtually no effect on average GCSE attainment. Yet there was a profound effect on the attainment of individual students who, despite having the same prior attainment, were placed in higher or lower sets.

Watson, (2006), has documented the detrimental effects upon students placed in low mathematics sets, yet pragmatically accepts that the norm for mathematics in secondary schools is to group students into sets (Watson , 2011a). Reporting on the Improving Attainment in Mathematics Project (IAMP), Watson and De Geest, (2005), found that improvement for low attaining students was contingent upon ‘the collection of beliefs and commitments which underpinned teachers’ choices’ (p1), rather than the methods and materials deployed. They identified common principles beneath these teachers’ superficial differences which included a rejection of the notion of students’ fixed ability and learning style and a rejection of the need to both artificially simplify mathematics for them and disguise it as something else in order to make it interesting. Rather, these teachers had a dominant belief in the worth of all students: that they could learn more mathematics, get better at it and feel better about themselves as students of mathematics.

Ireson and Hallam, (2009), examined the effects of ability grouping in schools on students' self-concept. They found that students' academic self-concept, but not their general self-concept, was related to the extent of ability grouping in the school attended. Students in high-ability groups were found to have significantly higher self-concepts in English, mathematics and science than students in low-ability groups. Students' intentions to learn in future were more strongly affected by self-concept than by achievement.

In 1978, only 2% of comprehensive secondary schools taught mixed ability groups in all five years and first year mixed ability classes for most subjects were only found in one third of schools, (HMI, 1978a). By the same year, although very few classes in primary schools were grouped by ability, almost three quarters of the classes were found to group the children by their ability for mathematics, higher than for all other subjects, and largely via individual work assignments, (HMI, 1978b).

Throughout most of the 1990s, mixed ability classes in primary schools were the norm. In comprehensive secondary schools, just over half used mixed ability classes for all subjects and students (Gillard, 2008). However, the focus of the then

Conservative Government shifted to that of urging teachers to differentiate the work given to students of different abilities in mixed ability classes. Coupled with the introduction of school performance tables, however, this led to targeting resources on those children who were on the borderline of acceptable target grades in the Key Stage 2 (KS2) National Curriculum (NC) tests or in the GCSE exams (Hart et al, 2004). The ‘League Tables’, as they have come to be known, refreshed the pressure on teachers and students and lead to comparisons being made between schools akin to that experienced in the 1940s and 50s.

Since 1997, in secondary mathematics classes in England, the most common form of grouping students has been that of ability grouping or setting. Figures from the Department for Education (DfE, 2010) state that in 2003/4 Ofsted found 83% of Key Stage 3 (KS3) students to be grouped by ability and based on an unrepresentative sample of Ofsted inspections in 2008/9 they suggested that 70% of students were set for mathematics in secondary schools. In 2008, I conducted a survey of PGCE mathematics student teachers at my institution. Sixty-five per cent of them were on teaching practice at secondary schools where setting was operated for all mathematics classes. Of the remainder, setting was operated in all years except Year 7 (11-12 year-olds) where only 12% had mixed ability for the whole year and the rest either had mixed ability for all or part of the first term only, or the highest attaining students were separated from the rest. KS2 NC tests and/or internal tests, they reported, were used as a measure of the students’ ability.

Since Boaler’s appeal to schools and policymakers in 1997, setting for mathematics in primary schools has also become increasingly common. The Millennium Cohort Study, (2011), found that 26% of the children were set for mathematics and literacy by the age of seven. In 2007, the Primary Strategy Mathematics Team carried out a focused visit of primary junior and middle schools in 11 Local Authorities (The National Strategies, 2008). The majority of these schools placed children in classes set by ability for mathematics and more than half of the schools that had mixed ability classes used within class ability grouping for mathematics. With the introduction of KS2 NC tests, it is argued that there has been a rise in the number of primary schools that are adopting the secondary model of setting whole classes for mathematics according to test score measures and an increase in ‘teaching to the test’, (Kyriacou, 2000; National Union of Teachers, 2009).

To allocate students into mixed ability groups or sets, as has been demonstrated, arises from the differing beliefs and perspectives, held by the policymakers, the education community and the public at large including parents, (Ireson & Hallam, 2001), about the nature of intelligence, about how children learn, about the goals of schooling, about the best way to support students with differing levels of attainment and about the effect of labelling students by perceived ability. The Primary and Secondary National Strategies guidance document on grouping students, (DfES, 2006), acknowledged that ability grouping was common place in secondary schools in the core subjects, which includes mathematics. The guidance document also stated that decisions on how to group students were largely made on the grounds that teachers found it easier to pitch the work when they know the ability range in the class. Claiming that they had drawn upon research into effective grouping, they suggested that, given the advantages for both setting and mixed ability, teachers should move away from the ‘old ‘for and against’ debates about grouping’, (ibid, p1), in favour of more sophisticated and flexible approaches. They added that, whatever grouping method is chosen between or within classes, its success is contingent upon high quality teaching tailored to suit the learning needs of the students. The difficulty then arises as to what form this high quality teaching takes and this will be addressed in the next section.

Returning to my introduction to this chapter, I referred to the debate about mathematics education in schools being far more complex than that of a choice between two options; between mixed ability/progressive and set/traditional. I suggested that there was a spectrum along which teachers can position themselves. In the case of student grouping strategy, this is currently not the case for most teachers of mathematics in secondary schools. The choice of grouping strategy is rooted in a range of deep-seated, socio-cultural beliefs about young people’s rights of access to education and the desired outcomes from the education process, (Gorard & Sundaram, 2008), which reflect the inequalities within society. Whilst the research evidence reviewed largely highlights the detrimental effects of setting on students, the key concern of the policymakers about the use of mixed ability teaching appears to be its effect on national standards particularly in relation to holding back the highest attaining students.

Ability grouping for mathematics in English secondary schools continues to dominate. For the policymakers there remains a choice. For the individual teacher, the choice is largely imposed and in the hands of school management driven by government policy and the standards agenda. I can therefore see the attraction, for the mathematics teacher, of following the National Strategy advice and moving away from the old ‘for and against’ debate about grouping in favour of focusing on a high quality, flexible teaching approach for any given group of students. However, on the balance of evidence, the option of mixed ability grouping with high quality, flexible teaching approaches appears to be an option that hasn’t as yet been fully exploited and this thesis provides some insights into possible reasons for this.

Given the dominance of setting for mathematics, for the purpose of this research, where I want to examine cultural scripts for teaching and learning mathematics in different grouping contexts, finding teachers that have experience of working with so-called mixed ability classes in mathematics is problematic. Getting teachers to act in contrast to current orthodoxy is difficult, (Brown et al, 2003). Even when they can be found, the extent of the mixed ability of the class is often questionable, first for the reasons given previously about the composition of secondary schools, secondly because of the methods used to measure ability and thirdly because, as Dunne et al (2007) found in their study of pupil grouping, as many as a half of the students appeared to be placed in a group for reasons other than their prior attainment, such as behavioural problems and socio-economic status though this was not explicitly stated by the school staff.

2.3 Approaches to teaching and learning mathematics

The second discourse, in the extreme, divides the approaches to teaching and learning mathematics into two polarised perspectives. Using Boaler’s (2009) definition, the ‘traditional’ or procedural approach consists of students working individually on practice questions following teacher demonstration. The ‘progressive’ or process-based approach is where students work collaboratively on rich problem solving tasks. Central to this debate is what constitutes ‘effective’ teaching.

2.3.1 Effective teaching

Kyriacou (2000) states that:

> *The notion of effective teaching derives from a psychological perspective on thinking about teaching, where the emphasis is placed on identifying observable behaviour in the classroom which can be linked to observable outcomes* (ibid, p11).

As stated in my introduction, the notion of effectiveness is problematic. A process can be deemed effective if it produces the intended outcome(s). Hence, the measurement of the effectiveness of the teaching and learning process is related to its outcome(s) or product, (Muijs & Reynolds, 2011).The problem then in relation to the product would appear to be twofold. The first is to define the outcome(s) that are deemed desirable; hence effectiveness is not neutral. The second is to employ methods of measurement that are both reliable and valid, both contested terms in themselves.

Defining the outcome(s) of teacher effectiveness

Harris and Rutledge (2007) draw attention to a key difference between teaching and many other occupations; that there is substantial debate, (i.e. different philosophical stances), about what it is that teachers are trying to achieve, whereas in most other occupations the outcome desired is clear and thus it is only the theory of workers' behaviour that is at issue. However, as they point out:

> *Every philosophy of teaching can define its own objectives and these in turn can be associated with theories of behaviour. Philosophical issues therefore make the task more difficult, but far from impossible,* (Harris & Rutledge, 2007, p47).

As shown in section 2.2, when considering different student grouping strategies, desirable outcomes of the school education process can vary between the many stakeholders in the education process. Research into the effectiveness of different grouping strategies has focused on either cognitive or affective outcomes, or both as measured by the effect on student attainment and/or attitudes. Kyriacou (2000) distinguishes between short term and long term outcomes, where the former might be expressed in terms of attainment in standardised tests and the latter in terms of participation beyond compulsory schooling. For these reasons alone, comparison of the findings from different studies is difficult. Because there remains no generally agreed consensus regarding the definition of effectiveness, this contributes to there being no generally agreed methods for measurement (Goe et al, 2008).

Muijs and Reynolds (2011) have traced British research into teacher effectiveness over the past 40-50 years and suggest that cognitive outcomes, largely in the form of improvements in students' academic achievement, have been the measure used in order to find causal links in the context-process-product paradigm. This would appear to be the case when examining major teacher effectiveness reports and research over the past decade. The Hay McBer Report (2000), which was commissioned by the DfEE and developed as a basis for teacher appraisal, used beginning and year end assessment data as their outcomes. Hattie (2003) criticised educational policy reforms for improving standards which took the form of tightening up on schools and teachers via greater curricular control, specified scripts and structures for teaching, coupled with national testing which produced narrower learning. However, whilst he acknowledged the limitation of using student achievement to determine effectiveness factors, he nevertheless used this as his measure of outcome in his meta-analyses synthesis relating to factors that contribute to effective teaching, (Hattie, 2003, 2009). The Variations in Teachers' Work, Lives and Effectiveness, (VITAE) study, (Day et al, 2006), also measured teacher effectiveness by the value-added to student attainment.

Harris & Rutledge (2007) state that most of the recent teacher effectiveness studies focus mainly on objective measures, e.g. test scores, and this puts constraints on the types of models that can be used. The arguments for using test scores, they state, are that in addition to being more readily available, they relate to a final outcome with which teaching is 'loosely coupled', hence student achievement gains might reasonably be attributed to individual teachers. By contrast, the arguments for using classroom evaluations are that they provide more direct evidence of each teacher's effectiveness and enable the consideration of outcomes other than student achievement. A focus on test scores, they suggest, has led to models of teacher effectiveness that are commensurate with the shift to student achievement becoming the central focus of educational understanding and policy making, (i.e. teacher accountability). In England, this shift in focus has been related to the introduction of the National Curriculum, (Cooper & McIntyre, 1996), and ‘teaching to the test’, which Torrance (2002) argues, if coupled to a teacher competency model, may ultimately reduce teacher effectiveness in the long term if effective teacher qualities are perceived as being fixed.

Goe et al (2008) conducted a systematic review of empirical teacher effectiveness research across the US, Canada, Great Britain, Ireland, Australia and New Zealand. They also noted how definitions of effectiveness, with commensurate changes in its methods of measurement, have changed focus with the more recent policy emphasis on school and classroom–level accountability. Definition of teacher effectiveness, they argue, has important implications since teacher effectiveness can become synonymous with student achievement:

> *What is measured is a reflection of what is valued and, as a corollary, what is measured is valued,* (ibid, p4).

They suggest instead the use of more comprehensive measures of teacher effectiveness to include a wider range of research instruments beyond test scores and classroom observations in order to capture the range of ways in which teachers may contribute to student progress and well-being.

Measuring the determinants of effectiveness

Figure 2.1, is a typical example of the context-process-output paradigm found in teacher education textbooks for considering teacher effectiveness. If the outcome is fixed as student attainment and one contextual variable is fixed as student grouping strategy, (e.g. sets or mixed ability), there are many other variables to consider when drawing any conclusions about the effectiveness of this one variable. Further, the make-up of the group whilst describing in some part the students’ characteristics, may also describe one or more of the other contextual factors such as the teacher’s characteristics, as highlighted in reports such as Plowden (1967) and Cockcroft (DES, 1982) and research such as Rosenthal and Jacobson, (1968) and Day et al (2006), with a consequent influence on one or more of the process variables. Figure 2.2, unlike the linear flow of the first diagram, shows the two way flow between each of the variables, within the constraint of the classroom, school and wider context.

However, it is still difficult to isolate one variable, such as grouping strategy or pedagogical approach, as a clear independent variable with a view to measuring the dependent outcome variable, such as student attainment, if hoping for a straightforward cause-effect relationship.

Using similar arguments, the choice of teaching method or approach presents similar challenges for analysis. In figure 2.1, the teaching approach would be placed in the process box. Questions then arise as to how many possible combinations can be made between the various process components which are then combined with the range of contextual factors preceding them. Figure 2.2 presents the same problems when the teaching and learning process is expanded to show its components. Hence, there appear to be multiple pathways through both diagrams which can be varied according to the outcome desired.

Figure 2.1: A basic framework for thinking about effective teaching, (adapted from Kyriacou, 2000, p7).

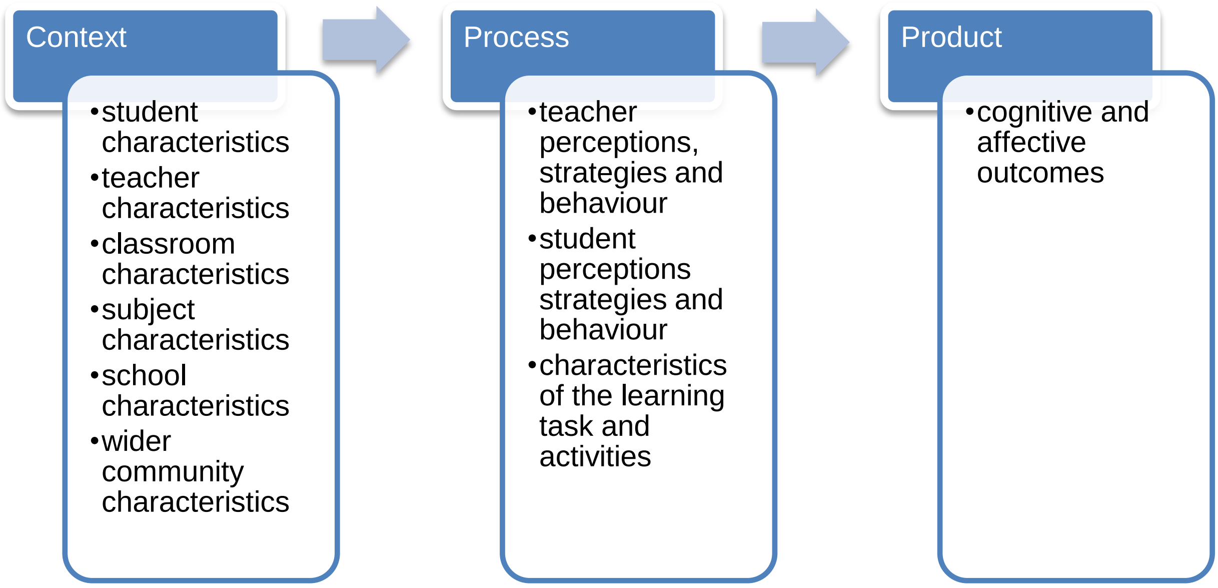
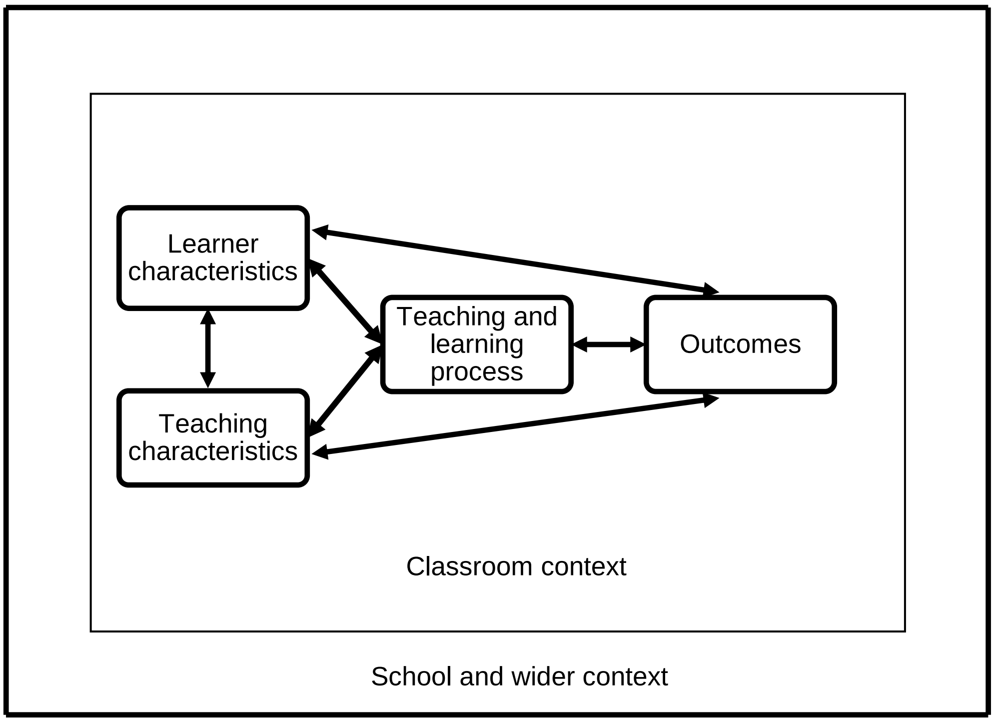


Figure 2.2: A Contextual Model for Learning (National School Improvement Network, 2002, p1)



Harris & Rutledge, (2007), writing from an American perspective, in seeking a relationship between worker characteristics and measures of effectiveness, describe how in classic occupational effectiveness research:

> *A model of effectiveness establishes a theory-driven relationship between effectiveness and worker characteristics. Such models begin with a general theory of work and then illustrate the theory's practical implications, including hypothesized relationships between specific types of effectiveness and worker characteristics. These hypothesized relationships can then be tested empirically and the model can be adapted accordingly. Or put differently, one can test whether the hypothesized "predictors" actually predict effectiveness and thereby test the validity of the models,* (ibid, p7).

However, in their review of studies into teacher effectiveness, they found that nearly all of the studies focused on a single model, there were no studies in which differences across models were systematically identified and the connection between theory and evidence outlined above was rarely found.

Harris & Rutledge (2007) also explored the difficulty in accounting for the distinctive features of teaching in models of effectiveness. Because teachers both function in their classroom and as members of their school, they have a dual allegiance to the students and the school management. Hence, different emphases in the resultant model can be placed on each of the school management, the teacher and the student. Further, there will be questions about teachers' classroom decisions, the nature of their knowledge base, and their level of control over the teaching task. They refer to the nature of the interactions between the teacher and the school management, which may differ between individual schools, the phase of education which the school serves, the size of school and the policy environment. This would suggest a variety of models to account for different aspects of teaching, the type of school and the school's context.

Goe et al (2008) concur with the suggestion that different measures may be necessary to capture teacher effectiveness in different contexts. As they point out, like Sammons et al (1995), it cannot be assumed that teachers are necessarily interchangeable between these different contexts. Hence a quest to find a generalised characterisation of the 'effective teacher' is arguably erroneous. Rather, attempts at such a concept need to be context specific for any reasonable comparisons to be made between teachers.

They also draw attention to the difficulties of pursuing direct causal relationships in teacher effectiveness and output. First because teachers may contribute to other desirable outcomes in addition to student achievement and secondly because teachers are not the only factor that contributes to students' learning. The latter can also be influenced, for example, by peers, other teachers, parents, and the school context.

Campbell et al (2003), in direct criticism of the Hay McBer (2000) Model of Teacher Effectiveness, also indicate the need for a differential model of teacher effectiveness. The differentials they suggested were teacher activity in and outside the classroom, curriculum subject, students' background and personal characteristics as well as cultural and organisational contexts.

The Hay McBer Report (2000) findings were also challenged by the British Education Research Association (BERA, 2001) stating that the report 'falls short of being an authoritative research-based account and may be misleading to anyone who treats it as such', (p9). Further, Davis (2001) suggested that the correlations found between the effectiveness factors and the outcomes were not necessarily causal in the direction that the report implied. Sammons et al (1995) had previously urged caution in defining key determinants in effectiveness studies and the danger of interpreting correlations as evidence of causal relationships because reciprocal relationships and intermediate causal relationships may also be important. Agreeing with Harris and Rutledge (2007), they added that, whilst providing useful insights, the findings should not be followed mechanically without reference to a particular school's context. The importance of context is also highlighted by Shulman & Shulman (2004) who state that effective teaching is not static but an ongoing reflective process which is created and sustained within a community context and in response to changing variables.

Goe et al (2008) draw attention to the problems associated with the validity of the measures of effectiveness used. They stated that classroom observation protocols and value-added models are not valid in themselves for measuring teacher effectiveness, but only in so far as they reliably and accurately measure what they intend to measure. Thus a classroom observation protocol is valid only in so far as it measures how well a teacher's practice meets the standard agreed by experts as important for that subject, that age of student, and in that context. Validity of value-added measures is dependent upon how well it captures the contribution a teacher makes to the progress of the student in a specific subject. They express concern that many teacher effectiveness studies attempt to express validity by correlating findings from these measures of two different constructs. Whatever construct is chosen as the output, they argue, be it for example, value-added, improved attendance or positive classroom atmosphere, validity is only measured by how well a teacher meets that construct. They conclude therefore:

> *There is no single measure that will provide valid information on all the ways that teachers contribute to student learning and growth and to their schools. Multiple measures – each designed to measure different aspects of teacher effectiveness – must be employed,* (ibid, p51).

Sammons et al (1995) also contribute to these methodological concerns. They alert us to the problems associated with the selection of schools for comparison from both the point of view of comparing like with like and also in terms of the applicability of findings across schools. They also raise the issue of choosing an appropriate timescale for the research study, given that, for example, the effect of some factors cannot be observed in a snapshot of time.

Both Sammons et al (1995) and Goe et al (2008) emphasise the issue of using appropriate methodology that will account for the wide range of variables that need to be taken into account. Goe et al, using the illustration of the ability to match students' test scores to their teachers and the concept of value-added, express concern about the development of analysis technologies being in danger of narrowly defining the measure of teacher effectiveness, rather than defining teacher effectiveness and then using appropriate analysis technology. They also argue that the focus on teachers' contribution to test scores may only be measuring the 'successful in the system' students rather than all students.

Key findings from teacher effectiveness studies

Despite the concerns expressed by researchers about both the definition of effective teaching outcome(s) and the methods used to measure them, there emerges a body of literature that attempts to find causal relationships in the input-process-product paradigm, where the outcome is focussed upon student attainment, as outlined in the examples below.

Sammons et al (1995) concluded that, whilst a child's ability and social background, particularly in relation to prior attainment, were the key determinants of achievement outcomes, schools with similar circumstances can achieve very different levels of student progress. Hence, given that there were schools with low SES in which students achieved higher outcomes than schools with higher SES students, other factors must be giving rise to this outcome. They identified key, yet not necessarily independent, characteristics of effective schools, (see summary in Table 2.1). They concluded that, whilst quality of teaching and learning and classroom processes were central to schools' academic effectiveness, they did not support the view that one type of teaching style was more effective than another or that the labelling of teachers as 'traditional' or 'progressive' was helpful:

> *In our view, debates about one particular teaching style over another are too simplistic and have become sterile. Efficient organisation, fitness for purpose, flexibility of approach, and intellectual challenge are of greater relevance,* (ibid, p55).

Muijs and Reynolds (2011) claim that the major teacher effectiveness research in the UK in the late 1990s and early 2000s was their own. Their 2003 study of the student population in 35 primary schools used multi-level modelling to identify 60 different teacher behaviours that contributed to improved student performance in mathematics across one year (Muijs & Reynolds, 2003). Adding that teachers' beliefs about teaching, their subject knowledge and their self-efficacy were also important factors, they concluded that when prior attainment, the factor that most influenced student progress, was controlled for, effective teaching had the strongest effect on student progress, (see summary, Table 2.1).

Significantly, they pointed out that teacher behaviours had a greater impact on student progress than the classroom organisation variables, such as setting, class size and in-class differentiation, which often attracted more policy and media attention. However, they also added some words of caution in relation to their findings (Muijs & Reynolds, 2003), which resonate with some of the cautionary remarks from Sammons et al (1995). The schools were not randomly selected and were unlikely to be representative of schools nationally. They also lacked variable data at school level, namely that of school ethos and climate. Furthermore, the study was focused on primary school mathematics and attainment was measured in the form of basic numeracy skills rather than that pertaining, for example, to higher order thinking skills.

The Hay McBer (2000) report (see summary Table 2.1) concluded that there were three distinctive and complementary factors that contribute to effective teaching which accounted for 30% of the variance in student progress: teaching skills, professional characteristics and classroom climate, defined as 'the collective perceptions by pupils of what it feels like to be a pupil in any particular teacher's classroom', (ibid, 2000, np). School context was not found to be a factor and neither was teacher's biometric data.

In 2002, Ofsted published its report 'Good Teaching, Effective Departments'. They concluded from their survey that schools that were effective overall, performed better than average in a number of areas, (see summary Table 2.1). The data used for their survey was from 152 secondary schools that they said ‘largely met Ofsted’s criteria for short inspections’, (Ofsted, 2002, p1). In the context-process-product paradigm for effective teaching these criteria would therefore constitute the product or outcome. It seems unsurprising therefore that they found the factors that contributed most to effective teaching were the criteria upon which they drew their sample. However, there are parallels here with their findings and those of the Hay McBer (2000) report but this would be expected considering that the Hay McBer report used Ofsted inspectors’ categories for assessing teachers’ classroom practice.

Hattie, (2003), acknowledging prior research in which individual student characteristics were shown to contribute 50% of the variance in student’s achievement and 30% teacher characteristics, concluded that it was the role of the school in the form of the teacher to make the difference. Based on a synthesis of 500,000 studies (Hattie, 2003, 2009) which showed that almost all that was done in the name of education had a positive effect on student achievement, he concluded that the focus should not just be on what teachers do, but what the most efficient teachers do. By contrasting expert and experienced teachers, he arrived at prototypic attributes of teacher expertise, (see summary Table 2.1).

Similar to the findings of Muijs and Reynolds (2003), who suggested that effective teaching was a combination of many small attributes rather than a few major ones, Hattie suggested that the expert teacher had a profile where, of the attributes identified, ‘there was no one necessary facet, nor equal presence of them all, but an overlapping of many facets into the whole’ (Hattie, 2003, p11). Hence, it should not be seen as a checklist. With an assumption that subject content knowledge was important for all teachers, be they expert, experienced or novice, it was pedagogical content knowledge that made the difference.

Following a large scale, mixed methods, three year longitudinal study of schools in seven local authorities, the VITAE study, (Day et al, 2006), also concluded that teacher ‘effectiveness’ is complex. However, they identified two associative dimensions of teacher effectiveness: relational effectiveness as perceived by the teacher and relative effectiveness as measured by comparisons between the value-added to student progress by teachers in similar contexts. They found significant variations in both teachers' relational and relative effectiveness across year groups and sectors influenced by variations in their work, lives and identities and their capacity to manage these. Effectiveness was found to be moderated by the teacher's professional life phase, sense of professional identity, and commitment and resilience. It was found to be mediated by continuing professional development (CPD), the ability to sustain commitment, quality of leadership at school and department level and relationships with colleagues and personal support. Teachers in secondary schools, more than primary schools, and those in more challenging schools (in terms of SES) were most at risk in relation to their ability to sustain commitment and resilience and hence long-term effectiveness. Unlike the findings of the Hay McBer report, these findings firmly place contextual factors back on the effectiveness agenda. This agrees with the findings of Harris and Rutledge (2007) who state that, aside from the concerns that have been raised about both the reliability and interpretation of estimates derived from the value-added models, it is still unclear whether the effects of home and community factors can be separated from those of teachers and schools.

A key difference between the research of Day et al (2006) and that previously outlined is the focus on an emotional characterisation of the teacher in terms of professional life phase and identity and the effects these have on both their relative and relational effectiveness:

> *If teachers are to manage the tensions they face within and across both, and sustain and, where appropriate, increase their commitment, resilience and effectiveness, they and those responsible for their leadership must draw upon and be encouraged to build understandings of the cognitive and emotional contexts in which they work in order to increase their capacities to manage these. This in turn is likely to foster their perceived and relative effectiveness,* (Ibid, p7).

Harris and Rutledge (2007) state that the evidence from their research review suggests that cognitive ability, personality and, to a lesser extent, education of teachers are shown to be factors in teacher effectiveness. Personality emerges as a secondary predictor compared to cognitive skills and they also found some similarities between teachers and other workers. They concluded that for both groups, conscientiousness and extroversion are consistently related to effectiveness.

However, they found that neither group of studies showed workers' education as a consistent factor.

In relation to the context-process-output model of teacher effectiveness, (Figure 2.1), Goe et al (2008) are in concurrence with the inputs, those of teacher characteristics: teacher background, beliefs, expectations, experience, pedagogical subject and content knowledge, teacher qualification and educational attainment. They also concur with the processes involved: teacher interactions mainly with students in the classroom but also activities within the school and community. The key determinants of effective teaching they arrived at are also shown in Table 2.1.

The Barber and Mourshed (2007) report, although critiqued as not strictly adhering to research principles, (e.g. Alexander, 2010), is quoted in the government's White Paper 'The Importance of Teaching' (DfE, 2010). The report, using data collected from twenty five of the world's school systems, concluded that the top performing school systems shared three essential ingredients: highest qualified graduates, high quality CPD, and high quality instruction for all students. They offered three suggestions for improving the likelihood of this happening: teacher reflection upon their own practice, opportunity to reflect upon and understand examples of best practice in authentic settings and motivation, beyond material incentives, to make the necessary changes to their practice:

> *Such changes come about when teachers have high expectations, a shared sense of purpose, and above all, a collective belief in their common ability to make a difference to the education of the children they serve,* (Barber and Mourshed, 2007, p. 27).

Table 2.1 summarises the key findings of the effective teaching literature thus far reviewed.

Table 2.1 Summary of effective teaching research reviewed – significant factors identified in terms of improving student attainment

a) Wider contextual factors	Sammons et al (1995)	Muijs & Reynolds (2003)	Hay McBer (2000)	Ofsted (2002)	Hattie (2003; 2009)	Day et al (2006)	Harris & Rutledge (2007)	Barber & Mourshed (2007)	Goe et al (2008)
Students' SES and prior attainment	√	√			√	√	√		√
Professional leadership and management at school and department level	√		√	√		√			
Organisational focus on teachers' continuing professional development, (CPD)	√					√		√	
Shared vision and goals	√							√	
Breadth and balance of curriculum				√					

b) Teacher's personal attributes	Sammons et al (1995)	Muijs & Reynolds (2003)	Hay McBer (2000)	Ofsted 2002	Hattie (2003; 2009)	Day et al (2006)	Harris & Rutledge (2007)	Barber & Mourshed (2007)	Goe et al (2008)
Teachers' subject and pedagogical knowledge/cognitive ability	√	√	√	√	√		√	√	√
Teachers' beliefs about teaching		√						√	√
Teacher's relationship with colleagues and personal support			√			√			√
Teacher's collaboration with other teachers, administrators, parents,	√								√
Teachers' identity/self efficacy		√				√			
Teachers' personality						√	√		
Teacher's professional life phase						√			
Teachers' passion for teaching and learning					√				

c) **Teacher's classroom practice**	Sammons et al (1995)	Muijs & Reynolds (2003)	Hay McBer (2000)	Ofsted 2002	Hattie (2003; 2009)	Day et al (2006)	Harris & Rutledge (2007)	Barber & Mourshed (2007)	Goe et al (2008)
Choice of teaching method	√	√	√					√	√
Monitors progress, and provides formative feedback	√		√	√	√				√
Has high expectations of all students	√		√		√			√	√
Classroom management and climate; clarity of purpose, efficient planning and organisation of time and resources	√	√	√		√				
Uses a range of resources with engaging learning opportunities				√	√				√
Gives positive reinforcement to develop students' self-regulation, mastery learning, self-efficacy, and self-esteem	√				√				√
Adapt instruction as needed								√	√
Review and practice		√							
Enhances surface and deep learning					√				
Evaluate learning using multiple sources of evidence									√

As discussed, the factors identified are not mutually exclusive, are connected in complex ways and, given the lack of consensus about both the product and the means of measurement; comparison needs to be treated with caution. Reading down the columns, an omission of a factor against a study may not necessarily reflect the insignificance of that factor in effectiveness, but rather, with the studies having different foci, may be indicative of a different contextual model. As Sammons et al (1995) advise, factors found in one context are unlikely to be directly transferable to another and international comparisons are also problematic given their different and rapidly changing contexts.

In relation to wider contextual factors, there is no complete agreement about any of the factors. However, what students bring with them in terms of their background and prior attainment remains a dominant factor. There is some consensus that effective teaching is contingent upon cohesion within the school in terms of leadership and with CPD emerging as a factor for sustaining effectiveness.

With regard to teacher's personal attributes, whilst a firm base in cognitive skills in the form of both their subject and pedagogical knowledge is largely considered a given, teachers' affective attributes, though featured, are less clear. Most of the studies make some reference to teacher's affective or emotional attributes but in different ways. Relationships with others, however, either in the form of collaboration or support, appear to have some weight. Combining the CPD factor in the wider school context with this personal affective factor of relationships with others gives strength to the notion of teachers working collaboratively.

The majority of the references to effectiveness factors in the studies reviewed relate, however, to the teacher's individual classroom practice, that is, a focus on the process variables. These are identified in terms of their contribution to students' cognitive progress in the form of the quality of the teacher's planning, teaching method and assessment coupled with high student expectations. Whilst referred to less, there is also mention of affective factors which are contained within the categories of classroom climate and development of students' self-regulation, self-efficacy, and self-esteem.

Whilst Barber and Mourshed (2007), in their international study of top performing schools, and the Hay McBer (2000) report in England placed emphasis on teachers'

CPD and collaboration as effectiveness factors, Day et al (2006) found that 80% of the teachers in their study of English schools were dissatisfied with the time available for CPD either in the form of reflecting upon their own teaching or learning from colleagues.

In this respect, it is interesting to note the challenges reported by teachers when engaged in a project that attempted to respond to the findings of such effective teaching research and/or reports. The Teacher Effectiveness Enhancement Programme (TEEP), (Ragbir-Day et al, 2008), was an initiative in teacher CPD with the aim of changing teachers' behaviours and classroom climates. Informed by both the Hay McBer Report (2000) and the research of Muijs and Reynolds (2003), Ragbir-Day et al claim that the programme went some way towards meeting the aspirations expressed by Barber and Mourshed (2007).

In relation to secondary schools, albeit with considerable variation between institutions, their evaluation found some notable changes in teacher behaviour including: less time controlling behaviour, less whole class teaching, increased use of group work, more student participation in own learning, more assessment of prior knowledge, more inclusive and higher order questioning and an increased use of ICT. However, Ragbir-Day et al state that successful implementation appears to require attention to a number of contextual factors in addition to process factors within the individual teacher's classroom. Factors that required consideration in the effective implementation of the programme included: introduction of the programme as a whole school initiative and time for it to become embedded, networking with other TEEP teachers and having a critical mass of teachers trained in the approach. Whilst teachers felt that the programme enabled them to link their prior knowledge of theory and practice into a coherent whole, the challenges presented also included embedding thinking for learning and use of collaborative group work with students with poor social skills and time within the lesson to complete all of the stages of the approach. Hence the nature of the CPD appears to be more critical than CPD opportunities per se.

2.3.2 Effective teaching of mathematics

The literature reviewed on effective teaching thus far, with the exception of that conducted by Muijs and Reynolds (2003), with its focus on primary school numeracy, has been generic, suggesting that the effective teaching factors identified are transferable across phases and curriculum subjects. Some authors, (e.g. Sammons, 1995; Goe et al, 2008), have, however, emphasised that these factors may vary with context. Context, as shown in figure 2.1, includes the characteristics of the school subject. Therefore, it is necessary to consider whether the findings from generic effective teaching research reviewed apply to the effective teaching of mathematics. However, since the teaching and learning of mathematics in English schools also lie within the wider context of current national policy on generic effective teaching, it is necessary to consider the ways in which this contextual influence comes to bear upon the school mathematics classroom. Therefore, in this section I will examine the literature on effective mathematics teaching in schools in relation to the generic teacher effectiveness research and policy.

In the process-product paradigm studies of effective teaching, Kyriacou (2000) distinguishes between short term outcomes; attainment as measured by standard tests or national examinations, longer term outcomes; participation beyond compulsory education and between cognitive and affective outcomes. He also distinguishes these models from process-only research models which focus on the activity within the classroom and relate the process variables to each other rather than to the product variables. For example, the teaching strategy adopted might be related to the student's behaviour, such as time on task. The implicit assumption here is that time on task will lead to improved attainment.

Hence, one qualification to the answer to the question of whether the teaching of mathematics in English schools is effective is the same as that debated in the generic teaching effectiveness literature. It will depend upon the desired outcomes, with their associated measures, of the teaching and learning process. In turn, the focus of these outcomes will depend upon the perspective of the stakeholders in the education process to include policymakers, researchers, teachers, students and their parents.

With regard to the desired product or outcome of effective teaching of mathematics in English secondary schools, taking into account a range of Government commissioned or independent reports, (e.g. Smith, 2004; Ofsted, 2008a, 2008b; Royal Society, 2008, 2010; Williams, 2008), and academic studies, (e.g. Stevenson & Stigler, 1992; Boaler, 1997, 2006, 2009; Stigler & Hiebert, 1999; Muijs & Reynolds, 2003; Watson & De Geest, 2005; Mendick, 2006; Dunne et al, 2007; Askew et al, 2010; Watson, 2011b) as well as the debate in the popular press and media, (e.g. Boaler, 2010; Eastaway & Askew, 2010; BBC Radio 4, Woman's Hour, 2010), there appear to be four distinct yet interrelated foci for outcome. These are performance, participation post-16, enjoyment, and equity.

Whilst acknowledging the interrelatedness of these foci, the common thread in the current debate is that there is something wrong with mathematics in English schools with the outcome that there is some considerable disaffection towards the subject and students overall are not achieving their full potential. This is the clear focus of the recent Government funded as well as independent reports on mathematics (e.g. Smith, 2004; Ofsted 2008a, 2008b; Royal Society, 2008, 2010; Vorderman et al, 2011) which, using students' performance in mathematics both nationally and internationally as measured by standardised attainment tests, public examinations or participation rates post-16, have considered the outcome to be wanting.

The Royal Society's (2008) analysis of trends in English public examinations shows that attainment in mathematics has broadly continued to rise, if slowly, since 1996. However, such a finding does not necessarily mean that standards in school mathematics are rising. Comparisons across the years of the percentage of students gaining particular grades are only valid if the measures used to arrive at these statistics are consistent across the years. The report suggests that there is evidence to show that this is not necessarily the case. Further, when comparing English students' performance over time within international comparative studies which, it is argued, use common standards of assessment, rising attainment is not confirmed either in public examinations or National Curriculum testing. Askew et al (2010) in their analysis of mathematics education in high performing countries noted that England's success in the Trends in International Mathematics and Science Study

(TIMSS), (Mullis et al, 2007), showed variability in English students' performance, both above and below the international average in different aspects of mathematics. They added that the weaknesses were only important if what was tested in TIMSS matched national priority and fitted with England's curricular emphases. A further concern raised was that both the TIMSS and Programme for International Student Assessment (PISA) studies did not collect longitudinal data of the same students in order to track learning over time.

A key concern for the policymakers nevertheless, is the resultant loss of contribution to the economy in terms of a skilled workforce that enables efficiency, growth and global competitiveness (Smith, 2004; Vorderman et al, 2011). Against this policy focus, it is unsurprising that much of the recent research into teaching and learning mathematics reviewed forms a search for the factors which contribute to these unsatisfactory outcomes.

Various explanations are offered. Ofsted (2008a), based principally on evidence from inspections of mathematics between April 2005 and December 2007 in 192 maintained schools in England, and two Royal Society 'State of the Nation' reports (2010, 2008), the former on 5-14 and the latter on 14-19 school mathematics, with representation from universities and schools and drawing upon data from independent research and national educational records, each suggest that too much emphasis is placed on students having to learn and recall rules and procedures at the expense of a deeper understanding of mathematical concepts and connections.

The Ofsted (2008a) report blames this on the following factors: the nature of teaching and assessment; the interpretation of the mathematics curriculum; the lack of opportunity to investigate open-ended problems and the lack of mathematical discussion in lessons. The Royal Society report (2010) is broadly in agreement with Ofsted's suggestions. However, via an analysis of the trends in mathematics attainment and a detailed review of research literature on mathematics education, it presents a deeper analysis of the situation. In so doing, it documents the enduring concern about national standards in mathematics over the past 50 years. This concern continues despite a range of teaching approaches having been used across this period, the considerable impact of the Cockcroft Inquiry (DES, 1982) and the government’s huge financial investment in the National Numeracy Strategy (NNS) introduced in primary schools in 1999 (DfES, 1999) and extended to Key Stage 3 (KS3) in 2001 (DfES, 2001). For the past decade, the National Strategy has advised particular lesson approaches and structures for mathematics, for example direct whole class teaching and the ‘three part lesson’ (see figure 2.4), offered cascaded professional development for teachers and provided much written support both in hard copy form and on the Strategy website.

Stigler and Hiebert (1999) suggest that the emphasis on performance and standards in debates about education has led policymakers to overlook what actually goes on in real-life classrooms in terms of how teachers teach and how students learn. They describe how in California in 1995, in response to low performance in reading and mathematics, curricular frameworks were produced which contained both the content that should be learned and instructional methods that should be used. Despite this, achievement remained low and this led to a debate between ‘reform’ and ‘traditional’ teaching methods. Although no research was conducted into how the frameworks were implemented in the classroom, they were nevertheless revised. The experience in California, they claimed, was not untypical. In the case of the mathematics frameworks for KS2 and KS3 in England, academic research was conducted both pre and post their introduction, the findings of which were not always heeded by the policymakers (Brown et al, 2003).

Following concerns about the form of the National Curriculum, the effects of national attainment tests at the end of the key stages and the flattening off of the results of these tests since 2001, there was a re-examination of the KS3 curriculum in 2007. For mathematics, the intention was to be less prescriptive and reintroduce some of the recommendations of the Cockcroft (DES, 1982) report. These included a renewed emphasis on problem solving and mathematical investigation which had diminished as a result of a focus on numeracy skills and ‘teaching to the test’. The latter had occurred as a result of the government’s aim to drive up standards by introducing published test results for each state school (Royal Society, 2010).

Mathematics is a compulsory, core subject for all students in England to the end of Key Stage 4 (KS4), age 16. At the end of KS2, students are tested nationally in mathematics, English and science to provide attainment levels for each child and to compare each school's results. At the end of KS4, mathematics, along with English language, public examination results are used to compare school's performance, particularly in the higher A*-C GCSE grades. These performance tables have become known as school 'league' tables. This, the Royal Society argue, was in the face of concerns expressed by professional bodies about the impact this would have on teaching and the students' enjoyment of learning. The result was that investigation and practical problem-solving virtually disappeared and, especially in Year 6, practising for short test questions predominated. Similar effects eventually occurred in the other key stages.

Drawing upon recent research evidence, both Royal Society reports concluded that students' attitudes towards mathematics generally diminish as they progress through the school years. The decline in both attitude towards and attainment in mathematics, as students' progress from primary to secondary school, indicates some underestimation of students' prior attainment by secondary school teachers (Royal Society, 2010). Nevertheless, whilst mathematics is not generally viewed very positively, with more girls being negative towards mathematics and less confident in their ability than boys (Boaler, 1997; Mendick, 2006), it is also seen by students as a valuable qualification and a gatekeeper subject for further study and employment (Royal Society, 2008). Yet, whilst girls' attainment at 16 equals that of boys, progression by boys to A-level mathematics significantly outweighs that of girls (Boaler et al, 2011). Askew et al, (2010), in their review of international research studies of mathematics teaching in schools, demonstrate that negative attitudes towards mathematics are not unique to England:

> *Internationally, explicit goals for mathematics education are similar in valuing high standards in knowledge and skills, learning dispositions and positive attitudes towards mathematics. No country, including those with high attainment in international studies, appears to have achieved all three of these goals. Groups with a cultural identity of being good at mathematics do not necessarily also identify themselves as enjoying mathematics,* (Askew et al, 2010, p44).

The negative attitudes in England are associated with students' perceptions of lessons being 'isolating, over-individualised, involving dull repetition and rote learning, exacerbated by dependence on applying techniques that were not understood, but gave the right answer', (Royal Society, 2008, p174). Contextualised learning activities purporting to be 'real-life' do not appear to be the answer with students perceiving them as irrelevant.

However, this negativity was not found to be true for all students, with some particularly high attaining students finding mathematics both enjoyable and not particularly difficult. The existence of such a group, frequently coupled with the restriction to this group to further study of mathematics post-16, may, however, have the effect of placing a limit on what the remaining students perceive it is possible to achieve. Additionally, the report adds, borne out by the statistics which show that it is more difficult to get a high grade in mathematics at both GCSE and A-level, mathematics is perceived by students as a hard subject. The report noted consistency in the research findings over many years despite many policy changes indicative of an underlying and deep-rooted resistance to change in attitudes towards the subject.

On examining trends in attainment and research on 14-19 mathematics education from 1996-2007, prior attainment is found to be the single biggest predictor of post-16 participation in mathematics in England and differences in attainment emerge well before the 14−19 age range (Royal Society, 2008). Boaler et al, (2011) demonstrate the inequities in both performance and participation that occur in this age group in relation to gender, class and ethnicity. This is corroborated by the findings of the Royal Society (2010) report which showed substantial differences in performance of different ethnic groups and students of differing SES in both Key Stages 2 and 3, suggesting that these students' likely future enjoyment of and interest, achievement and post-16 participation in mathematics is strongly influenced by their primary and early secondary school experience. Students' attitudes and perceptions of their own ability and the extent to which their choices are constrained by their schools' provision and their grades were found to be linked to participation post-16.

Ofsted's (2008b) recommendations to improve the situation concur with those contained in both Royal Society reports. They include investment in teachers' CPD to improve both subject and pedagogical knowledge and with greater opportunities to reflect upon alternative teaching approaches and share good practice. In relation to teaching approaches, they suggest increasing those which develop all students' understanding of mathematics and that encourage collaborative problem solving rather than simply 'teaching to the test'. The Royal Society (2010) report raises specific concerns about the expertise of teachers, particularly in primary schools, but also at KS3, in terms of both their subject and pedagogical knowledge indicative of the need for more trained mathematics specialists to be deployed in these phases:

> *There is a danger that important debates over the technicalities of level setting and measurement, and the undoubtedly negative effects that high-stakes testing has had on pupils and their teachers, may unwittingly hide a much greater and far reaching concern, namely that, as reports across the UK have attested, many teachers simply lack confidence in teaching science and mathematics. Quite simply, the extent to which the hopes and expectations of any curriculum may be met depends on the quality of the teaching workforce,* (Royal Society, 2010, p40).

Askew et al, (2010), concluding that not all high performing nations had closed the attainment gap between students from different SES backgrounds, add that students from low SES backgrounds were more likely to be taught by less experienced, less well qualified teachers.

The Royal Society (2010) report also suggests that initial teacher training courses are generally too short to equip trainees with adequate levels of subject-based knowledge, cognitive and pedagogical skills. This is an issue that has been raised for some 20 years. Ernest (1989), adding teachers' beliefs and attitudes to this list (see section 2.4), suggested that the psychological foundations of mathematics teachers' cognitions were underemphasised in teacher education. Stevenson and Stigler (1992) contrasted the professional development of American trainee teachers with those from Japan. The Americans, they suggested, emerged from college with a superficial understanding of the key theories of children's learning and cognitive development and an inadequate training in the design and implementation of effective lessons. The Japanese by contrast experienced highly valued on-going professional development with more opportunities for interaction with other teachers to plan effective lessons. The implication here is that in order to address these concerns more time should be given to the theoretical underpinnings of teaching practice during initial teacher education. This is directly contradicted in the government's White Paper (DfE, 2010) which suggests that universities should have less involvement in initial teacher education.

As it currently stands in England, during the nine month long Post Graduate Certificate in Education (PGCE) route into teaching, only three months is spent at the university. Here, mathematics pedagogy sessions integrate, or arguably compete, with lectures on wider educational issues, such as multi-agency working, in order to prepare English mathematics teachers for the multiplicity of roles that they are expected to fulfil in school. This leaves little time for beginning teachers to integrate theory with practice and collaboratively develop mathematics lessons whilst at the university. At their practice schools, they might be the only mathematics trainee at that school. Although all trainees will be mentored by an experienced teacher, who is allotted one hour per week to spend with them, the opportunity for collaborative planning of effective lessons can be variable and quite limited in some cases. Ironically, whilst on-going subject-based professional development of teachers is highlighted as an essential solution to some of the concerns expressed, one end-product of the 2004 workforce agreement was for teachers to 'rarely cover' for absent staff. This, the Royal Society (2010) states, has led to a reduction in teacher attendance at CDP opportunities. Askew et al (2010) conclude that whilst teachers' subject knowledge is widely acknowledged as an important basis for effective teaching, the relationship between subject knowledge and pedagogy is not straightforward:

> *Pedagogy depends on tacit values and expectations as well as knowledge. What a teacher emphasises in a lesson may depend on cultural factors such as beliefs about learners as much as on the subject knowledge,* (ibid, p46).

The Royal Society (2010) also argue that any attempt to improve the effectiveness of education 'must look at the characteristics of children as learners, and how learning processes are affected by the nature of different forms of educational provision and infrastructure', (ibid, p59). In agreement with some of the generic teacher effectiveness researchers, (e.g. Sammons et al, 1995; Goe et al, 2008), they add that the processes within the classroom are only part of the explanation and cannot be considered in isolation from factors such as students' individual and family characteristics, their access to high-quality pre-school education, and their participation in informal learning activities, (i.e. other contextual factors). Stevenson & Stigler (1992) in their international comparison of practices in mathematics teaching in primary schools found that American children scored markedly below Asian peers in mathematics even though, upon administering specially designed intelligence tests, no evidence was found to support any differences between them in terms of their apparent innate mathematical ability. They concluded that the differences must largely stem from their experiences at school and home. Askew et al, (2010), also report that internationally there are contextual differences which contribute to variations in student attainment. These include parents' accurate and realistic expectations of their children's mathematical attainment, mathematics education opportunities outside school, and students' self-perception of whether or not they are good at mathematics.

Developing the process stage of the context-process-product paradigm of effective mathematics teaching, Ernest (1989) argues that differences occur in the practice of mathematics teachers, even those with a similar knowledge base, as a result of differences in their conceptions of the nature of mathematics, the models of teaching, the models of learning and the goals of education. He defines three conceptions of the nature of mathematics which teachers may explicitly or implicitly hold: the problem-solving view; maths is a continually expanding field of human inquiry, the Platonist view; maths is a static body of knowledge with interconnected structures and truths, and the instrumentalist view; maths is a useful, but unrelated, collection of facts, rules and skills. In relation to mathematics, Ernest (1989) suggests that teachers' views about learning the subject range from perceiving the learner as actively constructing knowledge into a coherent whole to that of the learner being the passive receptor of knowledge:

> *The teacher's model of learning mathematics, in so far as it is realised in practice, is a vital factor in the child's experience of learning mathematics. It influences both the cognitive and affective outcomes of learning experiences. In the long term these learning experiences can vary in results from a student who is an interested, confident, skilled and autonomous problem-solver, at best, to one who is a disenchanted, non-numerate mathephobe, at worst*, (ibid, p23).

The model of teaching employed he states is likely to be closely related to the teacher's conception of the nature of mathematics and also manifests in his or her choice of classroom behaviours and activities. Hence, there is a range of teaching strategies from which teachers can choose such as: learner focused with emphasis on active construction of knowledge, content focused with an emphasis on conceptual understanding, and content focus with an emphasis on performance, (Thompson, 1992), each with commensurate materials ranging from rich problem solving activities to close practise of examples from textbooks or worksheets.

Using Boaler's (2009) terminology, the 'traditional' or procedural approach to teaching mathematics is more akin to the information-processing model with a focus on declarative and procedural knowledge and the 'progressive' or process-based approach with the social constructivist model, (Vygotsky, 1978), where conceptual knowledge is the product of activity, context and culture. The procedural approach, Schoenfeld (1988) argues, contributes to the mismatch between the mathematics that students encounter inside and outside of school with procedural knowledge being of little use in 'real life' situations. Drawing on the concept of 'situated cognition' (Lave, 1988), Boaler (1997) argues that different forms of teaching create different forms of learning because all learning is situated.

The Royal Society report (2010) defines the learning of mathematics as three inter-related components: knowledge of definitions, facts and procedures, understanding of concepts and competence with mathematical processes. A key component in the overall cognitive development of children, they state, is the development of conceptual understanding. A key part of the education process involves students, with guidance, being able to derive broadly applicable knowledge from specific examples. The processes of generalisation and re-contextualisation are also assumed to take place during classroom learning. They suggest that to generalise mathematical concepts, children's learning requires more experience of the phenomenon, and more explicit use of mathematical language to help link experiences. However, a tightly structured curriculum and framework for teaching mathematics such as that of the National Strategies, not only presupposes a uniform match with students' learning trajectories in these processes in terms of both order and pace, but also as previously noted, if coupled with a focus on 'teaching to the test' and an emphasis on the rehearsal of rules and procedures, may reduce the opportunity to develop these important processes in students.

The Cockcroft Report (DES, 1982) made strong recommendations for more process-based learning in school mathematics alongside teacher exposition and student practice. However, the policies of the Conservative Government of the 1980s and 90s continued by those of New Labour into the new millennium, arguably contributed to the perpetuation of a more traditionalist approach in schools, (Ball, 2008). As Ernest (1989) suggests, for these recommendations to be fully implemented, it would be necessary for many mathematics teachers to make significant changes to their model for teaching and learning mathematics. Instead in carrying out curriculum reforms, they tend to only change surface features of their practice. Sternberg (2009) suggests that:

> *The question is not whether expository or discovery learning is better [....] the current question is under what circumstances, and for whom, is one kind of instruction superior to another. [....] To think critically, you need to have content about which to think. Content in the absence of thinking is inert and meaningless; but thinking in the absence of content is vacuous* (ibid, p x).

The Royal Society (2010) report suggests that collaborative group work can help with some of the problems caused by the variation in students' learning trajectories and mathematical conceptual understanding. However, this is premised upon there being a range of knowledge amongst the group members and the group work being well planned and structured. This includes the design of mathematical tasks that encourage active discussion and collaboration with clear goals, but sufficiently open to allow for student exploration. Further considerations include the optimum size of the group and ensuring that all members are involved. Whilst more common in primary schools, group work in secondary schools, they report, is found infrequently in secondary classrooms, largely because of teachers' concerns about classroom control issues.

Stevenson and Stigler (1992) compared teaching and learning approaches in mathematics in matched elementary schools in America, Japan and China and found greater incidence and positive attitude of Asian teachers towards collaborative group work. Askew et al (2010) concluded that high attaining countries have wider learning goals within the context of mathematics. Citing the example of Japan, these teachers, they state, have the goal of developing personal qualities in students, such as working collaboratively and persevering, alongside mathematical goals. The

Assessment Reform Group (Black & Wiliam, 1998), endorsed by the National Strategy, has been influential in England, encouraging teachers to provide formative feedback to students, to, for example, encourage students to discuss their work, explain their reasoning and to learn from their errors and yet this does not appear to be commonplace in English mathematics lessons. This may be because, as Banerjee (2008) states, children do not learn to help their peers without guidance on how to do it. Stevenson and Stigler found that, unlike American children, Asian children were explicitly taught classroom routines and study skills first. Kutnick et al (2005a) in their literature review on pupil grouping in English schools also suggested that pupils needed to be trained in group work skills but rarely did this happen. For group work to be successful therefore, children also need guidance on how to perform their roles within the group. However, as Askew et al (2010) point out, whilst implicit goals, such as collaborative working, may have a powerful affect on attainment, transferring practices from other cultures is not unproblematic:

> *Adopting practices from elsewhere might mean adopting implicit goals that do not fit with England's vision for society and individuals* (ibid, p44).

The National Numeracy Strategy (DfES, 1999) in primary schools and subsequently the Framework for Teaching Mathematics in Key Stage 3 (DfES, 2001), as previously described, was introduced in response to on-going concerns about students' relative underperformance in mathematics. Coupled with national testing and inspection they have had a powerful influence on the structure of mathematics lessons in English state schools. One of the recommendations in the supporting literature was the 'three part lesson'. The suggested format of a typical lesson is shown in Figure 2.3.

Figure 2.3: The National Numeracy Strategy – A typical lesson

The National
Numeracy *Strategy*

Raising Standards
Standards and Effectiveness Unit

A typical lesson

whole class	**Introduction** • oral and mental work to rehearse and sharpen skills	**5–10 MINUTES**
whole class groups pairs individuals	**Main activity** • clear objectives shared with pupils • direct interactive teaching input • practical and/or written work for pupils on the same theme for all the class • if group work, usually differentiated at no more than three levels, with focused teaching of one or two groups for part of the time • continued interaction and intervention • misconceptions identified	**30–40 MINUTES**
whole class	**Plenary** • feedback from children to identify progress and sort misconceptions • summary of key ideas, what to remember • links made to other work, discussion of next steps • work set to do at home	**10–15 MINUTES**

2.7

In my capacity as teacher educator on a 7-14 PGCE programme between 2003 and 2008 and subsequently as a mathematics education researcher, I have observed many mathematics lessons of both inexperienced and experienced teachers. Over this period, I have mainly observed beginning teachers, and the majority of experienced teachers using this recommended ‘three part lesson’. However, in the main part of the lesson, I have far less frequently observed collaborative group work of a problem solving nature. The students, whilst they may have been seated in small groups in the classroom, are largely required to practise the rules and procedures as exemplified by the teacher. The use of problem solving as a vehicle for children’s learning of mathematical concepts, even though I have promoted it when working with the beginning teachers at the University, was notably absent from many day-to-day lessons. On enquiring about the reason for this, the beginning teachers frequently claimed that they were not encouraged to do so in their practice schools. More experienced teachers suggested that insufficient time for curriculum content coverage was a factor:

> *We have more to understand about how teacher education can be an effective intervention in the complex process of learning to teach mathematics, which is all too often influenced by teachers’ prior experiences as learners or by the contexts of their professional work,* (Even & Loewenberg Ball, 2009, p2-3).

Furthermore, English mathematics teachers, in my experience, if problem solving is included in their scheme of work, tend to place it at the end of a unit of work with the assumption that they need to teach the mathematical skills and concepts required of the problem first. Indeed, in the way the English National Curriculum was set out before 2008, problem solving, under the heading of Using and Applying mathematics, was presented as a separate strand of the mathematics curriculum rather than embedded within it.

There are further parallels here with Stevenson and Stigler’s (1992) findings that the Asian approach, unlike the American, included encouragement of children to solve problems using a variety of methods. Also, whereas American teachers were more likely to use language to define terms and state rules and, in their efforts to make mathematics meaningful, use language as a means of clarification and elaboration, Asian teachers tended to do the reverse with the initial focus on interpreting and defining the problem. Arguably, this description of the Asian mathematics classes is exactly what Ofsted and the Royal Society report to be missing in English mathematics lessons.

Askew et al (2010) found that high attainment in international comparisons did not imply high attainment in problem solving. On examining students' problem solving strategies, they did find that those using abstract and symbolic approaches were generally more successful. This they suggested was more indicative of pedagogical emphases than student development. In this regard, they found that in England procedural fluency and conceptual understanding were seen as separate aims. This contrasted with the teaching in the Pacific Rim countries which, though dominated by the aim of supporting procedural fluency, grounded the procedures explicitly in mathematical principles, rendering them more coherent and meaningful.

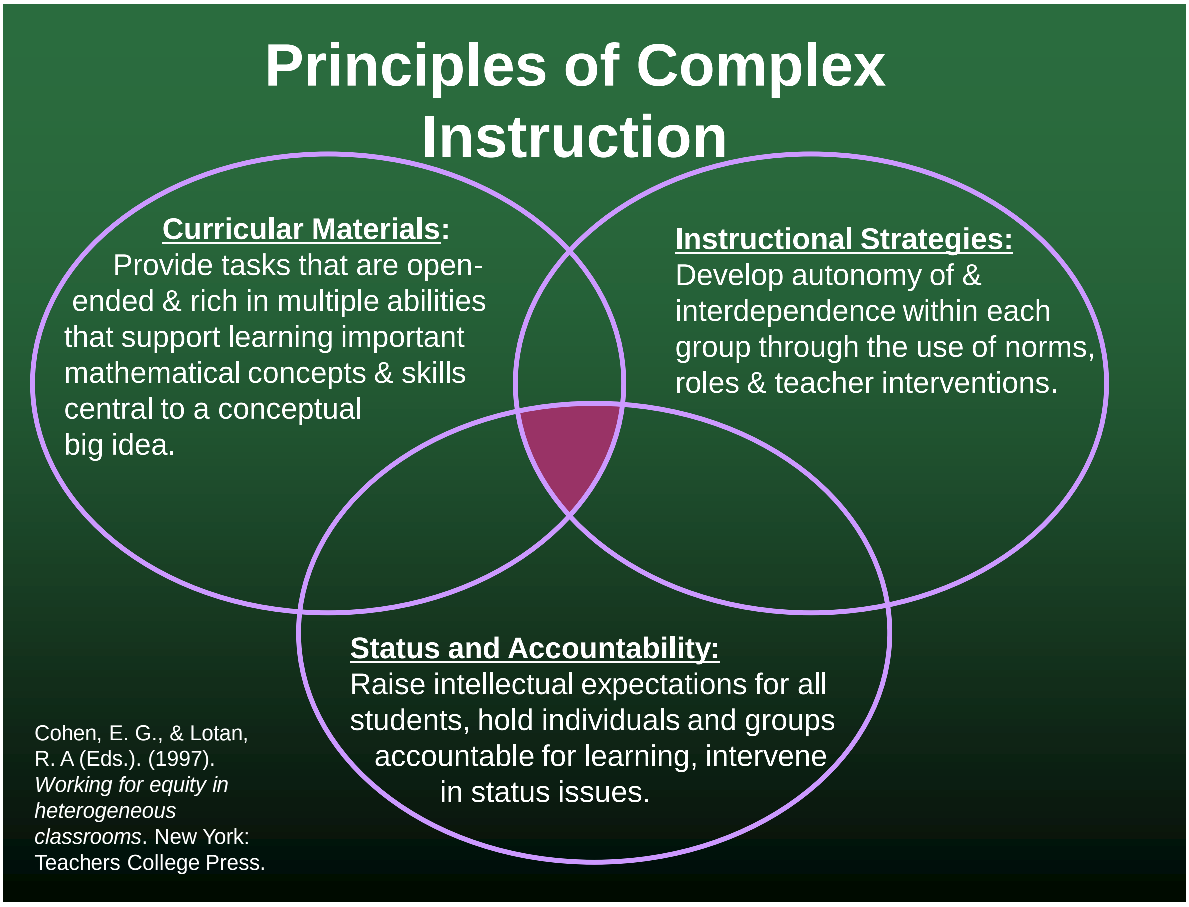
Boaler's two comparative studies of mathematics teaching approaches (Boaler, 1997, 2008a), the first in England and the second in the USA, though they also draw attention to the outcomes of equity and enjoyment, captured the attention of policy makers, the academy and the public at large with claims to improvement in both student attainment and participation post-16. The changes required Boaler (2009) argues are: teachers having higher expectations of students taught in more flexible grouping systems with inquiry based teaching approaches. She reported compelling evidence to show that there are significant gains to be made from properly designed small group work in mathematics. The research evidence of Boaler and Staples (2008) reporting from their five year study of three high schools in California, showed that students in the school that had mixed ability mathematics classes and where the students were taught using the Complex Instruction (CI) pedagogy, (Cohen 1994), using tests designed by the researchers, had higher attainment, including deeper conceptual understanding, enjoyed mathematics more, developed transferable skills and progressed to higher levels. The teachers, once released from the constant supervision of the whole class, were able to use their professional skills at a higher level. Furthermore, they suggest that the combination of the mode of within-class grouping of students (mixed prior attainment groups of four) and the teaching approach is the key to equity in terms of improving the quality of learning and achievement in mathematics for all, with no detriment to any particular category of students.

The CI approach assumes that students do not necessarily know how to work well in groups, but rather, through 'skill building' activities, need to learn groupwork behaviours (Cohen, 1994). CI consists of instructional strategies that incorporate the use of norms and roles and structured teacher interventions which hold both individuals and groups accountable for their learning (Cohen & Lotan, 1997). Thus the CI approach becomes distinctive from other forms of group work in that it is a set of pedagogical methods designed to make group work equitable. A common objection that teachers give to the use of group work is that some students do the majority of work and some students are left out, or choose to disengage. In the CI approach, students are assigned roles within a group, so that there can be a responsibility for each others' understanding and collaborative completion of a task (Sebba et al, 2011).

This is combined with 'group worthy' learning tasks. These tasks are 'rich' in terms of mathematical content, require interdependence of the group members in finding a solution, and are 'multi-dimensional'. Uni-dimensional classrooms are those in which there is only one way of being successful. As evidenced in the literature (Royal Society, 2008; 2010; Ofsted, 2008) there is concern that, in too many mathematics lessons in England, emphasis is placed on students successfully following the teacher's demonstration of rules and procedures and reproducing them. In multi-dimensional classrooms a range of ways of working mathematically are valued. This involves asking good questions, seeing problems in different ways, representing ideas through diagrams, words, symbols and graphs; connecting methods, reasoning and using logic (Sebba et al 2011). In Boaler and Staples' (2008) research, a key finding was that 'when there are many ways to be successful, many more students are successful' (p.630).

Figure 2.4 encapsulates the key principles of the CI approach.

Figure 2.4: The Principles of Complex Instruction (Cohen & Lotan, 1997)



It is important to stress that Cohen (1994), the originator of this approach, suggests that the length of time a class would spend on a multiple ability task using the CI approach will vary with the age of the students and that it can be used alongside other approaches to learning. Cohen adds that group work of this kind is not a replacement for all other modes of teaching and learning but enhances learning beyond that which can be achieved by other approaches alone. Thus, Cohen seems to suggest that CI should be a necessary addition to, and not a replacement for, all other teaching approaches. Boaler (2009), by contrast, appears to suggest that the CI approach should be used in all mathematics lessons.

Arguably, Boaler's (2008a) research findings resonate with the suggested solutions to the highly sought after outcomes of improved attainment and greater participation; those of more collaborative group work, more problem solving and more discussion. Whilst there is evidential support in the US for the CI approach to learning, (Hammond-Darling et al, 2008), as pointed out in Chapter 1, there are also challenges to Boaler and Staples' (2008) research claims, in particular that the adoption of the CI approach leads to higher student attainment in mathematics. These are based on challenges to the instruments used to measure this gain (Bishop et al, undated). In the recent English research on this approach (Boaler et al, 2010, Sebba et al, 2011), using Y6 and Y7 SAT tests as the measure, no conclusive evidence was found to show significant gains in the attainment of students being taught using the CI approach over comparator groups of students without the approach. However, no significant losses in attainment were found either. Given that these studies were conducted over just one academic year with both teachers and students grappling with a new conceptual approach, it may not be altogether surprising that no significant differences were found in this outcome.

There doesn't appear, however, to be any clear evidence to contradict Boaler and Staples' (2008) findings that students gained deeper conceptual understanding, enjoyed mathematics more, developed transferable skills and progressed to higher levels. Since the findings from the English research (Boaler et al, 2010; Sebba et al 2011) found that, where the techniques of CI were becoming more embedded, teachers and students reported in interviews that benefits were being derived from the approach, with the right instruments for measurement, such outcomes, including gains to attainment, might become apparent in the future.

Another recent study into group work by Galton, Hargreaves & Pell (2009) of 11-14 year-olds in English schools, which included mathematics, found that:

> *The attainment results suggest that a grouping approach is as effective, and in some cases more effective, than when whole class teaching is used. Classroom observation indicated that there were more sustained, higher cognitive level interactions when pupils worked in groups than during whole class discussions* (ibid, p119).

However, as Kutnick et al (2005a) show from their within-classroom studies, simply sitting students in small groups does not necessarily lead to students working collaboratively and may lead to them being more likely to work on the task individually. Similarly, Galton et al (2009) argue that group work results could be improved still further if teachers gave more attention to training pupils to work in groups. I support these claims in relation to mathematics classrooms in England based upon my experience as a school teacher, observations I have undertaken in secondary school mathematics classrooms in my capacity as PGCE tutor and more recently as a mathematics education researcher, (Boaler et al, 2010), with the opportunity to observe many mathematics lessons. Arguably, the CI approach, with its use of norms, roles and group accountability provides a method for training students in how to work collaboratively, a suggested prerequisite of effective group work. In turn, this offers support for those teachers who are reluctant to introduce collaborative group work through fear of losing classroom control:

> *We have worked with schools [in England] to introduce this form of grouping, with its associated pedagogy of 'complex instruction'. Six schools have changed the grouping of students in the first year of secondary school (year 7), teaching all students high level work. Already the teachers are reporting, and we have observed, greater participation amongst students with all students, rather than only those deemed as high achievers, participating and achieving success* (Boaler, 2009, p85).

Boaler (2008a), promoting the CI approach to teaching mathematics, claims that with the right teaching approach in a mixed ability classroom, all students can gain both in mathematical achievement and what she terms 'relational equity'; students treating each other with respect and responsibility. Watson (2011b) suggests that there are two kinds of equal opportunity in school mathematics education, the first in the form of social modes of participation and the second in the form of access to core cultural knowledge. In the case of the first, differentiation by input and task reifies teachers' preconceptions about students' capabilities. In the case of the second, differentiation is based upon students' disposition to work, but not on access to core subject knowledge. Hence Watson argues that a truly comprehensive education must give all students access to what the 'elite' know and therefore include access to the core ideas of mathematics and not just everyday reasoning within numerical and spatial contexts.

Both the research of Boaler (2008a) and Watson (2011b), in the form of equal opportunity for students, address issues of social justice in mathematics education. Both address these issues in terms of social participation and access to core knowledge. However, Boaler's focus is on innovative curriculum design and, as Watson and De Geest (2005) point out, many such innovations do not make explicit the difference individual teachers can make on the effects of the same innovations.

In their Improving Attainment in Mathematics Project (IAMP) these authors suggest that the relative successes observed may have been due to teacher and institutional factors other than innovative activity. These include CPD, in the form of collegial discussion and reflection, and leadership.

As the Royal Society (2010) report concludes, the changes in teaching methods introduced by the National Strategies have not, on their own, raised standards. Rather, the key to effective pedagogy is the calibre of the teacher in terms of the connectedness of their subject and pedagogical knowledge. Without this other factors of import, such as knowledge of students' prior attainment, knowledge of how students learn, having a repertoire of teaching approaches, including collaborative group work and formative assessment cannot be implemented to full effect. The Royal Society (2008) report found that students wanted to be taught by teachers who were enthusiastic and knowledgeable and who strengthened students' confidence in lessons through support and encouragement. Such factors were found to be more important to students than the use of any particular teaching materials. The report also notes the intense pressure within the education system to improve standards with commensurate pressure upon schools, individual teachers and students in a system of 'high stakes' testing. It further suggests that the concern about mathematics in schools runs much deeper than that which can be solved by curriculum or pedagogic reform, particularly if that reform is focused in the late secondary years. They suggest that a possible way forward may lay with research which focuses particularly on students' notions of self and identity:

> *These student perspectives are as much or more about lived experience and a sense of students' own life narrative as they are about motivation or intellectualized judgements. There is evidence that students have begun to frame likely narratives and associated choices well before the late secondary year* (Royal Society, 2008, p185).

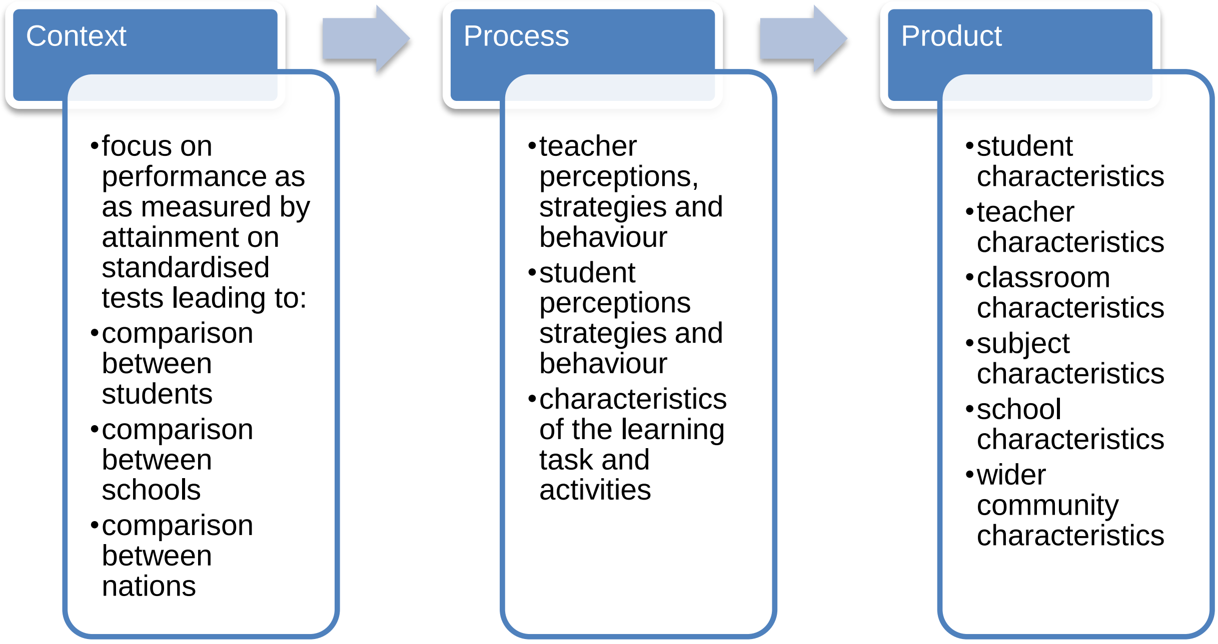
In the context-process-product paradigm of effective teaching, both the generic and mathematics specific literature reviewed demonstrate a heavy focus on cognitive outcomes in the form of student attainment. However, there does appear to be a turn in the mathematics education literature towards also gaining some understanding of the persistence of underlying affective outcomes. In relation to finding solutions to both cognitive and affective concerns, the recent literature on effective mathematics teaching appears to take more consideration of the wider contextual factors than the generic literature. These include national cultural factors such as the wider goals of learning, the characteristics of students as learners and expectations of parents. Generic and mathematics specific literature both emphasise the importance of teachers' subject and pedagogical knowledge and call for improvements in both initial and continuing professional development. However, both express concern about the availability of opportunities for teachers to collaborate and reflect upon effective practice. Time for CPD appears to be a key factor here.

The mathematics education literature also presents a more detailed analysis of the process stage, by looking at different teaching approaches in relation to both the kind of knowledge acquired and the effect on student participation and enjoyment. It is generally concluded that in England too much emphasis has been placed upon the learning of rules and procedures at the expense of collaborative problem solving and mathematical discussion with the former tending to be taught separately rather than embedded within mathematical concepts, which in turn adds to student disaffection. Whilst alternative teaching approaches are suggested to overcome the concerns expressed, the adoption of such approaches, either as an alternative to or in addition to prevailing methods, is likely to be hindered if the contextual factors outlined are not simultaneously attended to.

Perhaps the greatest hurdle to overcome in changing teaching and learning processes within the school mathematics classroom is the dominant culture, reinforced by government policy via the influence of the National Strategies, coupled with high-stakes testing and inspection of schools, of what Watson and De Geest (2005) describe as 'short-termism' (p228). This manifests in the form of content coverage to meet frequent test requirements, movement to the next task if concentration wanes, immediate display of good work habits and focus on finishing work.

Drawing upon the evidence presented in the review of the literature on student grouping and effective teaching generally and mathematics specifically, the dominant outcome focus in English school mathematics in the context-process-product paradigm previously described has been student's cognitive progress as measured by national standardised testing of student attainment with a focus on procedural fluency. This persistent focus has arguably transformed the product of this paradigm into a contextual factor within a new paradigm, with the product now showing in the form of student, teacher, classroom, subject, school and wider community characteristics as shown in figure 2.3 below. This outcome has produced a cultural identity of the successful learner of mathematics as being competitive, individualistic and elitist. Sammons et al (1995), suggested that there was a danger of creating another self-fulfilling prophesy. There appears to be strong evidence that, in relation to mathematics education in English schools, this prediction had materialised.

Figure 2.5: A framework for teaching mathematics in England derived from the dominant focus of effective teaching based on national testing of student attainment and teacher accountability



2.4 Beliefs about intelligence, personality and goals of learning

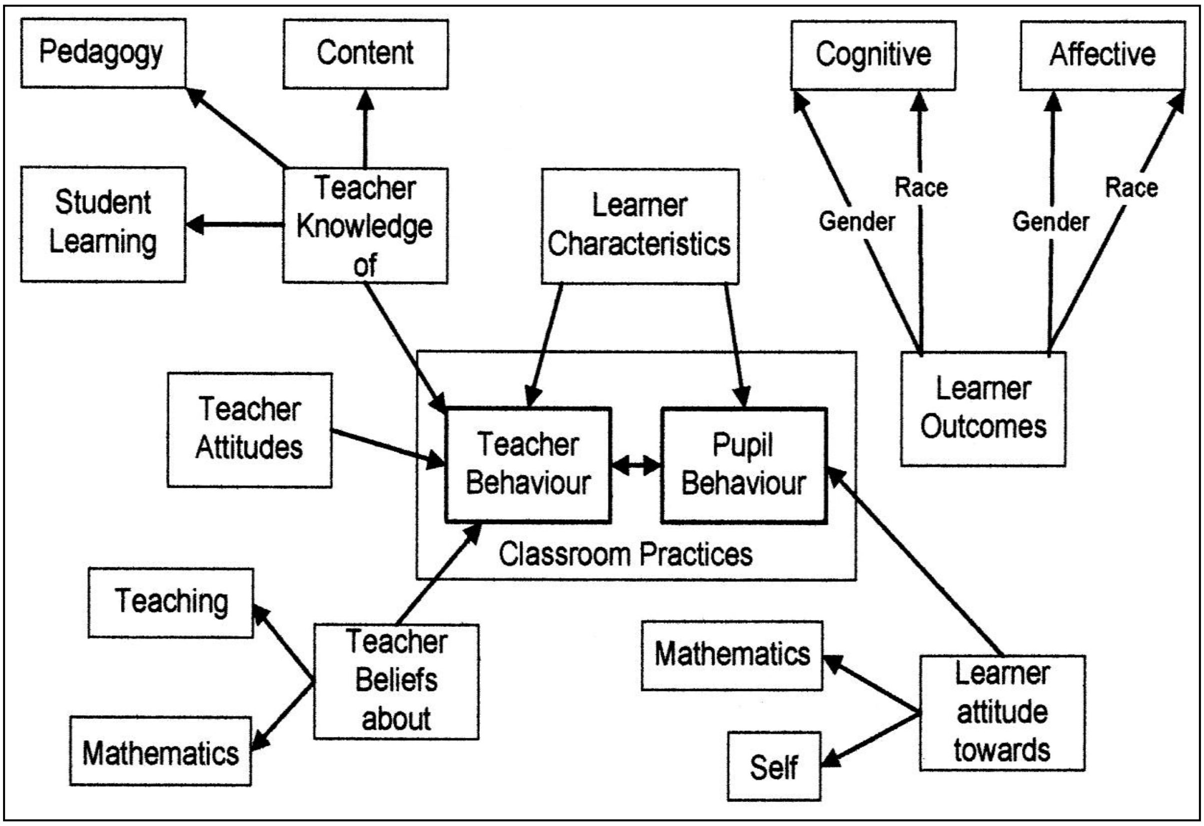
As shown in the review of the literature on both student grouping and effective teaching, there has been a significant focus on the desired outcome of raising standards in English school mathematics education in the form of raising students' attainment in public examinations and key stage standardised tests in order to achieve the national goal of achieving economic efficiency and competitiveness. The effect of testing and school accountability on narrowing the teaching strategies adopted has been demonstrated. The difficulties of finding a straight forward cause and effect relationship between the many variables in the context-process-product paradigm of education have been highlighted. Nevertheless, both policymakers and academics have been energised to find solutions to the relative underperformance and disaffection of many students of mathematics in English schools. The focus of solutions has largely taken the form of recommending how students should be grouped in conjunction with which pedagogical approach should be used. In achieving the solutions the cognitive capabilities and professional development of both beginning and in-service teachers have been strongly emphasised.

The review of the literature thus far also shows that for many years the affective characteristics of teachers have been considered in relation to, for example, their beliefs about mathematics and the models of teaching and learning, (e.g. Plowden, 1967; Ernest, 1989; Askew et al, 2010; Royal Society, 2010). However, factors such as teachers' attitudes towards, for example, the overarching goals of education, the nature of intelligence, and the characteristics of their students as learners appear to have been given less weight in recent policymakers' analysis of the situation. Yet, it has long been recorded that teachers' attitudes can have a powerful effect on students' performance (Plowden, 1967) and recent studies (e.g. Dweck, 2000; Adey et al 2004; 2007; Hart et al, 2004, Watson & De Geest, 2005) demonstrate how challenging teachers' conceptions of intelligence and the notion of fixed ability opens up broader opportunities for raising levels of achievement. However, teachers and teacher educators as members of society may simply reflect and reinforce prevailing attitudes or they can use their privileged position, with support, to act for change:

> *What mathematics teachers know, care about, and do is a product of their experiences and socialisation both prior to and after entering teaching, together with the impact of their professional education,* (Even & Loewenberg Ball, 2009, p1).

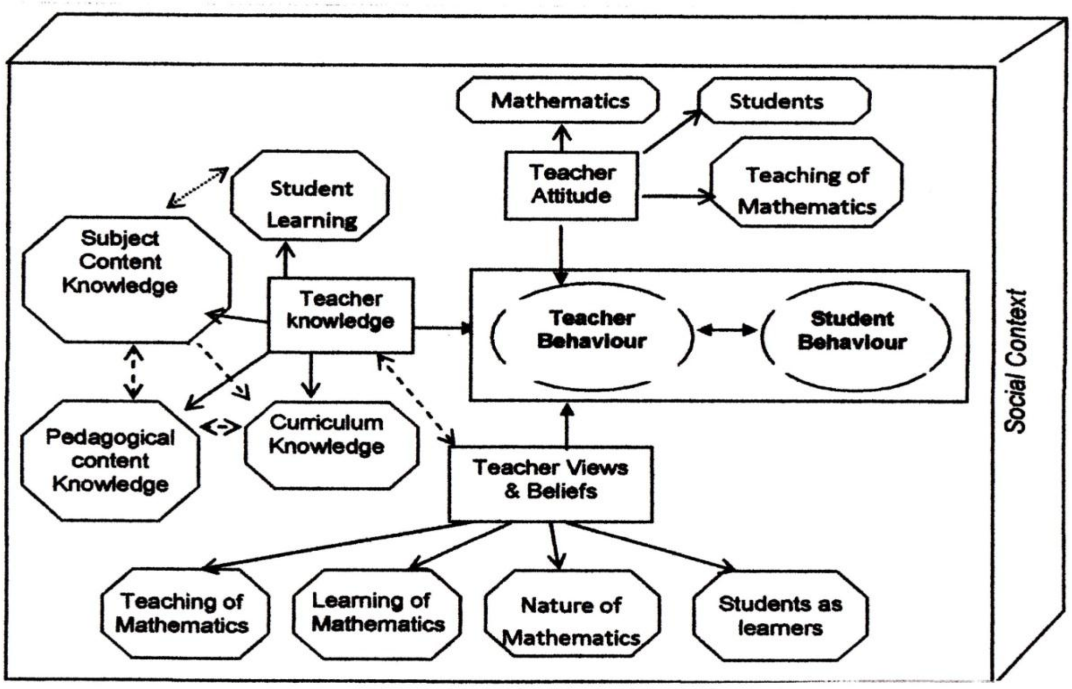
Koehler & Grouws (1992), drawing upon their analysis of mathematics education research, proposed a framework to describe classroom interactions and behaviours (see Figure 2.6). They argued that outcomes of learning are based on learners' own self-belief, their beliefs about mathematics and what teachers say or do within the classroom. In line with much of Ernest's (1989) work the latter they suggested is influenced by: the teachers' content subject-knowledge; their knowledge of how students learn; their knowledge of methods and their attitudes and beliefs about teaching mathematics.

Figure 2.6: Research Framework on Teacher Behaviour (Koehler & Grouws, 1992, p118)



Van der Sandt (2007) revisited and revised this framework, see Figure 2.7. In addition to expanding teacher's knowledge to include curriculum knowledge, she has also expanded teacher's beliefs and attitudes. In particular, van der Sandt (ibid) focused on teacher's beliefs and attitudes towards students. For example, if teachers hold beliefs about learners' with regard to their proclivity towards mathematics and their ability to learn mathematics they may be selective in their choice of teaching approach. If a teacher believes that groups of students, or individuals within a group, do not have the capability to learn mathematics in a problem solving manner then they might, for example, choose to teach mathematics as a set of rules and procedures. Teacher attitudes also impact upon student learning according to the enthusiasm and confidence displayed for the subject in the classroom. However, teachers are more likely, van der Sandt (ibid) argues, to be enthusiastic with students that they like teaching which may be affected by factors such as perceived ability, gender, socio-economic background or appearance. She also emphasises that teachers' knowledge, beliefs and attitudes are context specific and thus constrained by the school and social context. Thus, although teachers in their ideal world with their ideal learners may have a coherent model for teaching and learning mathematics, there may be other influences, of which they may be more or less conscious, over the model they actually enact in the classroom. These influences can take the form of individual learner or group attributes or the imposition of school or national policy.

Figure 2.7: Research Framework on Teacher Behaviour (van der Sandt, 2007, p347)



Teachers' tacit values and expectations form a set of beliefs about learners (Askew et al, 2010). These in turn impact upon students' self-perception of their mathematical ability. Aspects of this set of beliefs about learners were outlined in section 2.2 on student grouping. The dominant form of grouping for many years in mathematics has been ability sets. The selection of this mode of grouping is based upon the dominant beliefs held not only by teachers but also by policymakers and the public at large about the goals of schooling, the nature of intelligence, and how to maximise student attainment.

The government has been keen to look at international comparisons in terms of improving the nation's performance in mathematics as measured by standardised tests and to find factors which contribute towards the world's most improved school systems getting better (Barber & Mourshed, 2007; Mourshed et al, 2010). In these reports, teachers' expectations are highlighted as a key factor in effective teaching. These, Mourshed and Barber suggest, are hinged upon a collective belief in the common ability to make a difference. However, analysis of international comparative studies in mathematics shows that nations may have different collective beliefs about matters such as goals of education, the nature of intelligence and ways of grouping students in addition to differing beliefs about pedagogical approaches. For example, Askew et al (2010) found that Japanese teachers have the goals of students working collaboratively and persevering alongside securing high attainment in mathematics.

Such national differences have been noted for some years. The research into the teaching of mathematics of Stevenson and Stigler (1992) showed that the American teachers they studied were more likely to attribute academic successes and failures to students' innate abilities and Asian teachers were more likely to attribute them to environmental factors and the students' own efforts. With regard to students' innate abilities, they found further differences in cultural expectations. The American belief system, arguably akin to the English system, is an 'ability' model, which, they suggested, tends to place limits upon what can be expected from students, whereas the Chinese and Japanese system, described as an 'effort' model, creates opportunities for advancement for all. The significance here is that an emphasis on an ability model tends to lead to the categorisation of children and determine what kind of education students allocated to each category will receive (Ruthven, 1987; Hart et al 2004, Watson 2011b). Similar to the practice in England, the dominant form of student grouping they found in America was that of ability grouping. In the Asian cultures they studied, students were taught mathematics in mixed ability groups. Ability grouping was found to be justified by teachers in the America in terms of protecting students' self esteem by avoiding higher expectations of them than that of which they are deemed to be capable. In contrast, in the Asian contexts in which mixed ability groups worked collaboratively, with students encouraged to persevere, the overall level of performance of the class was raised even though individual differences remained. Furthermore, it was found that in the Asian culture errors were seen as a natural part of the learning process, whereas in the American culture errors they were frequently interpreted as an indication of failure.

These differences relate closely to Ernest's (1989) teaching and learning models outlined in the previous section; from social constructionist to instrumentalist, from which policymakers and teachers can draw. Crucially, it is suggested that the concept of teaching is a cultural activity (Stigler & Hiebert, 1999). As such, the dominant script for teaching mathematics in schools, in terms of which teaching and learning approach and which mode of grouping students prevail, will effect teachers' expectations of students with a subsequent effect on students' attainment. However, Stigler and Hiebert also argue that, on being asked to change their system of teaching, teachers often only change the surface features to fit their current system rather than changing the system itself. Hence it is necessary to gain some deeper understanding not only of why certain teaching approaches are used in English schools, but also of what barriers lay in the way of adopting approaches that have been shown to be effective elsewhere.

The contrasting cultural differences highlighted show marked differences in teachers' expectations in terms of their perceptions of students' ability or intelligence. Perceptions and measures of intelligence were shown to be problematic in section 2.2, yet there is a long history in England of separating children either between or within schools according to these perceptions and measures, which remains dominant. The studies of Adey et al (2007) and Dweck (2000) help to shed light on the relationship between these perceptions of intelligence and the subsequent effect this has on expectations and attainment.

Adey et al (2007) explain why the notion of intelligence in the form of general cognitive ability should be reconsidered, where general does not equate with fixed. However, they also acknowledge that this is difficult given the previous links in the past with movements such as the eugenics as well as political, cultural and social barriers. They argue that without this, 'efforts at theorising educational goals, setting standards and conceptualising assessment frameworks cannot be successful' (p1). The key, they state, is in appreciating the plasticity of intelligence and the way it accounts for individual differences, intellectual development and learning and the necessary design of approaches for raising academic achievement.

In this context, Adey et al examined programmes of cognitive stimulation against the development in learning indicators of stable progress, deviations from general development, independence and ability to transfer understanding. They looked at direct methods (e.g. Feuerstein's Instrumental Enrichment) which include challenging thinking tasks and collaborative learning in its elements. They also examined content-based development methods incorporated within school subjects such as science or mathematics, (e.g. Cognitive Acceleration, King's College, see Adey & Shayer, 1994) which, with reference to Piaget's staged development from concrete to formal operations (Piaget, 2000), introduces cognitive conflict through teacher mediation; combining guided reflective abstraction (Piaget, 2001) and scaffolding (Vygotsky, 1978). In the case of the first type, extra time within the curriculum is required plus professional development of teachers. In the case of the second, it requires the adoption of a different pedagogy for the curriculum subject which crucially, Adey et al state, may be at odds with what is currently recognised as 'good teaching' such as stating learning objectives, completing an activity within a time slot and having evidence of written work. This also requires intensive professional development.

From the evidence, Adey et al (2007) concluded that long-term intervention programmes in school can significantly influence the development of general intelligence. Within the developmental paradigm (Piaget, 2000) they suggest that, if appropriately influenced, the central meaning-making mechanisms of the mind can be developed, strengthened and restructured. Within the psychometric approach, the relative standing of individuals is modifiable given sufficient challenging opportunities to reach higher intellectual potentials.

Adey et al suggest that the gains made from the 'instructional approach' (p16) and structural redesign of subject curriculum may have reached its limit and that gaining insights from models of developmental psychology and developing general abilities are the way forward to raising levels of traditional academic attainment:

> *It is necessary to go beyond the simple objection to the teaching of general cognitive abilities that "it is all very well but we have a content curriculum to*

> *deliver" and to realise the more efficient way of "delivering content" is by promoting the development of general intelligence,* (ibid, p18).

However, they state, there are a number of prerequisites for this to take place in addition to professional development of teachers in awareness of the conceptual - pedagogical change if not already understood. Appropriate activities that offer challenge need to be designed and used. A collaborative work ethic between students needs to be established. There are clear parallels here with the concept of Complex Instruction.

Adey et al (ibid) suggest that in the current climate this may be difficult and risky for teachers since it is a challenge to cultural norms. Furthermore, education policy is dictated by non-professionals who see education as primarily the transmission of information seen as culturally or vocationally important and the public more readily understand and accept the need for better numeracy and literacy in political rhetoric.

Dweck's (2000) findings resonate with the findings of Stigler & Hiebert (1999) in relation to 'ability' and 'effort' models of teaching and illuminate further the framework on mathematics teacher behaviour proposed by van der Sandt (2007) with its focus on the effect teachers' beliefs and attitudes have on students' learning.

Dweck (2000) describes two frameworks for understanding intelligence and achievement, and found in her studies that learners' perspectives were equally balanced between them:

1. The theory of fixed intelligence or "entity theory" framework

Holding an entity theory framework of intelligence does not promote mastery-orientated qualities, which Dweck defines as the ability to persevere to overcome difficulties in learning a skill or concept. For this kind of learner an easy diet of successes is required. Valuable learning opportunities may be bypassed because making errors leads to feelings of inadequacy culminating in disengagement and a sense of 'helplessness', where learners feel out of control and denigrate their ability.

2. The theory of malleable intelligence or "incremental theory" framework

Whilst acknowledging individual differences between learners, holding an incremental theory framework of intelligence, Dweck claims, focuses on the idea that, with effort and guidance, all learners can increase their intellectual attainment. These learners do not see failure as an indictment of their ability and therefore the risk of trying to overcome difficulties is not so great.

This distinction, Dweck (2000) argues, has implications for the classroom and may illuminate the difficulties students face as they progress through school. A diminishing student attitude has been noted as a particular feature of mathematics (e.g. Royal Society, 2008, 2010). Asking why students of equal achievement have such different reactions to failure, she argues that a key factor is the belief that failure measures you and that holding an entity theory tends to turn students towards performance goals whereas an incremental theory leads students towards learning goals. These are summarised as follows:

1. The ‘performance goal’

   Concerned with their level of intelligence, the student seeks positive judgements of competence and avoids negative ones. Personal success is measured against the performance of others. Hence, students will choose tasks that are easy for them but difficult for others.

2. The ‘learning goal’

   Concerned with increasing their level of competence the student seeks the learning of new skills, mastering new tasks or understanding new things. Personal progress is the gauge of success. Hence students choose tasks that will increase personal achievement.

Dweck (2000) emphasises that nothing is inherently wrong with either goal. Problems arise when the goals are in conflict and a choice has to be made between them or when one type of goal takes precedence over the other. Importantly, she states that the best tasks for learning are often challenging ones that require periods of confusion and error and if performance goals take precedence over learning goals then valuable opportunities to progress in learning may be lost and lead to a ‘helpless’ state.

She argues that one of the reasons praise is used so lavishly in schools is that there is a belief that it will raise students’ confidence, and, if students have confidence in their ability all else will follow. However, if the learner holds an entity framework, failure or difficulty will imply low intelligence and regardless of a learner's level of confidence this will undermine their progress. Encouragingly, she goes on to argue that students' theories of intelligence can be influenced; though for how long she is unsure, claiming that college students who learned the incremental approach made a marked improvement in their achievement.

It was also found that performance and learning goals played the same role in social situations as they did in achievement situations and this could be linked to theories of personality, showing that students with fixed personality beliefs are more likely to endorse performance goals (Dweck, 2000). Thus, the framework of intelligence and/or personality that one holds can have an effect not only on the labelling and judging of self but also of others. This has particular relevance for the teacher:

> *Holding an entity-theory......in the case of others' failures, a judgement of low ability and a diminished belief in their capacity to learn may follow.*
>
> *Holding an incremental-theory.....in the case of others' failures, they are likely to think about effort or strategy, and.... to consider what kinds of instruction or remedial actions would help students overcome their difficulty',* (ibid, p75-76).

By way of explanation, Levy and Dweck (1996) found that, with their differing emphasis on heredity and environment, entity theorists believe that personal change is not a possibility whilst incremental theorists believe in the potential for change. Arguably, therefore, teachers' beliefs about intelligence and personality will have an effect on both what they think children are capable of and how they should be taught. Furthermore, the kind of feedback given to students is crucial since a key aspect of a mastery-orientated approach to learning is a focus on effort and strategy, otherwise, learners only feel worthy when they succeed and worthless when they fail. This is defined as 'contingent self-worth' (Dweck, 2000, p 115).

A further significant finding (Dweck, 2000) is that a more cooperative atmosphere between students can be fostered within an incremental framework because it enables all students to feel successful when applying their intellectual abilities to the task presented. Peers are no longer competitors and all students become winners because self-esteem is derived from using one's own effort and ability and by cooperating and helping others learn. Dweck (ibid) also argues that within an entity-theory framework grouping by ability labels children with disadvantageous outcomes.

However within an incremental-theory framework there is no stigma to being behind since ability is not perceived as fixed, thus attention is turned instead to the process of learning. Further, in line with the recommendations of the Assessment Reform Group, (Black and Wiliam, 1998), an incremental theory framework enables teachers to provide honest and genuine summative feedback to learners about their current levels of skills and knowledge and provide them with constructive formative feedback on how to achieve more.

Many teachers are concerned about ‘behaviour management’ in their classrooms, (Capel et al, 2001; Cowley, 2001; Muijs & Reynolds, 2005). At the time of commencing this thesis, the government’s National Strategy website had a large section devoted to behaviour management (DCSF, 2009). On the PGCE programme in which I was involved, specific sessions were run on behaviour management early in the course in acknowledgement that beginning teachers worry hugely about dealing with students’ bad behaviour. Pre-service teachers tend to overvalue affective student outcomes and undervalue cognitive student outcomes (Weinstein, 1990). Dweck’s (2000) research shows that much of an individual’s behaviour is influenced not by deeply seated personality traits but by the beliefs and associated goals that they hold. Significantly, through her research, she has shown that these beliefs can be taught. These findings are important to examine in the context of whether or not mathematics teachers and their students have particular beliefs about intelligence and personality and their associated learning goals and whether the success of suggested alternative approaches to teaching mathematics to improve both cognitive and affective outcomes is contingent upon having belief systems of this kind. Furthermore the results of such inquiry may be helpful in planning teachers’ initial and continuing professional development. However, this is not as straightforward as it might appear from reviewing Dweck’s ideas.

The construct of ‘belief’ is in itself problematic. Beliefs are difficult to define and measure (Pajares, 1992; Gates, 2006; Goldin et al 2009). They may appear under different names such as attitudes, values, and prejudices. It may be difficult to distinguish an individuals’ knowledge from their belief. For example, having information about a range of teaching approaches is knowledge; having a perspective about the relative merits of these practices is belief. These can be conflated in teachers’ professional discourse and hence difficult to distinguish. In the process of data collection and analysis, there are further problems to consider (Pajares, 1992; Speer, 2005). Both stated (professed) beliefs and observed (attributed) beliefs are subject to researcher inference. For example, the participant and the researcher may have different understandings about key terms, (e.g. group work). The researcher's questions and interpretation may be framed by the researchers' own perspective. Whilst analysis of teacher interviews (professed beliefs) may be compared with classroom observations (attributed beliefs) with the claim of triangulating the data and a view to lending robustness to the findings, arguably two different constructs have been measured. Speer (2005) argues that belief constructs are less messy when: clearly conceptualised; key assumptions are examined; precise meanings are clearly understood and adhered to; properly assessed and investigated; and context specific.

Nevertheless, there is strong evidence which supports Dweck's assertions that it is important to examine the beliefs of the participants in the learning process (Dweck, 2000). Pre-service teachers are different to many other new employees in that they are not new to the field. In addition to their wider beliefs, they are already shaped in their beliefs and attitudes as a result of their prior experience of school and their own teachers and this can be a barrier to developing new competencies (Speer, 2005; Maas & Schloglmann, 2009). Beliefs shape teachers' pedagogical decisions (Pajares, 1992) and categorisations of beliefs characterise teachers into typologies (Kuhs & Ball, 1986; Ernest 1989; Lerman, 1990; Dunne, 1994). Individuals' judgements of their ability to execute a particular task, their self-efficacy beliefs, are argued to be the strongest predictors of human motivation and behaviour (Bandura, 1986; Maas & Schloglmann, 2009), which may be related to the strength and level of academic outcomes in the form of engagement, perseverance and attainment. In relation to initial teacher education, beliefs have been shown to effect what pre-service teachers select from the course (Speer, 2005, p328):

> *[Study of beliefs is critical because], the more one reads studies of teacher belief, the more strongly one suspects that this piebald of personal knowledge lies at the heart of teaching* (Kagan, 1992, p85).

However, whilst Dweck (2000) states that the beliefs about intelligence, personality and goals of learning for improved affective and cognitive outcomes can be taught, there is considerable evidence in the literature to show that mathematics teachers' beliefs are highly resistant to change even in the face of strong evidence (Pajares, 1992; Swan, 2000). Beliefs about the fixed nature of students' capability in mathematics, for example, appear to be both dominant and relatively stable (Brophy and Good, 1974; Ruthven 1987; Boaler et al, 2000). Gates (2006) suggests that there is a coherent set of beliefs that is maintained and reproduced by English mathematics teachers which manifests in a dominant script in the form of teacher centred, model and practice lessons with a focus on remembering and practising rules and procedures. There are explanations offered for the apparent stability in this dominant script.

Pajares (1992) suggests that beliefs build into theories with causal relationships which leads to another self-fulfilling prophesy; beliefs influence perception that influence behaviour that are consistent with and reinforce beliefs. Furthermore, he states that since changes in belief precede changes in behaviour, changes in behaviour will only occur if there is dissatisfaction with existing beliefs and the change is consistent with other beliefs held.

There is also strong evidence that the social context both influences and maintains beliefs (Ernest, 1989; Cooney et al, 1998, Skott, 2001; Gates, 2006). Drawing upon Bourdieu's work on social theory, Gates (2006) examines the social influences on mathematics teachers' beliefs. Individuals' habitus, socially learnt dispositions, structure the experience of both teacher and student and, he argues, is reproductive rather than transformative. Through social interaction in the field, in this case the school, these dispositions become relatively stable systems of ideas, ideologies, which allow interaction with others. Groups adhering to different ideologies are then identified typologically. These ideologies appear as assumptions about, for example, society, intelligence, personality, learning, the goals of education, the role of the teacher and professional development. These assumptions are expressed through professional discourse. The interactional nature of these assumptions presents both limitations and affordances, but embodies relations of power:

> *Dominant discourses embody those common conceptions that organise the work of teachers as a collective. Sets of ideas become almost unquestioned, organising and habitual classifications which might be quite difficult to oppose,* (Gates, 2006, p355).

Thus, the professional discourse of ‘ability’, a dominant discourse, becomes sustained by a whole set of occupational practices. Accepting that beliefs can sit separately from dominant discursive practices provides the underlying logic and rationale for the contradictions observed between teachers’ professed beliefs and practices (Gates, 2006). Such inconsistencies arise because practice is affected by other factors; both contextual and situational, and the extent of reflection upon beliefs and practice (Ernest, 1989). Kennedy (2010) suggests that educational researchers and policymakers may be overestimating the role of teacher qualities in teacher effectiveness studies, in which a high percentage of variance in student performance remains unaccounted for, by not paying specific attention to situational factors such as resources, planning time and other aspects of school infrastructure. Attributing behaviours to personal qualities rather than situational factors may lead to fundamental attribution error where the situation is *perceived*, expectations are formed, behaviours are interpreted and causes are inferred.

The two frameworks that Dweck (2000) presents epitomise the opposing stances that can be taken by the different participants and stakeholders in the education process in relation to learning experiences in school. The entity-theory and performance goals framework has arguably been emphasised by successive English governments over the 20 years since the introduction of the National Curriculum, via rigorous monitoring of students’ performance through national and international testing, perpetual levelling and target setting of students, emphasis on grouping students by ability and rigorous monitoring of schools and teachers via performance tables, (Goldstein & Leckie 2008).

2.5 The research study

There is strong evidence presented in this literature review which calls for change in the teaching and learning of secondary mathematics in English schools. A range of explanations has also been drawn from the literature to explain why such change is not straightforward. These explanations have provided two conceptual frameworks for my research.

2.5.1 A 'cultural script' for teaching and learning mathematics

A key finding of Stigler & Hiebert's (1999) analysis of the Third International Mathematics and Science Study (TIMSS) lesson video research was:

> *As we looked again and again at the tapes collected, we were struck by the homogeneity of teaching methods within each culture, compared with the marked differences in methods across cultures*, (ibid, preface p x).

Hence, they introduce the concept of teaching as a cultural activity as referred to in my introduction:

> *[Teaching] is learned through informal participation over long periods of time. It is something one learns more by growing up in a culture than by studying it formally…There is a shared mental picture of what teaching is like…a script… mental models of the teaching pattern,* (ibid, p 87).

Since Stigler & Hiebert (1999) used the phrase 'cultural script', it often occurs in the literature in relation to the concerns about students' performance in mathematics in England (Gates, 2006; Royal Society, 2008; Askew, 2010).

Culture, which relates to societal, historical and behavioural constructs, is, however, a difficult construct to define (Andrews, 2010). Nevertheless, there is evidence to suggest that cultural norms shape values which in turn shape classroom practices (Hargreaves, 2012). In mathematics, these norms are manifested in how the subject is construed and in classroom practices that have a degree of consistency and predictability (Andrews, 2010). Hence the notion of a 'dominant cultural script' for teaching and learning mathematics is derived. However, there is a danger that the notion of a 'cultural script' for teaching and learning mathematics becomes reified by the mathematics education community and in so doing is assumed to be immutable.

The literature on international comparisons of mathematics education in schools suggests that drawing conclusions about national differences are not straightforward thus rendering the definition of a 'cultural script' for England or elsewhere problematic. This is due in part to the variability found around the observed consistency and predictability of teaching practices when comparing different national groups of teachers (Andrews, 2010) and in part to the unit of analysis used to compare these teachers' lessons (Clarke et al, 2008). Further, analysis of the TIMSS data suggests that national results may vary in different aspects of mathematics; that national attitudes towards mathematics are not necessarily positively correlated with students' performance in mathematics and even some high performing nations have not closed the gap between students with different SES backgrounds (Askew et al, 2010).

Nevertheless, there does appear to be some concurrence in the literature relating to cultural differences in the pedagogical development of teachers and the related pedagogical practices of teachers (Askew et al, 2010; Andrews, 2010; Stevenson & Stigler, 1992). Notable differences with regard to my research relate to the incidence of teachers having wider learning expectations, such as working collaboratively and persevering alongside mathematical goals, and the extent to which procedural fluency is embedded in conceptual understanding, rendering mathematics more coherent and meaningful.

Stigler and Hiebert (1999) suggest that prevalent cultural assumptions about teaching mean that the introduction of 'non-traditional' teaching methods in schools, for example those that appear to be successful in other cultures, are unlikely to be adopted quickly or easily without prior attention to the cultural beliefs and assumptions of the teachers expected to implement them. The teachers would need to revise their 'script' and this takes both time and support. This aspect of the concept of a 'cultural script' has provided me with a conceptual framework in which to explore potential resistances to alternative approaches to teaching mathematics, such as CI, and the apparent stability of 'traditional' methods.

One of the calls for change highlighted in the literature is for more process-based learning of mathematics in schools. However, it could be that the majority of teachers hold an understanding of learning which does not match with those (e.g. Boaler, 2006) who promote such approaches. In other words, group work of this kind and the way to organise it, is not in the prevailing cultural script of mathematics teachers in English schools. Hence, if such an approach were to be adopted more widely, it would be necessary for these teachers to examine their assumptions regarding matters such as goals of learning, learners' ability and subject and pedagogical knowledge in relation to the preparation of both students and tasks. In this regard, if a dominant cultural script exists, it would also be necessary to explore the ways in which it is inculcated in mathematics teachers and their students, internalised and enacted; what the characteristics are of teachers who appear to break the stereotype and the role that initial teacher education and continuing professional development of teachers could have in these matters. Hence, whilst the international comparisons of teachers of mathematics by, for example, Stigler and Hiebert (1999) and Andrews (2010) focus on a detailed comparative analysis of observed lessons, my research will focus upon an analysis of the explanations that teachers give for their teaching approach.

2.5.2 Teachers' and students' frameworks of intelligence and personality

This conceptual framework has also informed my research. In relation to mixed ability teaching, alternative teaching approaches, or both, it may be that there is a 'type' of teacher (in relation to themselves, the students they teach or both), as defined by Dweck's opposing conceptual frameworks of intelligence and personality and associated beliefs and goals (Dweck, 2000), that is more willing to engage with the changes proposed. Further, if, as Dweck suggests, people's frameworks of intelligence and personality are not as stable as the literature suggests but malleable, then the type of professional development required to encourage teachers to adopt these ideas is crucial, because as her research shows, each of the following beliefs is erroneous and may have the opposite effect (Dweck, 2000, p1-2):

a) *That students with high ability are more likely to display mastery-orientated qualities*
b) *That success in school directly fosters mastery-orientated qualities*
c) *That praise, particularly praising a student's intelligence, encourages mastery-orientated qualities*
d) *That students' confidence in their intelligence is the key to mastery-orientated qualities*

However, the professional development of both pre- and in-service teachers, highlighted in generic teacher effectiveness studies, (e.g. Sammons et al, 1995; Day et al, 2006; Barber & Mourshed, 2007), and mathematics specific studies, (e.g. Ofsted, 2008b; Royal Society, 2008, 2010), as a crucial factor in teacher change, is not straightforward either. In addition to the provision of sufficient time for sustained professional development and overcoming dominant belief systems, the effectiveness of professional development, Adey et al (2004) argue, is also dependent upon there being a favourable environment including a commitment from management. This could be at school, local education authority or national level. To these factors, Fielding et al (2005) add the need for joint practice development rather than transfer of practice which recognises both institutional and teacher identity and that fosters mutuality and reciprocity in an environment that builds relationships and trust.

Acknowledging teaching as a ‘system’, the following quote from Stigler & Hiebert (1999) is also pertinent in relation the introduction of more effective mathematics pedagogy in schools and professional development:

> [In implementing a curriculum innovation] *the successful teachers were provided with information and assistance by the project staff that, in our words, helped them improve their system and which the less-successful teachers did not receive’,* (ibid, p99).

In this context, they referred to the Japanese system of ‘Lesson Study’ which, interestingly, is also mentioned in the Williams report (2008) as a method of improving mathematics teaching and list a number of aspects of this approach that may contribute to its success which are useful to consider in relation to English reform. They argue, in response to the teacher critics who question the time that it would take to make any significant improvements this way, that being in a hurry and taking short-term views undermine the gradual improvement that leads to long-term improvements and real change. Maybe this is a problem for England as well? We appear to be in cycles of rapid revision with no clear evidence for each new wave of initiatives or evaluation of the previous ones (Dyson, 2009).

2.5.3 Research questions

In the context of teaching mathematics in English secondary schools and the call for the introduction of more process based teaching approaches, my research questions are as follows:

1. Is there a ‘dominant cultural script’ and, if so, what form does it take?
2. Are the ‘scripts’ of teachers who are willing to trial a previously unfamiliar approach, such as CI, different and, if so, in what ways?
3. Are teachers’ and students’ beliefs about the nature of intelligence and personality and their associated learning goals a key component in revising the ‘script’ for teaching mathematics?

3 Research methodology and methods

> *Researchers need to be clear not only about how they are doing research, but also why this approach rather than another* (Morrison 2007, p34).

In this section, I will present the rationale for my research approach.

3.1 Paradigmatic considerations

Here I must question my set of basic beliefs regarding the nature of reality; the ontological question, the nature of my relationship with what can be known; the epistemological question, and how I conduct my inquiry into what I believe can be known, the methodological question (Guba & Lincoln, 2005). Each of these considerations is sequentially contingent upon the other. As demonstrated in Chapter 2, beliefs in themselves are problematic; they are constructions.

Bryman, (2001), distinguishes the ontological position of positivism, in which social phenomena and their meanings exist independently of social actors, from constructivism, where they are continually being reconstructed by social actors. Thus, from a positivist perspective, a reality is assumed to exist which can be captured and described. Guba and Lincoln (2005) describe the constructivism position as relativist, where realities are, local, social and experiential. These constructions are true to the holder, hence individualised, though they may be commonly shared amongst groups of individuals or across cultures. Being more or less informed, they are therefore malleable. Guba and Lincoln also distinguish the ontological position of constructivism from that of critical theory describing the latter as historical realism. Thus malleable realities can be shaped by, for example, social, political, cultural and gender factors into structures that become taken as ‘real’.

The second paradigmatic assumption to be considered lies with epistemology and what is regarded as acceptable knowledge, (Bryman 2001). The positivist, or scientific, approach, can be defined, (Morrison, 2007), as a ‘value free’ analysis of objective, measurable facts. In the social sciences these could be about, for example, human behaviour and attributes. An interpretivist approach by contrast, accepts that there can be no objective reality which exists outside the meanings humans bring to it (Scott & Morrison, 2006):

> *Social actors negotiate meanings about their activity in the world. Social reality consists of their attempts to interpret their world...educational researchers insert themselves in this continual process of meaning construction in order to understand it*, (ibid, p130).

Guba and Lincoln (2005) describe the epistemology for both critical theory and constructivism as ‘transactional and subjectivist’, (p110-111). Both the researched and the researcher are assumed to be interactively linked. In the former the findings are inevitably influenced by the values of these two parties and in the latter the findings are created by them. Hence the distinction between ontology and epistemology becomes blurred.

With regard to assumptions about methodology which logically follow on from the assumptions made about ontology and epistemology, the positivist tends to seek answers in the form of hypothesis testing under controlled conditions and from which causal relationships can be found leading to generalisations, (Morrison, 2007). The critical theorist’s methodology, Guba and Lincoln (2005) state, will be ‘dialogic and dialectical’ (p110). Thus, through the exchange of logical argument, consciousness can be informed and transformed. The constructivists’ methodology, they state, will be ‘hermeneutical and dialectical’ (p111). Through interaction between the researched and the researcher, individual constructions are *interpreted.* With the aim of gleaning a more informed, agreed construction, the varying constructions are compared and contrasted through discussion of ideas and opinions. The interpretivist, Morrison (2007) suggests, pays attention to the detail of the setting of the observed and pays more attention to the holistic setting in which the research question is embedded. Unlike the positivist approach, where the observed is the object of the research, interpretivist researchers attempt to foreground the participants in the research, to bring their voice and/or eyes to the situation.

In Chapter 2, I demonstrated that much attention has been paid, despite substantial criticism, to finding cause and effect relationships in the context-process-product paradigm of effective teaching, suggestive of a positivist approach with the aim of prediction and control. I do not see the purpose of my inquiry fitting into this approach. The introduction of the concept of a ‘dominant cultural script’ for teachers of mathematics is suggestive of a critical theory paradigm for exploring the factors that have led to the prevailing approaches with the aim of ‘critique and transformation; restitution and emancipation' (Guba & Lincoln, 2005, p112). However, the nature of teachers' beliefs, arguably, sits more comfortably with constructivism with the aim of understanding the constructions that are held and with a view to a making a contribution towards more informed constructions.

On balance, therefore, this study tends towards a social constructivist perspective with an assumption that there is interplay between the individual and the social and on the basis that individuals in the teaching profession are influenced not only by their personal history and expectations, but also by the constraints of society's structures. The social constructivist approach assumes a high degree of determinism from the affects of society. Bruner (1990, p11) defines culture as 'shared symbolic systems of traditionalised ways of living and working together' and furthermore:

> *By virtue of participation in culture, meaning is rendered public and shared….shared meanings, shared concepts, which depend upon shared modes of discourse for negotiating differences in meaning and interpretation,* (Bruner, 1990, p12-13).

Thus, social constructivism also accepts the two-way interaction between the individual and society, which can lead to change. By considering the role that initial teacher education and continuing professional development can play in bringing about change in teachers' cultural scripts; I am concerned with the potential for change. Hence, there are three levels of analysis in considering the concept of a cultural script. The intrapersonal level focuses upon what goes on within the person and this requires exploration of both cognitive and motivational processes. The interpersonal level focuses on what goes on between people. This requires an understanding of self-presentation, the nature of relationships and social interaction. The third is the societal level, which requires an understanding of cultural processes and their effect upon the other foci. Since the intention of my research is to explore the nature, causes and consequences of teachers' cultural script for teaching and learning mathematics, itself a social construction, by focussing on teachers' subjective meanings, I take, therefore, an interpretivist approach.

3.2 A multi-strategy design

There are strongly held views (Robson, 2011) that the collection of quantitative data lies in the ideological domain of the positivist researcher and qualitative data in that of the interpretivist and that they should not meet. Lerman, (2009), suggests that the quantitative/qualitative debate focuses on problems of generalisability, the traditional realm of the positivist. It could be inferred from this proposition that, if the aim of the research is to generalise from the study's findings to the population, a qualitative approach would not seem appropriate. Dunne et al (2005) argue that generalisability is not in the ideological domain of interpretivist research, the paradigm that I am drawn towards with the aim of gaining understanding of a phenomenon and with view to reconstruction. However, do these propositions suggest that quantitative data has no place in interpretivist research? Robson (2011) and others (e.g. Bryman, 1988; Creswell, 2003; Sammons, 2010) suggest that there can be advantages in multi-strategy designs which combine qualitative and quantitative approaches. Gorard and Taylor, (2004) argue that the choice should be driven by the needs of the investigation and Morrison, (2007), proposes that the researcher should take the best option to address the research questions in terms of practicality and appropriateness. In this sense, qualitative versus quantitative is, arguably, a false dichotomy and a mixed approach can present itself as a justifiable alternative. In relation to my study, Creswell, (2003), provides compelling reasons for taking a multi-strategy approach in terms of affording the following possibilities:

1. Explanatory design: collect and analyse quantitative data then follow up with qualitative to explain quantitative findings.
2. Exploratory design: collect qualitative data to decide what quantitative measures are required, then use quantitative to validate qualitative findings.
3. Design triangulation: a means of comparing results, in terms of the convergence and trustworthiness of findings, from a variety of qualitative and quantitative methods.

With reference to the research questions, there is a circular flow from the exploratory to the explanatory to the exploratory which requires the collection of both qualitative and quantitative data. In the first part of the research, which I refer to as the reconnaissance stage, research questions one and two require an analysis of teachers' scripts in relation to their current approach to teaching mathematics in secondary schools. As a result of my career in teaching and teacher education and more recently, when immersed simultaneously in two research projects into mathematics education in English secondary schools, as described in Chapter 1, I had plenty of opportunity to listen to teachers' explanations for their teaching approach. Informally, I had begun to notice particular themes which I felt worthy of closer, more formalised exploration. Stigler and Hiebert (1999), state that teaching is a cultural activity that evolves over long periods of time and is consistent with the beliefs and assumptions that are part of our culture and the result of this process for teachers is '*a shared mental picture of what teaching is like; a cultural script'*, (ibid, p101). Informed by their work and using rigorous open-coded methods of analysis (Gibbs, 2002), as fully described in the data analysis section 3.5.3, I move from the analysis of specific teacher interviews and observations towards a theoretical construction of a 'dominant cultural script' for teaching mathematics.

In the second stage of the research, the characteristics of the 'scripts' of a sample of teachers engaging with a previously unfamiliar approach to teaching and learning mathematics are also analysed using open-coded analysis methods. These findings are then compared against the findings derived from the reconnaissance stage. Thus, the opportunity is presented to theorise about possible affordances and resistances to the adoption of alternative approaches to teaching mathematics with a view to making suggestions about how this information can be used to make recommendations to improve the quality of mathematics teaching and learning in English secondary schools; so clearly signposted in recent reports as an urgent need.

The data collected for each is qualitative and the findings are contingent upon my interpretation of the teachers' meanings. However, in terms of relating these data to the concept of a 'dominant cultural script', which in itself implies relative quantity in the form of more or less, the quantification of their responses assists in exploring this question of dominance. This quantitative data will not be used in the form of statistical generalisability but rather to explore further the shape of these teachers' scripts in terms of the relative strengths of the components; their light and shade.

The third research question follows the exploratory design of the previous questions seeking possible explanations. It takes the form of testing the pre-existing theoretical ideas of Dweck (2000) about specific beliefs of students and their teachers in two contrasting schools. In order to replicate a small aspect of her work, which comes from a psychology tradition, quantification and statistical analysis of the data are required. However, given the contextual nature of these contrasting schools and the relatively small sample they comprise in relation to the total school population, there is no intention to generalise these findings to the wider population. Rather, the intention is to integrate all of the findings in the subsequent interpretative phase of the study with the aim of understanding some of the issues that may lie in the way of introducing unfamiliar approaches to teaching and learning mathematics in English schools, which have been shown to be successful elsewhere. Integrating the data from a variety of sources also affords triangulation in the form of comparison to assess convergence (Robson, 2011) and trustworthiness (Guba & Lincoln, 2005).

A further argument for employing a multi-strategy approach is that the focus of my research raises issues of equity in the teaching and learning of mathematics in schools. Evans, (2004, p31), argues that ‘a perspective on social justice and equality is fundamental for many important research topics in educational research today. It is also central to many policy concerns’. He suggests that in the context of equality, three areas need to be considered:

1. Distribution; the share of cultural capital, knowledge or performance, attributed to different groups.

2. Recognition; give voice to the object of the inequality; make them the subject.

3. Representation of interests within social relations; power relations on a macro level: state and related institutions and also on a micro level: teachers and students. Macro policies are played out in micro practice.

However, the study of these areas of (in) equality does not fit neatly into a qualitative or quantitative paradigm either. Whilst the area of distribution, from which the source of my research emanates, may lend itself to a more quantitative approach, understanding the underlying factors, recognition and representation, which I aim to achieve, is more likely to require a qualitative approach, providing further justification for my mixed approach.

3.3 Research Ethics

3.3.1 Ethical clearance

Prior to commencing this research, a research proposal was submitted to the Director of Doctoral Studies of the Sussex Institute (now School of Education and Social Work). In this proposal, attention was paid to the ethical issues of collecting data from teacher and student participants (Bell, 2005; Cohen et al, 2000; Burton and Bartlett, 2005) and the University of Sussex, Sussex Institute Standards and guidelines on Research Ethics Annex (2007) was completed, (see Appendix 6). Hence ethical clearance was sought and given.

To comply with these ethical standards, the purpose and planned outputs of the research were to be explicitly stated from the outset to all participants involved. Confidentiality and anonymity of data collected would be assured such that individual teachers, students or schools could not be identified. There were four areas of data capture which required these stipulations to be met: interviews, lesson observations, workshop evaluations and questionnaires.

With regard to interviewing the teacher participants, with the exception of the interviews conducted with teachers at the schools with high post-16 participation in mathematics and science (see below), the interviews were conducted by me. The participants were informed of my status as a DPhil student and the purpose of my inquiry. They were assured of the confidentiality and anonymity of the data collected. The interviewees were also assured that they could terminate the interview at any time and were offered the opportunity to review the transcript of the interview.

In the case of the interviews with teachers at the schools with high post-16 participation in mathematics and science, I was privileged as Professor Boaler's research assistant on two projects that ran during 2008-9 to be invited by her to read the transcripts of interviews that she had conducted. I was subsequently given her permission to use the data for my own study. However, in addition to the affordances and limitations, described in section 3.3.2 below, of using secondary data in this way, there are further ethical considerations that should be acknowledged (Boddy et al, n.d.). These include the participants' consent, anonymity and confidentiality of the data collected and responsibility to the original researcher.

As my initial doctoral work supervisor, Boaler was aware of and supported my research focus. Whilst these data were analysed using different methods by Boaler and me, the aim for us both was to explore the teachers' explanations of the teaching approaches used. This purpose was made clear to the participants by Boaler at the time of the interviews when their consent for the interviews to be recorded was sought. Since I have maintained this integrity, I have not sought further consent from the participants, but have preserved their anonymity in my analysis.

Lesson observations can be problematic too and, like interviews, present the researcher with a number of methodological (see section 3.3.2) and ethical issues with which to wrestle, (May, 2001; Dunne et al, 2005). In all cases, my status and the purpose of the inquiry was made clear, permission from the teachers concerned was sought and assurances given regarding anonymity of participants, and confidentiality of the data collected. Similarly, the teacher workshop evaluations and the teacher and student questionnaires were also administered with the same regard for these ethical procedures.

3.3.2 Researcher Influence and Identity

An analysis of teachers' scripts for teaching and learning mathematics requires an understanding and analysis of teachers' belief systems and practices. Speer (2005) claims that research suggests that, in addition to teachers' knowledge, beliefs are one of the significant forces affecting teaching in terms of '*how they know what knowledge to evoke, when and how, what's important and plausible, as well as curriculum use, teachers' goals, and a myriad of social and contextual factors'*, (ibid, p4). However, these processes as shown in Chapter 2 are difficult to measure and furthermore are susceptible to researcher influence and attribution. Discrepancies between teachers' beliefs and practices, professed or attributed, she argues, may arise for two reasons:

1. A lack of shared understanding between teachers and researchers in relation to beliefs and practices.
2. The result of methodological artefacts; a lack of coordination between data on beliefs and data on practice in research designs.

I am, therefore, mindful of the relationship between teachers' beliefs and practices in terms of observed consistencies or inconsistencies and aware of the role the research design may have on these in terms of the data collection methods. Definition of terms like 'group work' and reliance on self-report, as well as interpretation of the data collected are subject to attribution by both the researcher and reader of the research. Speer (2005) suggests that research designs should:

1. Incorporate opportunities to assess and generate shared understandings of beliefs and practices.
2. Obtain data on beliefs in conjunction with data on practices.
3. Not classify beliefs as professed because all are to some extent attributed by the researcher.

The researcher, when faced with inconsistencies in the data collected, should ask whether teachers' beliefs are actually inconsistent with their practice or inconsistent with the researcher's conception of particular terms. These points are taken into consideration in my research design. In particular, in-depth interviews with teachers have been coupled with lesson observations in order to check for convergence and trustworthiness of the data collected. However, the very presence of a researcher-observer can change the dynamics of a lesson having influence on both the teacher and the students and bring the validity of the data into question. Such issues of necessity will be considered in my analysis.

Furthermore, in relation to a research design that allows for the most accurate attributions of teachers' beliefs and practices, as the researcher, I am presented with a number of issues related to my 'multiple identities and integrities' (Drake and Heath, 2008, p10). These can be summed up by the term 'insider/outsider perspective'. Drake and Heath also alert the researcher to the difficulties of taking a 'critical stance' and forming what they describe as a 'marriage of theory and professional practice' when teacher/teacher educator researchers already have an attachment to the institution/group they are researching. In my research, this can be manifested in the following key areas. Arguably, each renders the research open to criticism in relation to the objectivity of the researcher, the associated bias that may be introduced and hence any replication of the research findings.

1. My simultaneous work on a two funded projects also researching into issues related to mathematics education in secondary schools.

I acknowledge the challenge of finding a distinct ‘critical stance’ for my research. I have dealt with this by moving away from the specifics of introducing the Complex Instruction approach to teaching mathematics to looking at mathematics teachers’ scripts more generally in relation to the call for more process-based mathematics pedagogy in schools. Whilst it is impossible to put aside what I have learnt from my involvement in these other projects; they have had a part in the construction of my own thoughts and beliefs, I have nevertheless attempted to design my research in relation to a more general understanding of mathematics teachers’ scripts and the introduction of any unfamiliar approach to teaching mathematics.

2. My self-identity as both a former school mathematics teacher and mathematics teacher educator.

I have considered the difficulty of stepping outside my preconceptions of teaching and learning approaches in mathematics. I therefore challenge my assumptions and ideas about what I expected to find out in order to take a ‘theoretical stance’ (Drake & Heath, 2008, p3). As in the previous item, I cannot avoid the fact that my own thoughts and beliefs are a construction that is shaped by my past experiences and interaction with the social world. However, as a result of adopting rigorous, interpretative data-analysis processes, I have attempted to let the voice of the teachers take precedence over mine. I also acknowledge that both in this process and the further stages of analysis, there will always be some ‘researcher effect' in the interpretation of the teachers’ meanings.

3. My identity to others. Teacher participants in my research may consider me as either an insider or outsider.

In the first round of data collection, this is not an issue as I was not the interviewer, but have, with Boaler’s permission, conducted a secondary analysis of interviews that she conducted with a group of teachers. Whilst this removes the influence of my identity on participants, it creates its own problems regarding the status of Boaler which may have prejudiced teachers' responses. (See the data collection section 3.5.2 and reflections on the study Chapter 7, for further consideration of this point). With regard to other rounds of data collection, being a former teacher I may be viewed as an insider. This allows me easier access to participants both for recruitment to the study and in terms of the discourse used by them. It also affords opportunities, using the argument that I have an understanding of, and empathy with the teachers' situation, which could bring me closer to a shared understanding of the processes under analysis. However, being a former teacher educator and currently a researcher representing both the university and, by implication, the research of my supervisor, I am an outsider. I acknowledge the challenges that this presents, such as teachers reporting beliefs and practices that they think I will find agreeable. By collecting data from a variety of sources and by different means for comparison, I hope that such biases have been minimised. I have also, where possible, returned to the participants to discuss my findings and present them with the opportunity to clarify my understanding of their meanings.

4. Feeding back the findings of my research.

It is a challenge to report findings that might in any way appear unfavourable towards mathematics teachers with whom I have co-constructed knowledge. Whilst retaining the integrity of the findings of my study, by giving due regard to ethical considerations such as participants' anonymity throughout, I hope to avoid such tensions. Also as in the previous point, where possible, I have given participants the opportunity to comment upon my findings.

3.4 Methods

3.4.1 Timing of data collection

After initial immersion in the setting of the project as previously described in Chapter 1, collection and analysis of data were conducted for much of the project side by side, as shown in Table 3.1, and on the basis that as new theoretical ideas emerged, more data were collected to test out the limits of the theory's applicability and to amplify particular concepts and theoretical points (Gibbs, 2002).

Table 3.1 Summary of the Datasets

Research questions	**Datasets**	**Data source**	**Dates**
1. Is there a 'dominant cultural script' for teaching mathematics and, if so, what form does it take?	1. Explanations teachers gave for their approach to teaching mathematics	1.[1]Interviews with teachers at 20 schools with high progression into 'A level' mathematics and science	January 2008
		2. Lesson observations and discussion with the lead mathematics teacher and their students at 4 of these schools (one day visit each)	2008
	2. Responses from teachers when exposed to a new approach to teaching mathematics	3. 27 participant evaluations of a CI workshop	June 2008
		4. Lesson observations and discussion with the CI participant teacher and their students at 7 of these schools (one day visit each)	2008
		5. Notes kept in research journal of 29 teacher responses at 3 presentations of the CI approach	2008-2010
2. Are the 'scripts' of teachers who are willing to trial a previously unfamiliar approach, such as CI, different and, if so, in what ways?	3. Explanations teachers who were willing to trial CI gave for their approach to teaching mathematics	6. Interviews with a sample of 3 teachers willing to trial CI with mixed ability Y7 students	2008-9
		7. Two one-day visits with lesson observations of each teacher	
	4. Explanations given by two lead Y7 mathematics teachers in contrasting schools for their teaching approach	8. Interviews with two lead mathematics teachers at contrasting schools under the two conditions one trialling a previously unfamiliar approach (CI) with mixed ability Y7 groups and the other not trialling the approach with set Y7groups	March 2009
		9. One day visit with lesson observations of each teacher	
3. Are the teachers' and students' beliefs about the nature of intelligence and personality and their associated learning goals a key component in revising the 'script' for teaching mathematics?	5. Mathematics teachers' and their students' beliefs about the nature of intelligence and personality and their associated learning goals in two contrasting schools	10. Questionnaires administered to two Y7 cohorts of teachers (5) and their students (221) at two contrasting schools.	July 2009
		11. Follow up discussion about the findings with the lead teacher at each of the two contrasting schools	November 2010

[1] These were conducted by Boaler in the context of a funded research project but secondary analysis was undertaken for the purposes of this study with permission from Boaler (see discussion of ethical issues relating to data collection below).

3.4.2 Data collection

Data for the study were collected over the period 2008-2010. In the reconnaissance stage of this study, (with reference to Table 3.1), the first two sources enabled me to gain some initial understanding of teachers' explanations of their approach to teaching and learning mathematics. The third, fourth and fifth data sources enabled me to gain some understanding of teachers’ responses to an approach to teaching and learning mathematics that is claimed to be more effective and, by implication, reveal something of their current practice. Hence the first two data sets were derived from five separate, consecutive sources with the aim of working towards saturation (Gibbs 2002). Together, they provided a response to my first research question and created a benchmark for the second research question. Across these sources, I have data from 76 teachers representing in excess of 50 schools. The sources comprised:

1. Transcripts of interviews conducted in January 2008 with 20 teachers at schools that had high numbers of students participating in ‘A’ level mathematics or science.

These interviews were conducted by Boaler for another research project, (Boaler, 2009). They were conducted by telephone and were unstructured. The conversation with each teacher was allowed to develop within the area of interest (Robson, 2011). The interview was opened with Boaler explaining why their school had been selected and then the teacher participants were asked what they thought the reasons were for the high participation rates of their students and then they were asked to describe mathematics and science lessons at their school. Hence, the sample was purposive (Robson, 2011).

However, the interview was, nevertheless, not designed for the current study. Boaler, for example, was interested in both mathematics and science, whilst my interest was only in mathematics. Hence, my questions may have been posed differently. Furthermore, I have a different level of authority to Boaler; hence the responses may have differed as a consequence. Also, since I only have the transcripts and not the audio tapes of the interviews, I am not able to hear, for example, the teachers’ intonation and pauses and hence glean all of the nuances of their responses.

Furthermore, since the teachers were contacted on the basis that they were successful in achieving high levels of progression of students into 'A' level in mathematics or science, they arguably responded positively and openly to the interview. However, this sample represents a select group, cannot be assumed to be representative of the population of teachers, and was likely to be more positive. Additionally, the teachers contacted were speaking on behalf of their school and the departments of concern; therefore it can only be assumed that the descriptions given are representative of the actual practices in their school.

2. Lesson observations and discussion with teachers and students across one school day at four of these schools and notes kept in my research journal.

These schools were selected from an analysis of the interviews in data source 1 above, and on the basis that there appeared to be more problem solving and group work taking place in their mathematics lessons. During each one-day visit, the contact teacher arranged observations of a range of mathematics lessons across the school day. Although no formal observation schedule was designed for these lessons, descriptive notes throughout the duration of each of them were recorded in my research journal. Particular attention was paid to: the composition of the class (ability and gender), the intended learning outcome and the assessment of it, the structure of the lesson including the teacher and student activity, the nature of the mathematical task, evidence of any group work/student collaboration and peer or whole class discussion. With those mathematics teachers that were available, informal discussion took place at break-times about their approach to teaching mathematics. Notes were made in my research journal.

At each school, an interview with the 'A' level mathematics students was also arranged. These interviews were audio recorded. The students were asked their reasons for taking 'A' level mathematics and what a typical mathematics lesson had been like lower down the school. The latter explored the ways in which they had been grouped, the structure of the lesson, the kind of tasks they had been given, whether they had worked collaboratively with their peers on problems and the extent to which they had discussed their work with peers or as a whole class.

The collection of these data affords a check for convergence and trustworthiness (Guba & Lincoln, 2005) of the data from the interviews with the teachers in data source 1. By comparing the data collected from the students (see data analysis section), the teachers and the lesson observations it was possible to obtain a more trustworthy assessment of what mathematics lessons were like at these schools.

3. Course evaluations were completed by 27 teachers who attended a workshop on the Complex Instruction approach to teaching mathematics held in June 2008.

These teachers had been invited to attend the workshop through the mechanisms of the Specialist Schools Academies Trust to which the majority of schools are affiliated. Thus, this opportunistic sample of teachers was self-selected and hence cannot be assumed to be representative of the population of mathematics teachers either. However, the sample did comprise teachers from across the country, working in a variety of circumstances and with a range of positions in their schools.

The workshop took place across two days at the University of Sussex. It was organised by Professor Boaler, her research assistants, one of them being me, and two teachers from California who had participated in Boaler's (2008a) research into CI and who were continuing to use the approach in their school. The workshop began with the teachers being introduced by Boaler to the findings of her research. The teacher participants were then presented with an outline of the research project that was being funded by the SSAT, which included the doctoral research that I was undertaking.

For the remainder of the two days, the teachers were given mathematical activities to do by the CI teachers which explored the component factors of the approach and led to discussion of whether or not the approach could be used by these teachers with their students. As such the teachers explored the complexities of working effectively in groups of four to include issues of status and accountability, the nature of rich mathematical tasks which incorporated open-endedness and multiple entry points and instructional strategies which fostered autonomy and interdependence within each group.

At the end of the workshop, an evaluation sheet, which was designed and administered by me, was completed by all the participants (see Appendix 1).
The purpose of the participant evaluations was to elicit the teachers' key learning *focus, and to give voice to their questions or concerns. In so doing, they also revealed something of their current practice. Participants were assured of anonymity* in their responses but were also invited to leave their contact details if they were prepared to participate further.

As with course evaluations generally, participants can put more or less effort into them. Compared with interviews, for example, they are likely to lack the detail that one would like. Participants can also be more or less frank in their responses depending upon their perceived relationship with the presenters.

4. Lesson observations and discussion with teachers and students across one school day at seven of these schools and notes kept in my research journal.

This sample of schools was selected on the basis of the teacher workshop evaluations in terms of those teachers who indicated that they would like to participate further in the research on CI and follow-up emails. Hence, they were also a self-selected sample. The visits, which were conducted across one whole day, involved the observation of the teachers' mathematics lessons using the same methods and focus as described in data source 2. This was followed up with discussion with the teacher either during break-time or after school and interviews with a focus group of six students, selected to represent a cross section of gender and prior attainment, from the class that the teacher was trialling CI with.

As in data source 2, these observations and discussions afford a check, albeit limited, for convergence and trustworthiness of the data from the teachers' workshop evaluations and are subject to the same researcher-observer effects. They also facilitated the screening of teachers in terms of meeting the requirements of the research for further data collection, see data set 6.

5. Teachers’ responses to three presentations of the CI approach by Boaler over the period 2008-10.

As Boaler’s research assistant I was fortunate to be able to accompany her to a number of presentations of her research into this approach to teaching mathematics. At each of the presentations, my role was once again made clear as her research assistant and as a DPhil student undertaking my own research into mathematics education. I kept verbatim notes of the audience’s responses and questions in my research journal. Similar to the previous data set, in responding to an unfamiliar approach, these teachers also revealed something of their current practice. Twenty nine teacher responses were collected and their anonymity was preserved. Clearly, this is a small opportunity sample and again cannot be assumed to be representative of the population. Furthermore, the data I collected only represents those who were prepared to voice their opinions.

Further data were then collected in order to examine the characteristics of the ‘script’ for teaching mathematics of a sample of three teachers that were willing to trial the CI approach. The intention was to compare these data against the findings from data sets 1 and 2 and in so doing respond to the second research question, (see Table 3.1). The sources are as follows:

6. Interviews with three mathematics teachers working with mixed ability Y7 classes and trialling a previously unfamiliar approach to teaching mathematics (CI) during the period 2008-9.

This group of teachers is small due to the low incidence of teachers that agreed to trial the alternative approach at the time, coupled with the low incidence of those teaching mathematics to fully mixed ability groups. This purposive sample was derived from contacting the CI workshop participants by email and follow up visits to seven of them as previously described. Only four of the teachers at the time met the imperative of using the approach with fully mixed ability groups. Three of them agreed to participate in the research.

These interviews were unstructured, were audio recorded and transcribed. They were conducted by me within two day-long visits to the teachers' schools; once in the autumn and once in the spring of the academic year 2008-9. This facilitated the opportunity to discuss with the teachers the detail of the way they group and teach their mathematics students, to check and clarify my interpretations of their meanings and to see for myself the context in which they were working. This approach was taken since it acknowledges the 'multiple and distributed self', (Goodson and Sikes, 2001, p2), which is consistent with the social constructivist methodological approach.

Whoever conducts the interviews, associated methodological and ethical problems must be addressed, notably in the form of researcher bias (Hammersley and Gomm, 1997). Accounts are fictions both in terms of what is and what is not told and will be affected by both the relationship with the listener and the interpretation of the listener (Goodson and Sikes, 2001). They add that interviews conducted in this way are unlikely to succeed unless the kind of relationship is developed between researcher and participants that lead to 'quality' data or unless the researcher is sufficiently sensitive to the central tenets of the approach. Whilst I had no control in this matter over the interviews in the first data source, in subsequent interviews, I endeavoured, through whole-day visits to the selected teachers' schools and communications by email, to build up such relationships.

7. Observations of each of these teachers' lessons on the days that the interviews were conducted and from which I made notes in my research journal.

These teachers' mathematics classes were observed using the same methods and focus as described in data sources 2 and 4. They were also conducted under the same ethical guidelines as described in section 3.3.1. They afford the same opportunities and are subject to the same limitations as previously discussed.

Alongside the on-going collection and analysis of data sets1-3, (see Table 3.1), further data were collected over the period 2009-10 in order to conduct a comparative case study of two schools across the academic year 2008-9. A criticism of using the case study approach is that the findings will be specific to the case in hand and hence it is unlikely that the researcher can make generalisations about other populations, (Cohen et al, 2000). However, as Bell (2005) points out, others may be able to draw upon the findings if their case is similar. Furthermore, as Shulman (1992) argues specifically in relation to teacher education, cases are attention captivators and can lead teachers to reflect upon their practice. Hence, in this instance, a case study approach is justified since, if teacher change is important to the improvement of mathematics teaching and learning in English secondary schools, even though local circumstances may vary, captivating teachers' attention in order for them to reflect upon issues underlying their practice, such as their 'cultural script', is necessary.

Both the schools were in the same local education authority and were selected on the basis of their similarity in terms of their GCSE A*-C pass rate, Ofsted reports and student's socio-economic status (SES) at the time. Full descriptive statistics of these two schools are given in the findings chapter. In one school, students were taught in mixed ability groups for mathematics and one of the teachers was trialling the CI pedagogy. In the other school the students were taught in sets and none of the teachers were familiar with the CI pedagogy.

In addition to making direct comparisons between the scripts of two lead teachers in these schools and thereby adding to my findings in response to my second research question, I also wanted to examine the third research question, (see Table 3.1), of whether, in the context of teaching mathematics to Y7 students, key components of the 'script' for teachers' pedagogy are the frameworks of intelligence and personality, with their associated beliefs and goals (Dweck, 2000), held by both the teachers and their students.

The data sources are as follows:

8. An interview with and lesson observation of a lead Year 7 mathematics teacher at each of the two contrasting schools at the beginning and end of the period. These were conducted in the same way, with the same ethical considerations, as described above and with the same affordances and limitations.

9. Questionnaires were administered by the students' teachers, with written instructions from me, to the two Year 7 cohorts of students, n= 156 (School D1) and n=83 (School D2), at the end of the academic year 2008-9 in order to explore their framework of intelligence and personality and associated beliefs and goals in the context of mathematics. The response rate from the students was 97% and 84% respectively (n= 151 and n= 70).

10. At the same time, questionnaires were completed by the teachers of the two Year 7 cohorts of students to also explore their framework of intelligence and personality and associated beliefs and goals in the context of mathematics. Five out of a possible seven of these teachers responded. Only one of these teachers had received any professional development in CI.

The design of the questionnaires (see Appendices 2 and 3) followed Dweck's instructions in her book (Dweck, 2000) which reports the findings of her research into 'theories of self and others' in which she gives permission for the use of the measures. As described in the literature review, section 2.4, in the context of education, the frameworks of intelligence and personality held have been found to be related to the goals pursued. Holding an entity theory framework of either intelligence or personality tends to turn students towards performance goals and holding an incremental theory framework towards learning goals.

For the student questionnaire, Dweck's questions were used to gain four measures: an implicit theory of intelligence in relation to self; confidence in one's intelligence; an implicit theory of personality in relation to self and learning or performance goal choices. For the teacher questionnaire Dweck's questions were selected to gain three measures: an implicit theory of intelligence in relation to others; an implicit theory of personality in relation to others and learning or performance goal choices.

Usually, questionnaires should be piloted to check for ambiguity and imprecision, (Bell, 2005). In this case, however, it was first assumed that this process had already been completed by Dweck for the essential content of both the teachers' and students' questionnaires. Secondly, as my intention was, as far as possible, to replicate an aspect of Dweck's research, I did not want to change the essence of the questionnaire. However, as Dweck writes from an American perspective, the questionnaires were necessarily adapted for teachers and students in England in order to take account of variances in the use of the English language. They were also adapted to make the questions specific to mathematics, being the focus of my research. The questionnaires were, nevertheless, trialled with a small group of school students and a group of PGCE students to check for their comprehension of these changes.

The questionnaires were administered following the University of Sussex Research Ethics standards in terms of assurance of confidentiality of the data collected and the anonymity of participants.

If any students or teachers were absent, they were not followed up. In the case of the students, I considered the response rate to be sufficiently high not to warrant pursuit of those missing. In the case of the teachers, one was on sick leave and the other had subsequently left the school. Thus the samples were purposive and opportunistic.

In addition to affording some triangulation with the qualitative data collected from the lead teachers, the teacher questionnaire data enabled further comparisons to be made between the teachers in terms of their students' 'concept of self' under the two conditions of engagement with CI/mixed ability groups and no engagement with CI/set groups.

However, whilst questionnaires allow for data to be captured economically and efficiently in order to 'measure or describe any generalised features' (Cohen et al, 2000, p 171) concerns are necessarily raised by using this method of data collection. First, samples are constrained by the small number of teachers who are, as yet, using the CI approach fully in the way prescribed from which to draw participants and this is coupled with a low incidence of mixed ability mathematics classes in English secondary schools, an imperative of the CI approach. Secondly, matching schools by any means is problematic because, as raised in the section on student grouping, the make-up of a school and the organisation of students within it are affected by many factors and as such, each school is arguably unique. Thirdly, as Burton and Bartlett (2005, p101) state:

> *Questionnaires are useful in collecting a large amount of general data and opinions from a large number of people. However they are of far less use if you are collecting detailed information with subtle differences from respondent to respondent*.

Therefore, additional methods of data collection were required. Hence, three methods of data capture were used for the comparative analysis of these two cases, since, '*by concentrating on a particular case, data is usually collected by using several methods*', (Burton and Bartlett, 2005, p86). A key purpose of this, as previously mentioned, was to triangulate the data captured by the different methods since, as Stigler and Hiebert (1999) also remind us, what teachers say about their practice and the rationale they provide for doing it, are not necessarily the same as what they actually do in the classroom. In addition to the questionnaires, interviews, as previously described, with the two lead teachers from each of the mathematics departments including lesson observations of each across a period of an academic year were also conducted. This longitudinal approach, whilst time consuming, affords the benefits of being able to 'chart development' contemporaneously and 'make reliable inferences' across teachers whilst reducing the possibility of 'chance occurrence' (Cohen et al, 2000, p178).

11. After data analysis of the interviews and questionnaires had taken place, I returned to each of the two schools for a discussion with the two lead teachers about the findings. Notes were made in my research journal of any comments they made.

Again this afforded the opportunity for trustworthiness of the data collected. It also allowed me to explore with the lead teachers my interpretations.

3.4.3 Data Analysis

The reconnaissance stage

Data collected from sources one, three and five (Table 3.1) were analysed with the help of the software package NVivo. The data from the first source was read through carefully several times and subjected to open coding analysis. That is to say, I had no preconceived codes but allowed the teachers' responses to 'speak for themselves' and create the coding nodes (Gibbs, 2002). However, there is a degree of interpretation on the analysts' part even at this stage in the decision to create a node that is believed to best summarise each point that the participants are making. By using the data from my observations and discussions with teachers and students at a sample of schools from which themes had been noted in my research journal, I was able to triangulate my interpretation of the coding nodes for this data set.

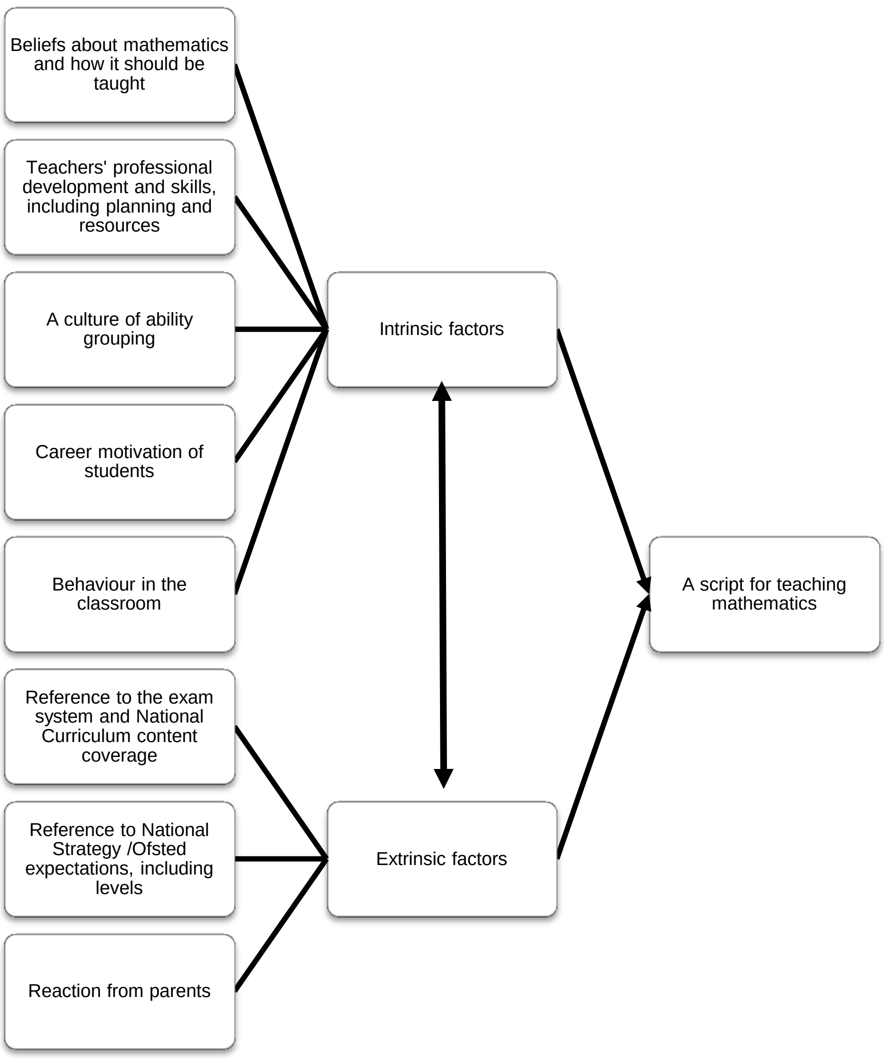
The nodes were then sorted through to see where the respondents were, in my judgement making the same point but using different words. For example, one teacher might refer to their method of student grouping as 'setting' whilst another referred to it as 'ability grouping'. Such responses were then combined into a single node; 'group by ability'. Many passes of the data were made until there were no additions to the total nodes.

The data from the third source was analysed in the same way using the coding nodes from the first source and adding in any new ones and checking against my lesson observations and discussion notes. Similarly, data from the fifth source was analysed after which point, no new codes were generated. This is described as the 'constant comparative' method of data analysis, (Robson, 2011, p149).

In the next stage of the analysis, I grouped these nodes into categories. For example, the category called 'Reference to National Strategy/Ofsted expectations including levels' contained the nodes of 'targets', 'levels', 'National Strategy guidelines', 'Ofsted expectations'. Once again this stage is subject to researcher interpretation in terms of the choice of category that best describes the data.

Then I began to explore the relationship between the resultant eight categories. Thus, I arrived at the central phenomenon of interest, a 'script' for teaching mathematics, with the eight categories divided into two subgroups. The first I have called intrinsic factors; those relating to influences within the teacher and the school environment in which he/she works. The second I have called extrinsic factors; those relating to influences outside of the teachers' workplace. As previously stated, (Evans, 2003), macro policies are played out in micro practice so this distinction between intrinsic and extrinsic is not clear-cut. For example, the set called 'culture of ability grouping', which I have placed under the heading of intrinsic factors based on my interpretation of teachers' responses, may have been internalised by the teacher as a result of influences from, for example, their own history, their school's policy or government policy. Similarly, if the two-way interaction between the individual and society, which can lead to change, is accepted, there will be interplay between the intrinsic and extrinsic factors. This is shown diagrammatically in figure 3.1.

Figure 3.1: A theoretical model for teaching mathematics



However, this diagrammatic representation as it stands does not reflect the relative weight given by participants to each of the categories. Thus, bar graphs were subsequently produced to provide a visual representation of the two levels of analysis, the first from the open coded analysis of the teachers' responses into nodes and the second from the collection of the nodes into the categories as described above. Since each data set had a different number or participants, the number of responses assigned to each node or set was converted into a percentage of the total coded responses for the data set in order to make comparisons between data sets. This conversion of qualitative data into quantitative data served the purpose of being able to compare the relative weight or strength of the teachers' responses by node or by category both within each data set and also between datasets. It is the overall shape or pattern of the bar graph when comparing the datasets in relation to teachers' 'scripts' for teaching mathematics that is of interest rather than direct comparisons of the actual percentage response to each category.

Exploring the 'scripts' of three teachers willing to trial an alternative approach to teaching mathematics with Y7 students in mixed ability groups.

These interview data, data source 6, were also analysed using NVivo and open coded analysis methods as previously described, adding in any new nodes as appropriate, and with view to revision of the categories shown in figure 3.1. As before, my lesson observations of these teachers were used to check my interpretations.

Exploring teachers and their students' frameworks of intelligence and personality, their associated goals of learning and the 'script' for teaching mathematics

The interviews with the two lead Y7 mathematics teachers at each school, (data source 8), were also analysed using the software package NVivo, using the open-coding methods to arrive at thematic categories and using the lesson observations of the teachers (data source 9) to check my interpretations as previously described.

A statistical analysis was carried out on the questionnaires administered to the Y7 students and their teachers (data source10) using the software package SPSS using the following procedures (Field, 2009):

1. The questionnaires were visually checked to ensure that each student respondent could be matched to their teaching group and hence their teacher. This was the case.
2. The questionnaires were checked to ensure that they had been fully completed. Two student questionnaires were discarded on the basis that, in the researchers' opinion the questionnaire had not been taken seriously. The questionnaire is designed in such a way that random responses to clusters of questions can be identified and hence checked for internal validity. In the cases where a questionnaire had not been fully completed by a participant, the decision was made to include the questionnaire, but record a non-response against the question missed. Non-responses are shown in the analysis.
3. For the questions which required participants to indicate their agreement on a Likert scale, ascending numerical values were assigned to the scale, (e.g.1= strongly agree, 6 = strongly disagree). Where questions required selection from a choice of statements, the choice was also assigned numerical value.
4. The data were then entered into the SPSS database by me.
5. By subsequently obtaining the students' KS2 National Curriculum levels from the lead teachers, these were added to the database.
6. The analysis of the students' questionnaires was done in two stages. First descriptive statistics were produced for all of the students' responses to provide univariate analyses as follows:

    a. Number of students in each cohort

    b. Number of boys and girls in each cohort

    c. Number of maths teachers in each cohort

    d. Number of students in each teaching group

    e. Number of boys and girls in each teaching group

    f. Responses to each of the questions individually where:

        i. Questions 1-3 are indicative of the students' implicit theory of intelligence in relation to self

        ii. Questions 4-6 are indicative of the students' confidence in their intelligence

iii. Questions 7-9 are indicative of the students' implicit theory of personality in relation to self

iv. Questions10-14 are indicative of the students' learning goal choices; performance versus challenge

g. Coding of the clusters of questions in section f, above, were accumulated for each participant to give them an overall score for each area of inquiry.

Then a bivariate analysis was conducted on each sub-section above to include:

A. Comparative analysis of the two Y7 maths cohorts where students at D1 are taught in set groups and none of their maths teachers attended the CI workshop and where students at D2 are taught in mixed ability groups and one of their teachers, Teacher CI, attended the workshop.

B. Comparative analysis by gender

C. Comparative analysis by maths group

D. Comparative analysis by maths teacher

E. Comparative analysis by KS2 National Curriculum level

7. The analysis of the teachers' questionnaires was also done in two stages. First descriptive statistics were produced for all of the teachers' responses to provide univariate analyses as follows:

a. Number of teachers in each cohort

b. Number of male and female teachers in each cohort

c. Responses to each of the questions where:

i. Questions 1-4 are indicative of the teachers' implicit theory of intelligence in relation to others.

ii. Questions 5-8 are indicative of the teachers' implicit theory of personality in relation to others.

iii. Questions 9-13 are indicative of the teachers' learning goal choices; performance versus challenge.

d. Coding of the clusters of questions in section c, above, were accumulated for each participant to give them an overall score for each area of inquiry.

Then a bivariate analysis was conducted on each sub-section above to include:

F. Comparative analysis of the two cohorts of Y7 mathematics teachers by mode of grouping of their students, where teachers at D1 taught maths in set groups and the teachers at D2 taught in mixed ability groups.

G. Comparative analysis by gender

H. Comparative analysis by attendance at CI workshop

Where group sizes were large enough, the results for each of A – H above were tested for significance using non-parametric tests (Mann Whitney U Test or Kruskall-Wallis). Non-parametric tests were used because the data were non-parametric, i.e. ordinal, such as attitudinal scores, or categorical such as gender, which ‘offer useful information to address questions of educational and pedagogic significance’, (Hartas, 2010, p319). The Mann Whitney U Test was used when comparisons were made between two categories of nominal variables. Kruskall-Wallis was used when comparisons were made between K categories of nominal values.

Finally, I returned to each of the schools to discuss the findings of my research with each of the lead teachers. This provided them with an opportunity to check my interpretations of the data collected and to offer their explanations for the findings.

4 Is there a ‘dominant cultural script’ for teaching mathematics and, if so, what form does it take?

4.1 Introduction

This chapter presents and discusses the findings from the reconnaissance stage of the study using the first two datasets (see Table 3.1):

1. Explanations teachers gave for their approach to teaching mathematics.
2. Responses from teachers when exposed to a new approach to teaching mathematics.

In the context of teaching mathematics in English secondary schools, it responds and leads to some conclusions about the first research question:

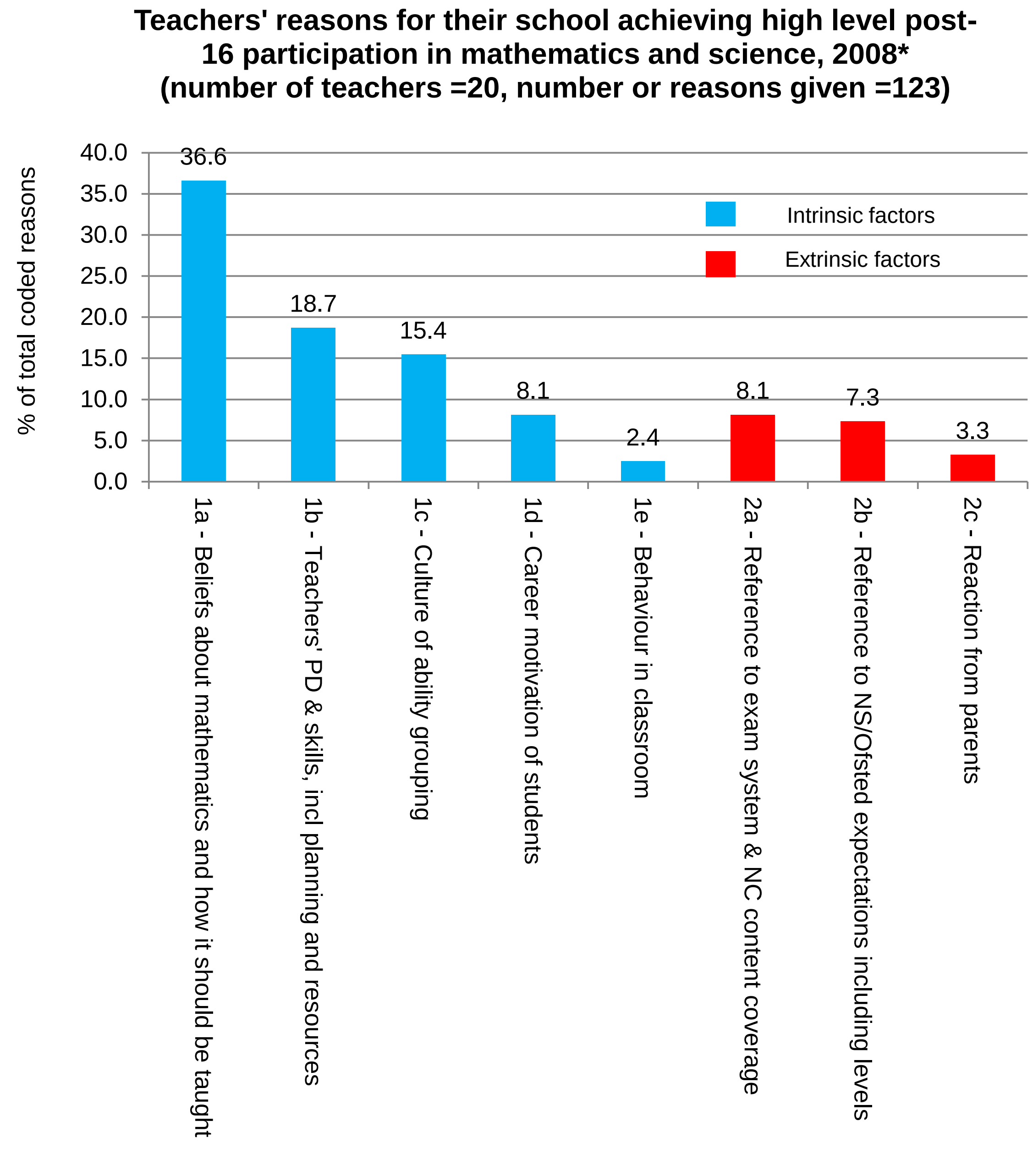
> *Is there a ‘dominant cultural script for teaching mathematics and, if so, what form does it take?*

Note: ‘Mixed ability grouping’ and ‘ability grouping’ or ‘sets’ are the common terms used by mathematics teachers to describe the formation of their teaching groups whereby the former is assumed to have a wide range of ability composed of students from all levels of attainment and the latter a narrow range of ability, with students of high prior attainment placed in the ‘top’ set and those with low prior attainment placed in the ‘bottom’ set. As outlined in Chapter 2, research shows this assumption to be problematic (e.g. Dunne et al, 2007). Indeed the term ‘ability’ is problematic (e.g. Dweck, 2000; Adey, 2007) and I share these concerns. However as these terms are common parlance amongst teachers, and because I am exploring teachers’ ‘cultural scripts’, I will use them as the teachers have used them throughout the presentation of my findings.

4.2 Findings

These findings will be presented under the headings of the thematic categories generated from the second level open-coding analysis of these qualitative data sets as described in Chapter 3 and summarised in Figure 3.1. Figures 4.1, 4.2 and 4.3 below show the relative weight of the teachers' responses from each source of data.

Figure 4.1: Thematic coding of interviews with teachers at 20 schools with high level post-16 participation in mathematics and science



*These interviews were conducted by Professor Boaler, but analysed by the author

Figure 4.2: Thematic coding of 27 teacher participant evaluations of a two-day CI workshop

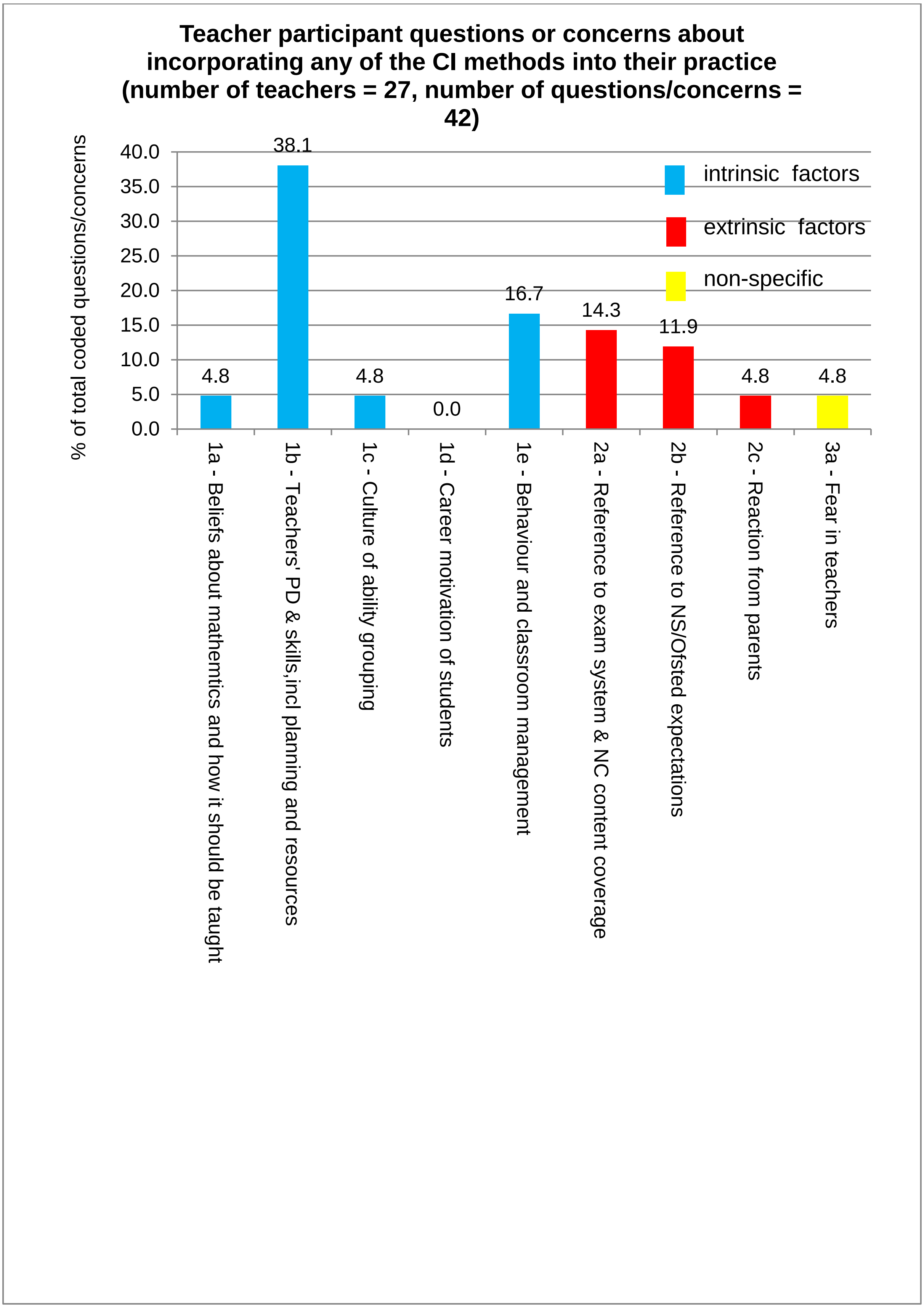
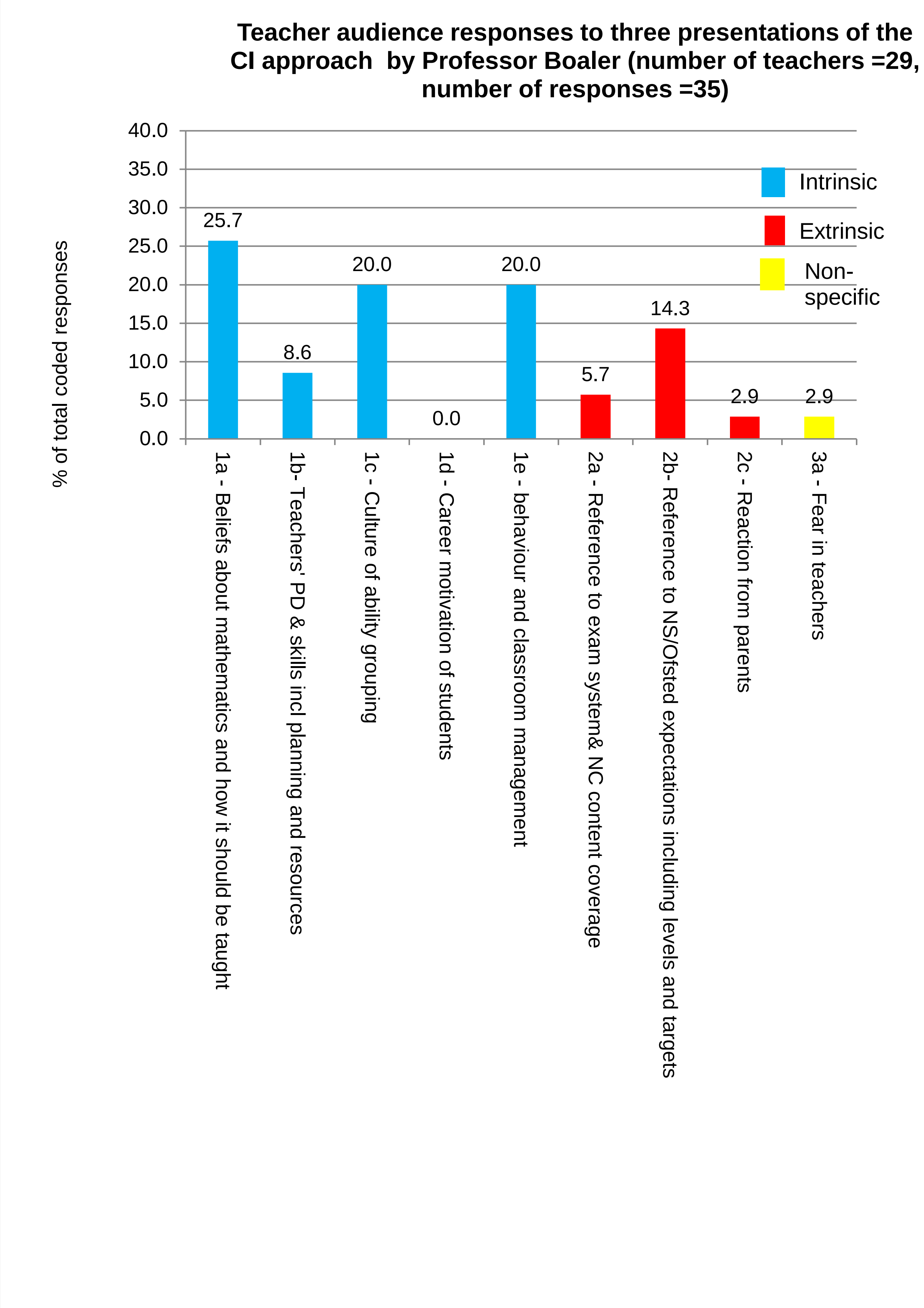


Figure 4.3: Thematic coding of 29 teacher audience responses to three presentations of the CI approach



Comparison of figures 4.1, 4.2 and 4.3 shows that in each of these data sets, the teachers' responses are weighted towards what I have described as intrinsic factors, those factors relating to influences within the teacher and the school environment in which he/she works, 81.2%, 64.4% and 74.3% respectively. However, when comparing the three data sets in terms of the teachers' exposure to the ideas of CI, from no known exposure, (teachers at the schools with high level post-16 participation), some exposure, (a presentation of Boaler's research findings on CI), and intense exposure, (participation at a two day workshop on CI), there appears to be a progressive shift towards a greater consideration of what I have called extrinsic factors, influences outside the teacher's workplace and largely relating to external accountability, from 18.7% to 25.7% to 35.6% respectively.

On comparing the categories within these clusters of responses it can be seen that both the teachers with high levels of post-16 participation and teachers exposed to a single presentation of Boaler's research findings both place most emphasis on the category of 'beliefs about mathematics and how it should be taught', (36.6% and 25.7% respectively). The participants at the CI workshop, however, in terms of their questions and concerns about incorporating CI into their practice, place their emphasis on the category of 'teachers' professional development and skills including planning and resources'. There are two further notable differences. The first is that of the lower emphasis placed on the category 'culture of ability grouping' by the workshop participants, 4.8% compared to 15.4% (high post-16 participation) and 20% (presentation of Boaler's research findings). The second is the expression of concerns about 'behaviour and classroom management' by those exposed to a single presentation of Boaler's research (20%) and the workshop participants (16.7%) compared to the teachers at schools with high post-16 participation, (2.4%).

The following presents in detail the teachers' qualitative responses within each of the categories identified in Figure 3.1.

Intrinsic Factors

Beliefs about mathematics and how it should be taught

The teachers at the schools achieving high post-16 participation rates gave most weight to the teaching methods used as a factor for their school's success. They mostly described what can be termed 'traditional' methods in the form of didactic, whole class teaching with students individually remembering and practising rules and procedures modelled by the teacher:

> *I was taught maths in a very traditional way, and I think I still, and a lot of the other teachers still do. I mean we still teach from the front as it were.* (Teacher HP2)

Reference was also made to the format of the National Strategy three-part lesson; being interpreted as a starter followed by teacher explanation, followed by a period of students working on examples and finishing with a plenary.

There was low evidence in the interviews that these mathematics departments regularly used group work and problem solving in their pedagogy. If students were given investigations and problem solving to do, it might be as infrequently as once or twice a term. On visiting a sample of four of these schools, where discussion with lead mathematics teachers and observation of lessons across the department took place, the findings from the interviews, indicative of a dominant, ‘traditional’ mode of teaching approach, were largely confirmed. However, this was not necessarily the case for all of the mathematics teachers observed. There were some, albeit in the minority, who were seen using rich mathematical tasks to promote mathematical discussion in either pairs, groups or as a whole class.

There was strong evidence from the interviews that rigorous practice and revision were perceived as other factors in their success:

> *We do a lot of revision with them and we have a lot of resources and we use tons of revision booklets and stuff so they all get past papers [..….] also on top of that we have loads of revision material and we make them do it.* (Teacher HP16)

> *A: Yeah, we have quite a lot of things like ‘10 Ticks’, a whole bank of work, we use those quite a lot.*
> *Q: What are they like, how are they different from the books you would use?*
> *A: They’re just good for extra practice really; lots of more of the same, sometimes you just need to do more of the same.* (Teacher HP4)

The teachers exposed to a presentation of Boaler’s CI research findings spoke about the difficulty they envisaged of leaving students to struggle with mathematical problems rather than showing them how to do it, even though they could see the value of doing that. One teacher commented that UK teachers would normally intervene when they saw a student was struggling (Boaler’s presentation was illustrated by a video of US students engaged in the CI collaborative group work approach). Another said:

> *[There was] rich discussion between the four students. Sustained discussion beyond what you would normally see in a typical UK classroom.* (Teacher P6)

A further concern was about whether the students should be taught the content before doing problem solving group work, and what skills would have to be taught before they can do the problem solving:

> *Was there any initial teaching before? – You've got a curriculum to cover – do you have to demonstrate/ model first as a teacher?* (Teacher P8)

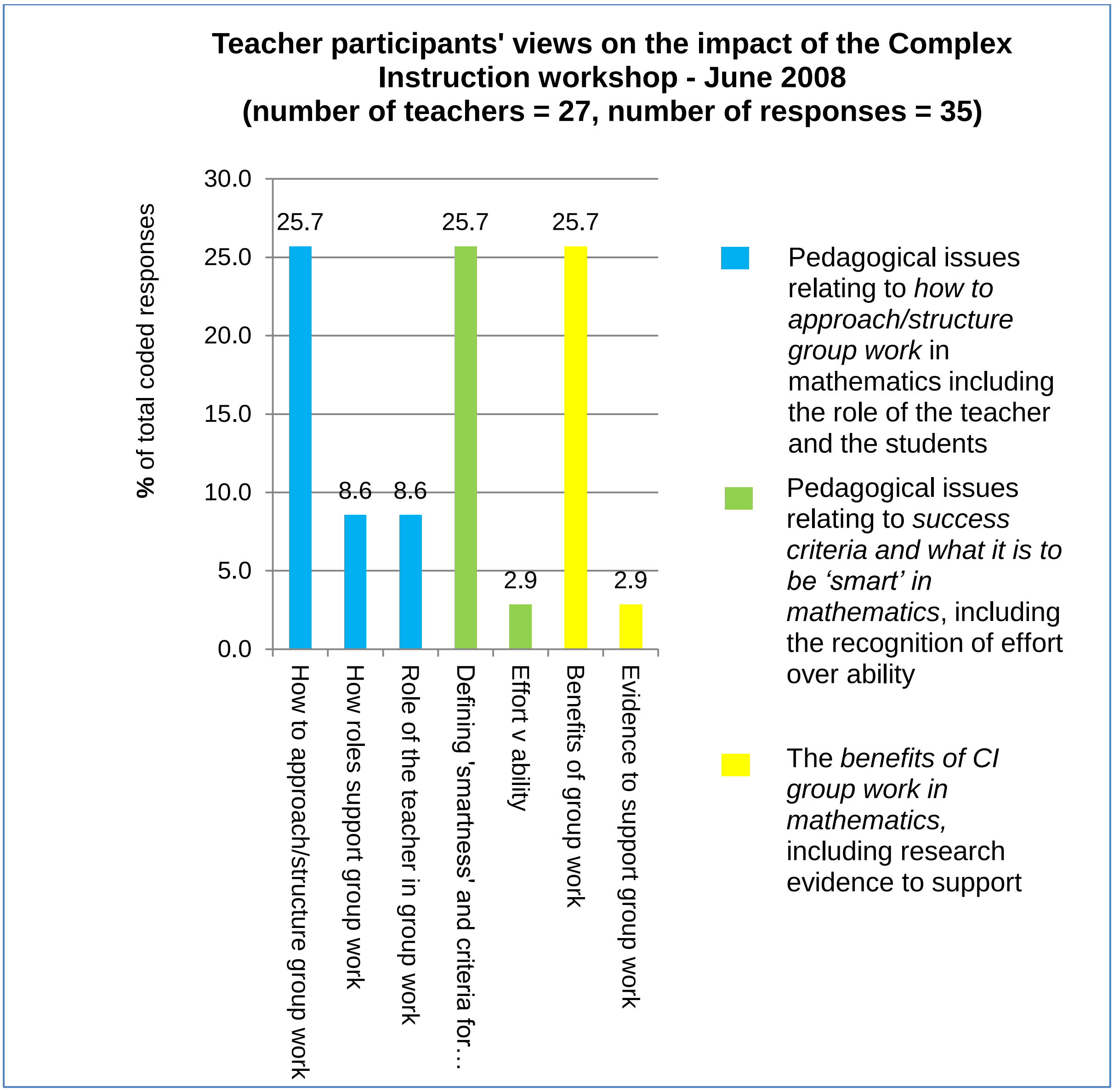
Another teacher spoke of a similar initiative being run at York where students work in small teams. He stated that it was mainly teachers of English that were involved and that maths teachers didn't want to take it forward. Teachers who were positive about the approach indicated that they were only likely to consider it with younger students, (11 or 12 year olds).

On asking the two day CI workshop participants to share their questions and concerns about implementing the approach, this category appeared to be a weak feature of their responses. However, on asking this same group what impact the workshop had had on them (see figure 4.4), in addition to referring to the understanding they had gained about the benefits of properly designed group work, they also commented on intended specific personal pedagogic shifts:

> *The use of roles in establishing productive group work, including the teacher's role.* (Teacher CIW25)

> *Discussing and explaining are very valuable mathematical skills that I have not focussed on in the past but hope to in the future.* (Teacher CIW18)

Figure 4.4: Teacher participants' views on the impact of the CI workshop



Teachers' professional development and skills including planning and resources

The teachers at the schools achieving high levels of post-16 participation spoke about the qualities of the teachers in their mathematics department as a key factor for success in terms of their enthusiasm, their motivation and being good role models in an inspirational way. They also spoke of the level of experience and stability of their department:

> *It’s a good department, in the sense that we are good mathematicians, we're experienced teachers. And a number of us have been here for quite some time, like myself, so there’s stability.* (Teacher HP2)

> *There is a range of success with different teachers. The most successful methods are when the teacher is really enthusiastic about the subject, irrespective of how they actually teach it to be quite honest.* (Teacher HP13)

A further quality raised by these teachers in this category as a factor for their success was the teachers’ ability to embrace and share ideas within the mathematics department:

> *We are good at sharing ideas, modifications, problems, worksheets, that sort of thing.* (Teacher HP2)

> *...you know they are trying to use it and they are trying to adapt to the new strategies but you know it takes time to get used to that. But I think that is the case in all departments. You have got a lot of people who are very eager and quick to pick up new ideas and other people who are more used to their own way.* (Teacher HP14)

Questions were raised by the teachers exposed to a presentation of Boaler’s CI research findings about the calibre of the teachers required to successfully implement the CI approach, the professional development required and time required for planning resources.

This was the strongest feature of the CI workshop teacher participants’ responses. They responded in general terms about learning how to achieve more effective group work in mathematics through the CI group-work approach, and more specifically to the shift in the role of both the teacher and the students. They referred to practical matters such as how to plan and structure group work, provide different activities and sustain engagement. The time required to address each of these issues was highlighted:

> *Time to feedback to the department and decide how to incorporate CI methods as a whole department in September. What are the key things I'd like us to do?* (Teacher CIW20)

> *The need to carefully prepare tasks with on-hand ready resources to enable practical activities/investigations to take place.* (Teacher CIW9)

The necessary training of both the teachers and students in the approach was signalled:

> *Teacher training. Logistics, feasibility, applicability to our teaching system. Ability to do this 'properly' i.e. well enough to be effective. Ability to train pupils to work this way.* (Teacher CIW3)

> *Teachers need moral and practical support to implement and learn further. Teachers need ongoing workshops of a similar kind. Designing conceptual curriculum is not easy - training is essential.* (Teacher CIW27)

Culture of ability grouping

The teachers at the schools achieving high levels of post-16 participation described how the students were grouped for mathematics at their school and, in some cases; with incredulity that maths could operate other than in ability sets:

> *Q: And is ability grouping up for question or is that not part of it?*
> *A: No we are sticking with our ability groupings. We've briefly discussed, you know, mixed ability grouping and very quickly dismissed it as well. We are quite keen to stick with ours.*
> *Q: OK and is everybody on board with that?*
> *A: Yes absolutely.* (Teacher HP9)

Without exception at these schools students were placed into sets from Year 7 onwards for mathematics even though they might be in mixed ability groups for other subjects and including those schools in the sample that had a selective intake:

> *A: Because it's a selective school. I'd say we take probably about a top, well from the numbers who apply; we generally take the top fifth of those because we have a set number of places; so pretty high in the ability range.*
> *Q: So does that mean they are mixed ability in all their subjects?*
> *A: No, some, Maths set them, for example.* (Teacher HP13)

> *Q: And where is the resistance [for mixed ability groups]*
> *A: (…) I think it is the maths department.* (Teacher HP7)

In the following example, the teacher presents a rationale for why he thinks it is acceptable for the mathematics department to put their students into sets with a perception that children learn maths in very different ways to other subjects like science:

> *Year 7 onwards they set and, you know, very, very rigorously [...] But I think that is because maths is different from science, I think that it is easy for them to focus on a particular area and get those kids, you know, proficient in that skill area and then move on. Whereas in science I think it is because kids construct knowledge by talking amongst themselves that it just makes sense to have people who can raise the game and people who can challenge people who don't quite get it.* (Teacher HP8)

A key concern expressed by the teachers exposed to Boaler's presentation of her findings was that, working in mixed ability groups, the students who found the problems difficult would hold the others back:

> *Aren't we holding back the brighter kids – supporting the least able at the expense of the high attainers?* (Teacher P9)

This was coupled with concerns about dealing with status issues in the groups both between students of differing mathematical ability and also gender differences.

On asking the CI workshop participants about their questions or concerns, few made comments that fell into this category. However, during the workshop, an impassioned presentation was given by one of the presenters on defining 'smartness' in students and creating opportunities for assigning them with competence. Teachers' evaluation comments, see figure 4.4, show that this impacted upon them in a variety of ways in terms of defining what it is to be 'smart' in mathematics, by widening the range of measures for success and considering the impact this can have on issues of equity and how children are valued:

> *That participation in my classroom can be significantly affected by my ability to recognise and affirm the value of different kinds of 'smart' working.* (Teacher CIW12)

> *The power of collaborative work and the importance of developing a classroom ethos that everyone shares about what it means to be 'smart'.* (Teacher CIW24)

Career motivation of students

This category was only referred to by the teachers with high levels of post-16 participation. Whilst featured with relatively less strength than the other categories, it was nevertheless mentioned by seven of the twenty teachers and tended to reflect the intake of the school (see also reaction from parents in extrinsic factors below):

> *Maths gets high numbers and it's a combination of things again. Now you cannot negate our intake and that we have a lot of able students who are very good, who have come in and already have it in their heads that they want to be Pharmacists, Medics... (Teacher HP8)*

Behaviour and classroom management

This category was rarely mentioned by the teachers at schools with high post-16 participation:

> *You know, there are still some naughty children here but they are few and far between and much more manageable because they are few and far between. (Teacher HP17)*

Teachers who had been exposed to a presentation of Boaler's findings, however, asked questions about the time taken to establish the group approach, whether there were any problems such as getting students' cooperation, whether some students were reluctant to work with each other and getting all students to participate. Concern was also raised about what students did when they were waiting for the teacher's attention. It was also suggested that the students in the film were behaving well because of being filmed and hence not typical of the average English mathematics classroom.

For the teachers who attended the CI workshop, their concerns also centred on their anxiety about getting all students to participate and that the approach might result in unacceptable behaviour in the classroom:

> *Pupils not cooperating. Overcoming lack of confidence in the majority of my pupils as well as the lack of respect for each others' ideas.* (Teacher CIW18)

> *[I'm] worried how it will work with large classes and different topics.* (Teacher CIW8)

However, based on the evidence presented to them by Boaler and the activities they had engaged with, these teachers also commented on the range of benefits of CI group work that they had learnt about, (see figure 4.4), including raising students' confidence, feelings of success and attainment:

> *[I have learnt] How a teacher could raise students' academic and social status using such pedagogy.* (Teacher CIW27)

They commented specifically about the use of group roles to ameliorate status issues between members of the groups and to support productive team work:

> *The need to work together, listen to ideas, evaluate and select the most appropriate form of representation. Selecting the best bits to report on. That the team is as strong as the individual's commitment to the team.* (Teacher CIW19)

> *How to use group work effectively. How to help groups 'work'. Strategies for training groups (raising status, roles, smart, multiple reps).* (Teacher CIW20)

Extrinsic Factors

Reference to the exam system and National Curriculum content coverage

Few references were made specifically to the exam system and National Curriculum content coverage by the teachers at the schools achieving high levels of post-16 participation. However, when mentioned, they tended to reiterate points made in connection with how they group their students and the teaching methods used in order to maximise their examination success:

> *Q: Do you have discussions in maths at all?*
> *A: Yes, I mean it's, to be honest it depends on the amount of time you have. We have these accelerated groups, and you know you have a lot of pressure on you to get them through things.* (Teacher HP2)

> *We have an early entry group, we in fact have two and we try to take GCSE early [...] for those who are, you know, would like to and are capable of achieving an A grade at the end of Year 10 [...] We will take it two years early if we can [....] a group of 30 might actually take the GCSE two years early and are now doing an AS over the next two years when they would normally be doing the GCSE. So you know we are not afraid of just pushing things forward. (Teacher HP18)*

Whilst this was a weak feature of the teacher audience responses to Boaler's findings, the teachers who attended the workshop expressed concern that adopting this approach would take up time needed to cover curriculum content sufficiently well to prepare students for their exams:

> *Mainly regarding assessment, and how often to teach CI group method and when to directly deliver content.* (Teacher CW1)

> *What's the frequency of lessons delivered in this manner? Concerned in case the students take too long to settle into group work thus 'wasting' a proportion of the time.* (Teacher CIW8)

Reference to National Strategy/Ofsted expectations including levels and targets

Few references were made in this category by the teachers at schools with high post-16 participation. Of those made, they were mindful of Ofsted expectations and put an emphasis on assessment:

> *Ofsted very much bears in on value added data; it's really the only criteria.* (Teacher HP1)

> *A standard lesson would be a starter, a main and plenary to be honest. Starter not necessarily linked to the main, I think we are fairly, fairly consistent in that. A lot of teachers will use a lot of past exam questions. We again, we try, we are not perfect at all these things but we are developing our assessment for learning and working quite hard on that. So sharing learning objectives, recapping what you've done, we have level descriptors/grade descriptors in everybody's exercise books.* (Teacher HP14)

There was also the occasional reaction against perceived Ofsted expectations:

> *You can have a method which would be only satisfactory according to Ofsted which is really effective. So, we do have to take things with a little bit of a pinch of salt sometimes.* (Teacher HP13)

> *I think I have got a good department. Ofsted will say: 'Yeah department good but the Head of Department's satisfactory because I was told that I don't push hard enough.* (Teacher HP19)

The teachers who had been exposed to a presentation of Boaler's findings referred to the changes that would be required in their practice that would be contrary to what they had come to regard as expected, such as whole class teaching and differentiating the level of work given to students of differing abilities:

> [In response to introducing more problem solving group work] *the new National Curriculum supports it, the Strategy supports it, but, you've got to get your level 4s up to a 5 and the emphasis is on modelling to achieve this.* (Teacher P10)

One workshop participant commented that the research evidence gave support to their preference for working in this way despite the pressure of government policy:

> *That somebody has been allowed to do something for 20 years without new government forced initiatives getting in the way and therefore having hard evidence that it actually produces improvements*. (Teacher CIW7)

Some of the teachers who attended the workshop expressed concern as to whether all of their students would learn with this approach and at the correct pace:

Will pupils see or understand that learning is taking place? (Teacher CIW14)
Extending the very able. Involving the very low status groups (i.e. lacking basic number skills, counting in 2s, 5s etc). (Teacher CIW11)

Reaction from parents

Student behaviour was not considered an issue by the teachers at the schools achieving high levels of post-16 participation, but, linked to student motivation, it was notable that those teachers who gave parental influences as a reason for success were those that reported working in schools with a high number of Asian students or due to the fact that their school was selective:

> *We do have parents who are keen on maths and especially the children feel that maths is important for their career [.....] It's maybe because it is mainly Asian students that come here and it maybe just that the community values maths as something important [....] I think it's coming, you know, from staff and students and parents partnership.* (Teacher HP16)

> *And obviously the parents have been interested enough to want to get them into a school where they have to pass an exam to do it and therefore by the very nature it means that they are more interested in their children and I think that has a positive impact for us [in the maths department]. (Teacher HP 17)*

This was a weak feature of both the teachers who attended the workshop and those who were exposed to a presentation of Boaler's findings. However, when it was referred to, it was in the context of anxieties about the reaction of parents to mixed ability grouping of the students.

Fear in teachers – non specific

Only teachers who had been exposed directly to a presentation of CI responded to this category and then spoke of concerns about changing their current practice and getting up to speed with a new pedagogy.

4.2 Discussion and conclusion

The findings from the interviews with teachers at secondary schools with high post-16 participation in mathematics and science, suggest that, within these schools, there is a 'dominant cultural script' for teaching mathematics which, in line with recent reports (e.g. Royal Society, 2008, 2010), takes the form of grouping students into sets and using predominately ‘traditional’ or procedural methods, defined as students working individually on differentiated, practice questions following teacher demonstration (Boaler, 2009) and relatively low evidence of ‘progressive’ or process-based approach, defined as students work collaboratively on rich problem solving tasks (Boaler, 2009). There was a strong emphasis on rigorous practice in preparation for examinations student performance in public examinations which these teachers related to the students’ career motivations and parental expectations. These findings lend weight to the reconsideration of contextual factors in the context-process-product paradigm of teacher effectiveness (e.g. Goe et al, 2008), particularly where the outcome is student attainment as measured by, for example, GCSE results.

Additional reasons given for the success of their school, regardless of the student grouping methods and teaching approach, were the qualities of the individual teachers: their subject knowledge, their ability to enthuse the students and their ability to work collaboratively with colleagues. This supports the findings in the Royal Society (2008) report and is also in line with the teacher qualities identified in influential teacher effectiveness reports in England (e.g. Hay McBer, 2000).

I visited four of these schools, observed a sample of lessons across one day and talked to the lead mathematics teacher and a sample of students. These visits largely confirmed the findings from the interviews. However, I also observed two teachers who gave their students activities of an investigative or problem solving nature and, although the students were not working in groups in the Complex Instruction way, the students were actively engaged in mathematical discussion. It was this kind of lesson with this kind of teacher that the students remarked upon as being the most inspiring, contrasting them against what they described as traditional lessons which they said they had mostly experienced.

The feedback of the workshop participants also lends weight to the notion that there is ‘dominant cultural script’ for teaching mathematics in the form of organising students by ability for mathematics and also in terms of the traditional pedagogy they use in the classroom, whatever mode of student grouping is used. This is evidenced by the majority of the workshop participants’ recognition of the need to change their practice if they were to embrace the ideas of Complex Instruction. I argue that what these teachers said they would have to do to change their practice is indicative of what they are not currently doing in their practice.

The feedback from these teachers suggests that many of the teachers felt they had been provided with strong evidence to challenge their current pedagogy. However, in this respect, most of them would have to consider a shift in their pedagogy by planning their lessons to incorporate group work, sourcing rich activities, and changing how they operate within the lesson, including giving more opportunity for their students to discuss and explain mathematical ideas. This evidence supports the findings in the literature that mathematics teachers were rarely found to be investigating open-ended problems with opportunities for students to discuss their ideas, reason and generalise (Ofsted, 2008a).

These teachers also said that they would have to value their students in different ways using a wider range of measures of success, thus challenging the dominant culture of measuring students by attainment tests alone, (Goe et al, 2008). However, in order to do this, and assuming that they were able to manage students' behaviour using this approach, they questioned whether they would have the time to meet these changes without detriment to the coverage of curriculum content and fear of damaging their accountability in terms of examination results and inspection. This exemplifies the tension for teachers between extrinsic and intrinsic factors and the concerns expressed in the literature about the time made available to teachers for professional development (e.g. Day et al, 2006).

In an email follow up of these participants and observational visits to seven of them, only four teachers were using the ideas of Complex Instruction with their students in mixed ability groups with any regularity, and then only with the younger students; those in Year 7 and occasionally Year 8. None of these four was using CI for all of their students' mathematics lessons. Six of the participants reported that they had tried aspects of the approach with students grouped in sets with some success. Thus, a strong resistance to the introduction of an approach like Complex Instruction, with its imperative of mixed ability groups, is the dominant cultural script of setting students for mathematics in England (DfE, 2010).

The teacher responses to Boaler's presentations of the CI approach also lend weight to this picture of a 'dominant cultural script'. These teachers spoke of national norms:

grouping by ability, whole class teaching and differentiating the level of work for students. Against this widely accepted culture of grouping students into sets for mathematics, the presentation raised concerns about whether students of differing mathematical attainment are able to work together in acceptable ways and without detriment to the students and their exam results, particularly those of the highest attaining students. Thus concerns expressed by the policymakers (e.g. DfEE, 1997) were reiterated about stretching the ‘brightest’ students. They also emphasised concerns about behaviour management, a concern often expressed by teachers in relation to group work and given as a reason for its lack of frequency in mathematics lessons in English schools, (Royal Society, 2010).

The findings in this chapter support the existence of a ‘dominant cultural script’ for teaching mathematics in English secondary schools. It is one of ability grouping (sets), ‘traditional’, teacher led, model and practise, pedagogy and a focus on the highest attaining students. Couple this with teachers’ anxieties about unacceptable behaviour in the classroom were they to break from this norm in addition to finding time to plan and resource a different approach and it is not surprising to find that teachers are reluctant to change to the Complex Instruction approach, despite the evidence presented in its favour. There is an irony here in that a major concern expressed by these teachers about using the CI approach; that of unacceptable student behaviour, was found in the long term to be ameliorated by the CI approach, (Boaler & Staples, 2008). However it requires teachers to value students in different ways, which as shown (Dweck, 2000; Adey et al 2004; 2007; Hart et al, 2004, Watson & De Geest 2005) presents a challenge for some teachers.

It would appear that these characteristics of the ‘dominant cultural script’ for teaching mathematics have become internalised by the majority of the mathematics teachers interviewed, they have become intrinsic factors which shape how mathematics is mostly taught. Further, they are sustained by extrinsic factors in the form of teacher accountability through examination and inspection success, thus, macro policy is played out in micro practice, (Evans, 2004). Whilst many of the teachers exposed to the research findings of CI expressed interest in adopting aspects of the approach, the availability of time for professional development and collaboration presented a further resistance.

However, there are teachers of mathematics who do not adhere to this script. As evidenced by the data thus far, there are those who work with students in inspirational ways both with students in sets and in mixed ability groups. There are those who do not group students into ability sets, those who use collaborative group work, those who source and use engaging activities to encourage rich mathematical discussion and engagement. In the next chapter I will explore the findings from interviews with three teachers who appear to have broken the mould of this ‘dominant cultural script’ for teaching mathematics in England.

5 Are the ‘scripts’ of teachers who are willing to trial a previously unfamiliar approach, such as CI, different, and if so, in what ways?

5.1 Introduction

In the context of teaching mathematics to Y7 students, this chapter presents and discusses the findings from the next two datasets (see Table 3.1):

3. The explanations that three teachers who were willing to trial the CI approach gave for their teaching approach.

4. The explanations given by the lead teachers in two contrasting schools for their teaching approach, one trialling a previously unfamiliar approach (CI with mixed ability groups and the other not trialling the approach with set groups.

It responds and leads to some conclusions about the second research question:

> *Are the ‘scripts’ of teachers who are willing to trial a previously unfamiliar approach, such as CI, different, and if so, in what ways?*

5.2 Findings from three teachers willing to trial the CI approach

These findings are presented under the headings of the thematic categories generated from the second level coding analysis of this data set as described in Chapter 3 and summarised in Figure 3.1.

At the time of interviewing, Teacher CI-1 had been teaching for approximately 10 years and had entered the profession as a mature student. The school where she worked had low socio-economic status (SES), (DCSF Tax Deprivation Indicator 2007 = 68.97%), and below average attainment at GCSE, (5 A*-C GCSEs including Maths and English 2007 = 19%).

Teacher CI-2 had been teaching for approximately 16 years and had only been employed as a mathematics teacher. The school where she worked had high SES, (DCSF Tax Deprivation Indicator 2007 = 35.56%), and above average attainment at GCSE, (5 A*-C GCSEs including Maths and English 2007 = 67%).

Teacher CI-3 was a young newly qualified teacher (NQT) and her school also had high SES (DCSF Tax Deprivation Indicator 2007 = 23.64%) and above average attainment at GCSE, (5 A*-C GCSEs including Maths and English 2007 = 62%).

Figures 5.1, 5.2 and 5.3 below show the relative weight of each of these teachers' explanations for their approach to teaching mathematics under each of the thematic categories.

Figure.5.1: Thematic coding of an interview with Teacher CI-1 (Y7 mixed ability with CI group work)

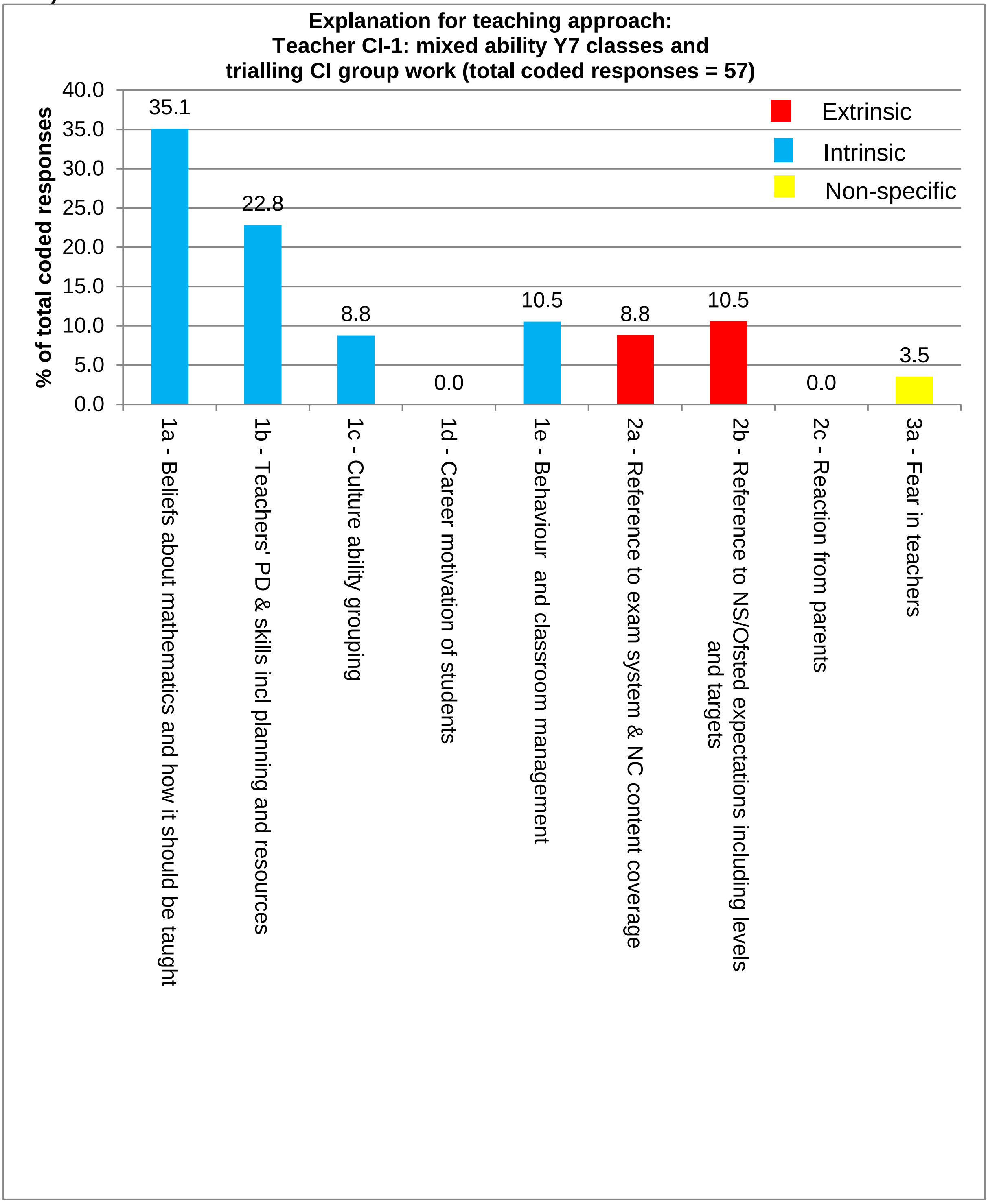


Figure 5.2: Thematic coding of an interview with Teacher CI-2 (Y7 mixed ability with CI group work)

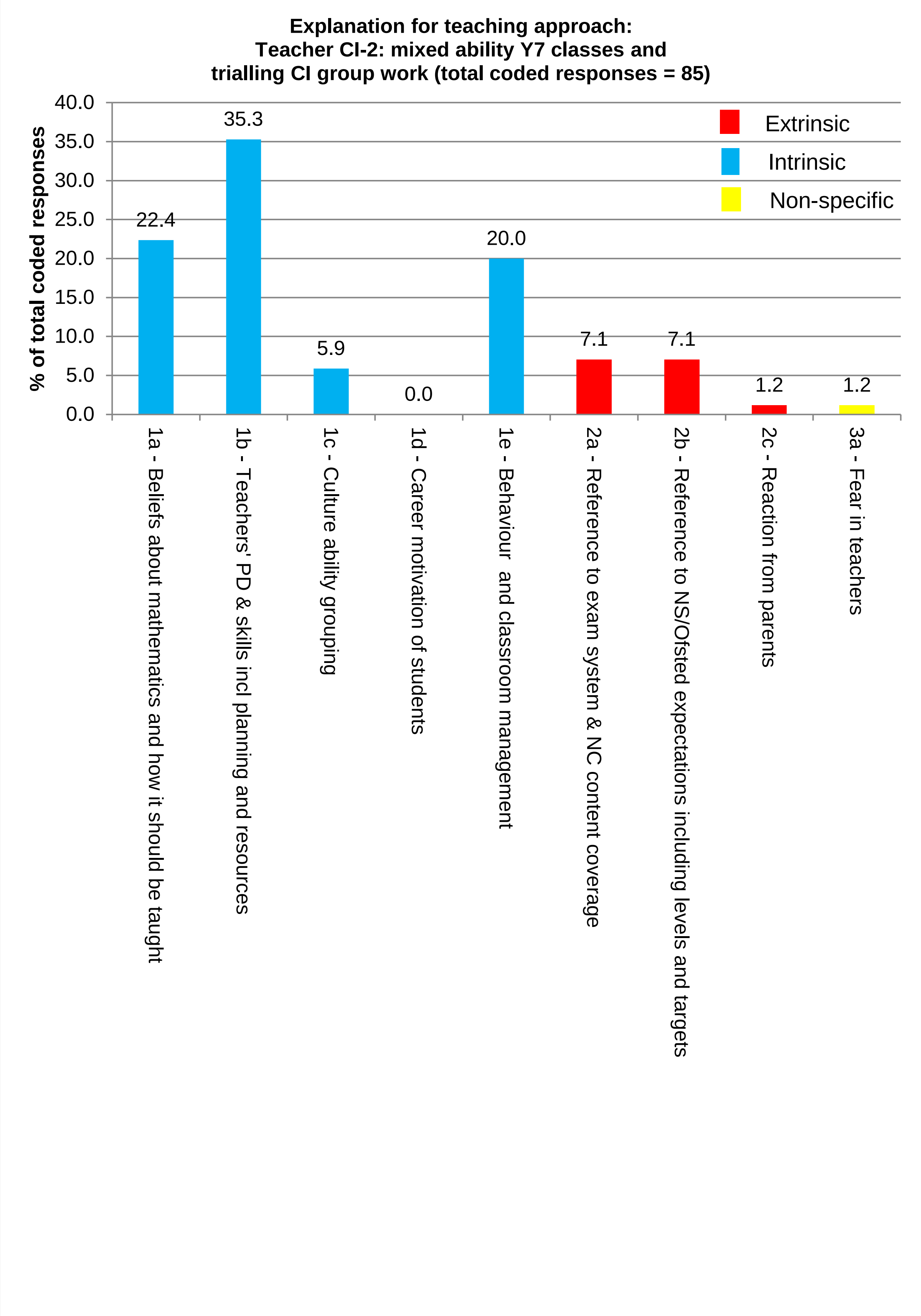
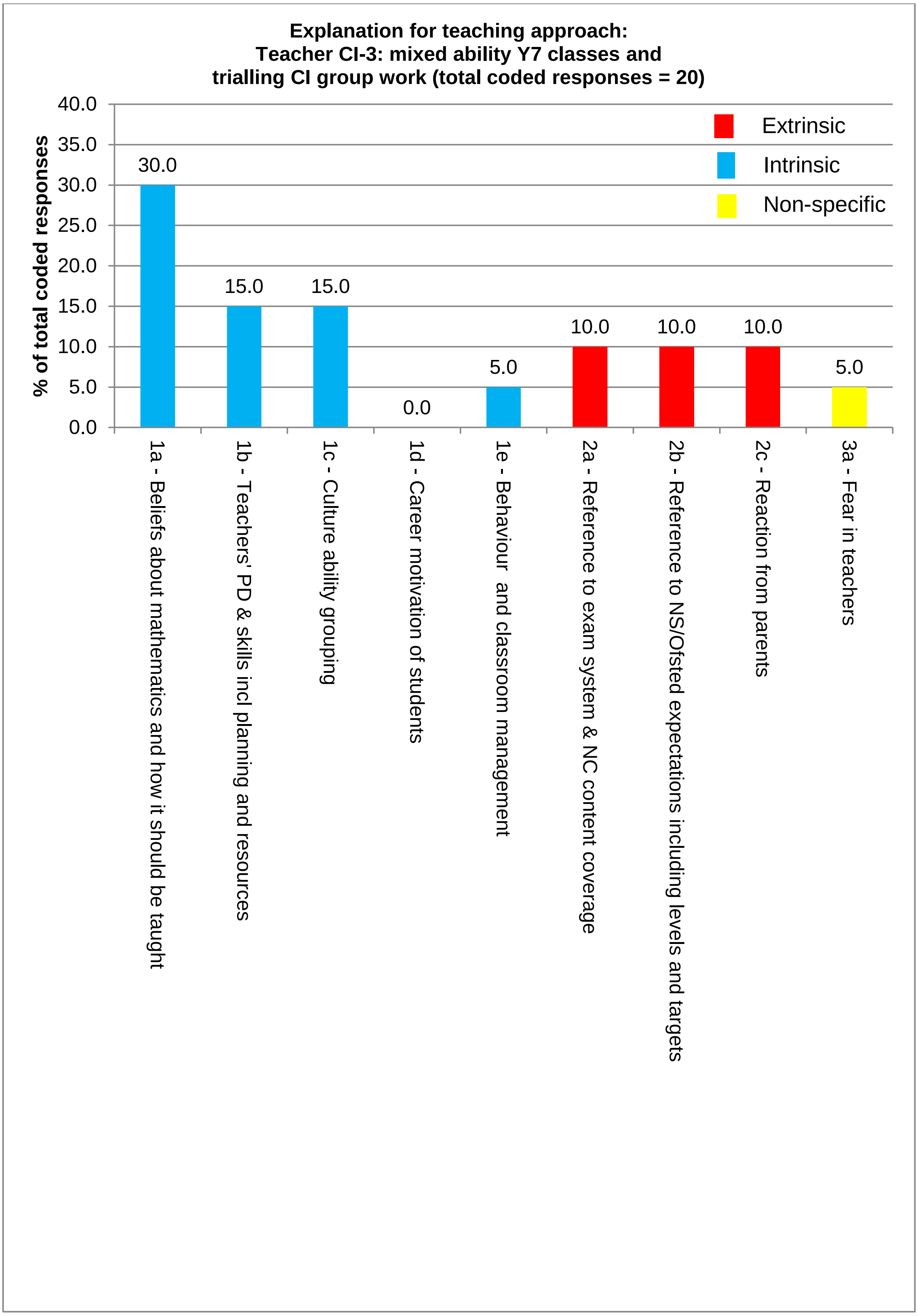


Figure 5.3: Thematic coding of an interview with Teacher CI-3 (Y7 mixed ability with CI group work)



Comparison of figures 5.1, 5.2 and 5.3 shows that in each data set, these teachers' responses in relation to describing their practice are also weighted towards what I have described as intrinsic factors, that is those relating to influences within the teacher and their school environment, 77.2%, 83.6% and 65% respectively. The teacher with most experience, Teacher CI-2 placed most emphasis on these intrinsic factors and the teacher with the least experience, Teacher CI-3 placed the least emphasis on them.

On comparing the categories within these clusters of responses it can be seen that within the intrinsic factors cluster both teacher CI-1 and teacher CI-3 placed most emphasis on 'beliefs about mathematics and how it should be taught', whilst teacher CI-2, placed most emphasis on 'teachers' professional development and skills including planning and resources'. However, teachers CI-1 and CI-2 both placed more emphasis than teacher CI-3 on 'teachers' professional development and skills including planning and resources'. Teacher CI-3 placed more emphasis on 'culture of ability grouping' than either CI-1 or CI-2. Teacher CI-2 placed more emphasis than either of the other two teachers on 'behaviour and classroom management'.

Within the extrinsic factors cluster, 19.3%, 15.4% and 30.0% respectively, the least emphasis was given to these by the most experienced teacher, CI-2 and the most emphasis by the least experienced teacher, CI-3. Most of this greater emphasis of Teacher CI-3 was accounted for by the greater number of references she made to the 'reaction from parents' compared to either of the other two teachers.

The following section presents in detail the teacher's qualitative responses within each of the categories identified in Figure 3.1.

Intrinsic factors

Beliefs about mathematics and how it should be taught

Teacher CI-1 had three lessons per week with each of her two Year 7 classes. In one lesson the students were taught in 'traditional' ways along the lines of the National Strategy three-part lesson with the students practising concepts modelled by the teacher. In the second the students worked individually on the computer using a web-based resource called 'My Maths' to give further practice of the concepts taught. In the third they did group work based on the ideas of Complex Instruction.

This teacher, recently influenced by the work of Carol Dweck, saw children as individuals who learn in their own unique ways. She described herself as 'a lifelong learner' who is open to new ideas, whose judgements on whether or not to stick with new ideas was based on how the students responded. Talking about group work she said:

> *I am enjoying this and I can see that the children are enjoying it as well because if we don't have a group lesson on the day we normally have one planned they ask 'why aren't we having our group lesson today' and you can really see that they're disappointed, they do enjoy it.*

Teacher CI-1 felt that she hadn't really come across theories of learning in any depth until she started her MA in Education and also when she went to a professional development conference featuring Dweck's work. She said that initially she had been more of a traditional teacher because that was what she was taught at University and what she saw on teaching practice, but her experience in the primary school sector had changed her thinking:

> *I thought that teaching was traditional but I think that Primary has also made me, a looser teacher, for want of a better word then just coming straight into secondary school, there is much more freedom, playtime and enjoyment, learning through play, so you see that happen in Primary so I would like to do it again.*

However, she talked about the expectations on her of differentiating work in her 'normal' lessons:

> *What I tend to do in normal lessons now is I pitch at the middle, the lower end gets support because I have got a TA with me and if my top end have finished that then I'll always have something ready for them. [....] Well in the group work I don't really need to differentiate because they do it themselves, it's all done for you really.*

Teacher CI-1 also thought that her experience in primary school had developed her in ways that are different to how she perceived most secondary school teachers; a more holistic view of the child:

> *[..] a lot of secondary school teachers think 'right you're in secondary school now, you sit down and you get on and do' they're coming from such a different environment they're not really used to that at all, [...] I do think that I probably have*

a different attitude, I've definitely got a more pastoral attitude [...] so I'm not necessarily concerned with the learning, although that is very important, I'm concerned with the child and what they're bringing in with them.

Nevertheless, she spoke about how she had changed her practice in all of her lessons since trying out Complex Instruction in her group work lessons:

Because in the Complex Instruction you pull back and you try and make them work it out even if it's a tedious process, now I've got used to that I'm much more prepared to do that in a normal maths lesson, once upon a time it would have been 'no that's not right, let me show you how to do it again, let's have another go' I will say to them now 'well this still isn't correct, what do you have to do to get the right answer here?' and I'll say 'I'll come back in a few minutes and see if you've got it'.

She felt that by using this approach she was better able to assess students' progress because the students were communicating more with her and each other:

It makes life easier for me for assessment purposes because if they're talking about what they're doing I know that they understand.

She thought that this was assisted by her views on classroom atmosphere; she was happy for there to be a certain amount of noise in their group work lessons, provided they were talking about maths. Importantly, she had noticed that students were beginning to help each other more:

I've actually got children saying 'well I'm just helping her do this' and that's never happened before so I think they're getting used to helping each other in group work.

Teacher CI-1 thought that a challenge to working with her Y7 students in non-traditional ways was that the students themselves expected to work in more traditional ways, including working individually:

They still want to work individually and it was reining back on the ones who wanted to work by themselves, one of the young men [name] he just couldn't get the hang of it to start with, he wanted his bit of paper and wanted to answer all the questions and he really wasn't involved. He has learned very much now that he has got to discuss within the group, so that was difficult, just getting them to understand group work.

Teacher CI-2 said that her own history, her own experience of mathematics at school, which was taught very traditionally, formed her opinion of how she wanted to teach it differently:

Well I have always wanted to be a teacher, I wanted to teach when I was at school and I was taught very traditionally and thought it was rubbish, I mean the teaching was very nice but it wasn't inspiring and I would do the work quickly and then muck around because I was bored and I always thought 'I could do better than this'. Maths I find fascinating and nobody else seemed to notice how enjoyable maths was and I think a lot of that is about how it was taught.

Talking about PGCE students who come on teaching practice she had noted how they expect maths to be taught in traditional ways:

They look at what we're doing and say 'Oh my God, you're not doing…write down 20 questions' and all the questions like 'why aren't you writing in their book? Does it matter that you're not doing that?'

She was very much in favour of collaborative planning so that everyone in the department owns the ideas and believes that this is one way, in addition to encouraging teachers to have a go at alternative approaches, of enabling teachers to shift their practice away from more traditional methods.

*The schemes we have aren't prescriptive in how you teach so we are collectively planning activities we want people to try because you're all involved in that, everyone owns it so it's not like 'I've made this thing up and now you've got to teach it like this' we all talk about the activity and create it together***.**

Teacher CI-2 believed in encouraging students to take an active part in all their maths lessons right from the start in Year 7:

And it's including them in the process rather than it happening to them. Having been taught in such a traditional way myself like most of us have been, I was never part of what happened there, it was just something I did because I was told to [...] whereas, I really want my class to be involved with what they're learning. It's their life, it's their learning. If they appreciate what they're doing it'll mean more to them and they'll learn more.

However, she was also conscious of the different starting points of the students that came to her school. Whether it was a product of their home background and/or their primary school experience she was aware that some students had a negative attitude towards learning and it could take a while to overcome that attitude with them:

> *[....] having taught here for so long, you can almost spot which schools the kids have come from by their whole approach to learning. Because we have two or three catchment schools which are very proactive with parents, parents are very involved and it's very much a learning environment. And they come out all very keen and learning is very highly valued. And yet we have a couple of schools where it's not quite like that, the kids don't really want to learn or it's not cool to learn.*

Teacher CI-2 thought it important for children to struggle with challenging problems and to ask good questions of her and their peers in order to become more independent in their mathematics lessons. She believed that her relationship with the students facilitates this approach:

> *And because I have a good relationship with them and they have a laugh and they know I don't mean it in a personal way, I feel confident to do that [....] the whole point is to make them think [.....] I can see them really growing in what they understand.*

Until being introduced to CI and group work by her head of department, Teacher CI-3 thought that all the Y7 students' work should be differentiated at three different levels. Hence, she often felt she was planning three different lessons. She tended to allow the students to choose which level to work at:

> *[E]specially in Year 7 because they are so keen to please, a lot of them, they want to pick the one that is more challenging, yet they try to get to that one even if it means starting with the red one and working really quickly all the way to get more confident whereas perhaps higher up where they are not used to it, they perhaps choose the easier ones so that they have less work to do but definitely lower down they do it because they want to show they can do it.*

Before introducing group work, which she did approximately once every two weeks, she tended to talk more from the front and then spent a lot of time getting their attention. She still taught what she described as their 'formal' lessons where they have to do questions individually. She welcomed the discussion that the group work provoked and was pleasantly surprised by how much they knew:

> [Talking about group work] [....] *I find I'd have half a dozen or ten of them going through and saying 'you can do it like that' and explaining it to other people and all the discussions that go on are incredible because they want to put their points of*

view forward saying 'this is the way I have done it' and it is all that interaction and within that they don't seem to be lacking in confidence.

Teachers' professional development and skills, including planning and resources

Teacher CI-1 thought that teachers needed to be open to new ideas and flexible in their approach. She believed that teachers had to have a particular kind of personality to take on ideas like Complex Instruction:

> *I think some people [....] once we get into our classrooms, that's it. I think they get set in their ways and that is the way forever and ever. I think probably because I haven't been teaching that long in the big scheme of things, just been ten years and maybe not got to the point where I can say 'Right this is how I'm going to do it' I'm still receptive to new things because its more interesting…well I think I'm a lifelong learner, well I know I am and I just like to do new things.*

She thinks the dominance of a more traditional approach to teaching mathematics in secondary schools comes from initial teacher education courses and what happens in most secondary schools:

> [Traditional] *because that is really what you get taught at university and that is what I had seen on my teaching practices.*

Teacher CI-1 thought that teachers needed to be shown how to cater for a wide range of ability in the class:

> *Because I always thought that setting was the way to go especially in maths because then I was just teaching it this level basically with a bit on either side instead of this level from low to high, now it doesn't actually bother me.*

She also thought that teachers need to have professional development which showed them the effect of setting by ability on students' learning. She didn't feel these issues were covered in her own teacher training and thought that that was still the case based upon her experience of working with PGCE students:

> *A couple of years ago I decided to do my MA we were doing theories of learning and intelligence theories and that again was really the first time I did it and that was very interesting.*

Teacher CI-2 also suggested that teachers need to be shown how to ask key questions; how to get the children to explain their thinking and in connection with this, she sometimes questioned her own subject knowledge:

> *Our children don't have good communication skills and that's what the lesson is about really, communicating…but your video clip about America where the teacher kept saying 'How did you get the 10?' that intrigued me, asking a student 'well I got it by collecting them' show me where the 10 is…and I thought God I can't show them where the 10 is, because it's not that easy.*

She thought that teachers needed to think about where they put their energy when planning a lesson; that they should move away from setting worksheets at several levels towards having good questions that the students can engage with at a lot of different levels in order to meet Ofsted requirements of differentiation:

> *My effort goes into questions and how I respond to questions I'm thinking what will they ask me and if they do what am I going to say and so I try to pre-empt, I pre-empt lots of things.*

Teacher CI-1 thought it was important to have good relationships with the students to be able to work in less traditional ways and to understand what she termed 'non-confrontational methods of behaviour management'. She feels her primary school experience has helped her with this and along with her professional development course on CI and the ideas of Dweck she was more inclined to see students as individual learners. In addition she felt that teachers had to learn to give over more responsibility to the students for their learning. However, she talked about the difficulties she had of finding appropriate resources for group work and had begun to drawn upon Cognitive Acceleration through Mathematics Education (CAME) resources with which she was previously unfamiliar.

Teacher CI-2 claimed that the more experienced staff at her school had developed their pedagogy in mathematics very differently to other schools in her area, such as doing group work, getting students to explore and investigate for themselves and find their own way in their methods, not being at all prescriptive and never standing at the board and saying things like 'you must do it like this'. However she has discovered that the younger teachers do it quite differently and in more of what can be described as 'traditional' methods explaining that this is what they have experienced in their training; students grouped in sets and learning from textbooks:

We don't have a scheme that we follow, we don't follow the Strategy, we very much do our own thing and it takes a lot of guts to go 'yes, this is what I want' because it's going to be difficult work.

Her department was dealing with this by introducing more collaborative planning, and reflection on how lessons went. The part they found most difficult was planning for effective group work and that was where CI had helped. New teachers were not forced to try the group work approach, and some were quite reluctant; wanting to stick to teaching rules and procedures. However, she said, they were encouraged to work with others that did group work, claiming that eventually they saw the advantages of it:

He [referring to a new teacher] was soon like 'hmmm that's interesting' and when we're all getting excited and talking about things he can't fail but to be interested and with the new National Curriculum with all the process focus and me saying 'right this is what we've got to do now' he was like 'ok then', he likes the lessons but it is hard and he sees it as more work and he doesn't have the time for that.

Teacher CI-2 perceived herself as a very down to earth person, very hands on, practical and straightforward. When she talked about what she thought her responsibilities were as a teacher she said she was talking about her responsibility to the students. She was inspired to work this way when she got interested in 'Thinking Maths' lessons:

The ethos behind the 'thinking maths' lessons and what they were trying to do fitted in with what I thought was true [...] A lot of my teaching is about listening to students and really trying to see how they see it so I can tailor what I'm saying to fit in with what they understand [....] I see each child as an individual person.

She has a humorous relationship with the students yet describes herself as 'quite a scary teacher':

So when I was walking round I was like 'ask me something' and having checked that they were all ok I wasn't really interested in just sitting and watching them do it so I was stirring it up.

She spends time discussing with the students how to work in groups and reinforces this in their individual lessons:

[Referring to the department 'what it means to be good at maths' poster] *Yes, we talk to the students to tell them about how to introduce the group task and we chat*

> *through what it means and how and why do we think that's more important than just doing sums and then it's up and all the rules are displayed clearly and that's what we value. So it's a little thing that we refer back to when we are reflecting.*

Teacher CI-2 said her best lessons were where students were challenged with interesting problems that gets them excited about maths, but believes that the teaching approach used is 'only as good as the teacher who's working with them'. She thinks you have to be quite confident to teach in the way she does; confident about how you plan the lessons including planning which students you put together:

> *Teaching mixed ability is harder because when teachers teach in a set they generally think that everyone has the same ability in this class so will all do the same work [......] We are aware of the big spread of ability. [.....] All of that is more planning, more work and more preparation time for the teacher so that adds a level of difficulty in their work, once you're in the lesson you've got to organize that as well.*

Acknowledging that her approach was based on very hard work in the beginning and taking a long term view, she said that the payoff was worth it:

> *I have had a couple of classes over the last 3 or 4 years where it has worked beautifully and it is just a joy to see them but that takes a lot of effort getting there. A lot of control aspects, getting them to accept each other and being open and supportive and not judge other students because they can't do it and be tolerant, it's all stressful at the beginning and it takes a lot of effort [....] you have to be thinking ahead all the time of how to help them to help each other knowing that at some point that will become their focus and not yours.*

Further additional hard work and effort on the part of the teacher she said came from the need to develop appropriate teaching materials:

> [...] *but also going back to hard work there isn't text and questions and activities out in the ether for us to use, you end up creating all your own.*

Rich tasks that the department have sourced and developed collaboratively were put on to the department's resource space on the computer network for all members of the department to access, though they were not compelled to use them:

> *And even though that's there, the schemes we have aren't prescriptive in how you teach so we are collectively planning activities we want people to try because you're all involved in that, everyone owns it so it's not like 'I've made this thing up*

and now you've got to teach it like this' we all talk about the activity and create it together.

Teacher CI-2 said that she and her department had spent a lot of time getting to grips with and adapting the ideas of CI, like the roles, to suit their environment. For example they have, in her opinion, anglicised and democratised the CI roles:

We didn't want a team captain so we put the organiser in as that person because we want someone who's going to organize the group but they're not the captain. It's very much a…upper class…

Teacher CI-3 found teaching mixed ability quite hard especially when there was a very wide range of ability in the class. She thought she had had received little training during her initial teacher education in approaches designed to support teaching mixed ability groups, so she tended to mostly teach in what she described as 'formal' ways with differentiated work. She described the challenges of planning differentiated work for her classes:

And in terms of preparation [....] you feel like you are planning three lessons every lesson and you're having to have the resources for all those different levels available.

However, she was finding group work easier and more beneficial as she did more of it, although she also suggested that she thought group work alone was insufficient:

Because I don't have to do so much talking, I don't have to rely on them being quiet so much which they often don't want to do so you have to stand there and fight them to be quiet which is a waste of time and they enjoy it a lot more and they should be enjoying it. They get as much from it because they have to do their homework and they have to do questions and things so they still get the formal bits.

Teacher CI-3 was surprised to find that students who were performing well in her group work lessons reverted to being unable to do the work that she set in what she described as her 'ordinary' lessons:

I suddenly decided that last week, I would have what I called an ordinary lesson because I couldn't think of any activity to make sure they could divide fractions [....] and some actually started saying 'I can't do this miss' and I was actually shocked because I thought they were somewhere up here and really wanting to and able to do anything put in front of them because there have been some very difficult things and all of a sudden they decided they couldn't do it.

She said that finding rich activities for group work presented a problem for the department. Although there were many web-based resources available such as those on NRICH and CRE8ATE, it took much time to select appropriate ones for her classes. So when someone in the department developed a task that they thought worked well they shared it and they were also beginning to design their scheme of work around rich tasks that they had sourced and trialled:

> *What we do is try to share things that have worked really well in our development session [....] quite a few of the things that I've done from the NRICH website I've explained it…so I think it's much better when someone shows you, I found this, it works and this is what it covers and you're going through the lists and lists and you think 'I can't make head or tail of this' but there are some fantastic things.*

Culture of ability grouping

Teacher CI-1 taught in a relatively small mathematics department (3 classes in Y7) that had mixed ability groups in Years 7, and 8 and sets in Years 9, 10 and 11.

She explained her feelings about mixed ability teaching which had changed over the years. She used to think that setting, especially in mathematics, was the right way because it enabled her to prepare and teach within a narrower range of ability. She acknowledged that she found mixed ability teaching hard work initially:

> [....] *when I first started teaching Maths I hated this mixed ability because it was such a stretch on me to have to design a lesson where I was hitting all the level 2s up to the level 6s and I had extension work if they finished, it was a lot of work [....] A few years ago the (Ofsted) inspector actually said 'I don't know how you do this on a day in day out basis'.*

However, influenced by the beliefs of her head teacher, whose background is in SEN, having attended the CI workshop and having been to a professional development course which, drawing upon the research of Carol Dweck and John Hattie, presented the factors which most affected student learning, she had became more enthusiastic about it:

> *Our head has always insisted and she is a big believer in mixed ability for Key Stage 3 and definitely with Year 7 and 8 [....] and I've done some work around Carol Dweck because she says the same sort of things basically [...] and some*

research that John Hattie had done as well, [....] it said 'the influence of learning in a classroom' and everyone put their ability setting at the top and things like that and ability setting was actually at the bottom, it wasn't making the impact that people think it did so the reasons why our head talks about it is because it's negative isn't it?

Although Teacher CI-1 gave a rationale for supporting mixed ability teaching in mathematics for Key Stage 3 students, based largely on issues of equity in terms of labelling and holding back low attaining students, she was happy to accept that Key Stage 4 students (Years 10 and 11) should be in sets for maths:

In upper school setting is…well I think you need to when you teach a GCSE from foundation to A it would be impossible in one class but I definitely think in Key Stage 3.*

Teacher CI-2 explained the system of grouping for mathematics at her school. In Year 7 the groups were fully mixed ability. Whilst they do not set as such in years 8 and 9, they do have banding with four groups. Two of the groups have the higher level students, levels 6-8, and two having the lower levels up to level 7 to avoid having the most and least able in the same class:

We don't feel that the students are mature enough to deal with students who find it very difficult. [....] I think its during Year 8 that you start to get kids struggling with that and getting intolerant because they're faster and the other kids are struggling which is why we do the top half and the bottom half just to avoid that situation really [...] they're quite aware of their abilities and they say 'oh I don't want to sit next to them, they can't do it'

In Key Stage 4, the six groups are split three and three where each group of three has two classes working on the higher tier and one group working on the foundation tier for their GCSE.

The rationale for having more mixed ability groups for maths began at the school in the late 1990s when they noticed that the students made most progress when they worked in mixed ability groups for 'Thinking Maths' lessons and from being concerned about behaviour in some of the set groups when they had their 'regular' maths lessons:

We started to challenge our thoughts about setting and we never were particularly happy with it because you always get a group which is really troublesome in terms of behaviour and from that point of view setting always causes that, that lower end *drag and we're trying to avoid that so we started mixing up our groups to avoid that and really for our sanity more than anything.*

Whilst Teacher CI-2 did have concerns about students of a very wide range of ability working together, she was happy with how her fully mixed ability Year 7 groups were progressing and explained this in terms of the methods and resources used:

All the fears everyone had about it, it's been fine because the kids have coped, and the weakest kids have coped which is obviously our main worry. And partly because of the way we work the sort of extensions and the thinking stuff, the kids at the top end don't seem to have suffered at all, they don't seem to have missed out, they don't moan about things being too easy. [...] I think that's really helped the other teachers to come on board. Those who were perhaps a little sceptical about the groupings to thinking, well actually this will be ok to do.

Teacher CI-3 explained that only Year 7 students were completely mixed ability for maths at her school. Remaining years in Key Stage 3 are split into higher and core halves with a top set in the higher half. The maths department moved towards more mixed ability grouping because the Head of Mathematics had noticed, during a period of staff shortage when she sometimes ended up with the groups of students in her class from different maths sets, that they worked well together; supporting each other and with previously ambivalent students joining in more. She said that going more mixed ability, which is her preference and aim, was restricted by requirements of other subjects and timetabling limitations. Hence the middle groups were 'mixed ability' with the highest and lowest attaining students separated out:

So rather than have the six groups on the high side go 1, 2, 3, 4, 5, 6 we've still got the top set...I'm not sure about the wisdom of that, I perhaps would like to discuss that with you but underneath that the others are all completely mixed up and then the core groups at the bottom are sort of mixed but they're ability doesn't vary that much.

In Key Stage 4, they have the higher side and the core side as well but because this is dictated by other subjects, children are not necessarily placed in groups according to their mathematical attainment so, as Teacher CI-3 claims, they are more mixed ability than if they were set for maths only:

We have children that if you were going to split them up according to their maths results they would have been on the opposite side to the side they are in so to a certain extent there is proper mixed ability in 10 and11 because the kids that *would have been down there are actually in mixed higher groups so in a higher group you can have anything from an A* to D really.*

Teacher CI-3 referred to some of the difficulties that some students, and their parents, had with the move to more mixed ability groups:

> [Referring to a complaint about the grouping policy] *there is quite a lot of arrogance coming into it and I don't just mean the students but the parents as well. If we took that group and put the label 'Set 1' on it they would be happy without changing the children [Instead] They've just got numbers that go down and the teachers initials.*

Behaviour and classroom management

Describing herself as a 'firm but fair' teacher, Teacher CI-1 didn't think that issues of behaviour management were necessarily related to working in mixed ability or set groups and she based this on her experience of more challenging behaviour from a few students in high set groups in Year 9. She didn't agree that behaviour management was a reason for setting children. She thought that behaviour management was about how you respond to children and the kind of work that you give to them. Hence, for her, the challenge was to create a positive atmosphere in her classroom and throughout the school. She thought that using the roles in group work with her Year 7 classes enabled the students to work with her to achieve what she described as acceptable behaviour in the classroom:

> *Yes it is a bit noisier [in group work] than other lessons but I just have to say 'team captains can you sort your teams out?' and then the team captains will tell them to be quiet so that works really well.*

Teacher CI-1 described the difference between the noise level in her group work lessons and that in her 'normal' or 'ordinary' lessons and how the 'noise' was beginning to take the form of constructive discussion with students helping each other:

> *I don't particularly like a quiet classroom I'm quite happy for them to have a certain amount of noise level than an ordinary maths lesson as long as they're talking about maths [...] I've actually got children saying 'well I'm just helping her do this' and that's never happened before so I think they're getting used to helping each other in group work*

She was, however, reluctant to use the CI approach with older students, suggestive of an anxiety about the likelihood of adapting older students' behaviour:

I thought trying to instil it when they're in Year 10 might be a waste of time, what I am thinking now is, are the year 7's and 8's going to go through the school with this group work and probably be able to do it right the way through?

Describing herself as 'quite a scary' teacher, Teacher CI-2 had a dominating, controlling presence coupled with a sharp sense of humour. She is very clear about her expectations from the students in terms of their behaviour. She thought that dealing with behaviour in the classroom was a reason for having mixed ability groups; it avoided the troublesome behaviour that, in her experience, most often occurred in the lower sets.

However, she only has completely mixed ability groups in Year 7. Due to anticipated concerns about the behaviour of older Key Stage 3 students, she had reservations about putting the highest and lowest attaining students together:

Year 8 and Year 9, they're all organised so the most and least able are not in the same class, [...] we don't feel that the students are mature enough to deal with students who find it very difficult.

She suggested that some children found it difficult to work with each other within the mixed ability classes and, although the group work roles helped, it took time to establish good team work behaviour through constant reinforcement:

[...] *but actually in class some kids don't work well together and we're struggling to get those social links going with the group and [CI] has given us that structure to do that. The kids work well with the roles…some of them…there are hard bits like the inclusion person ends up the kid that doesn't want to take any part of anything and they generally don't include them and everyone gets on with it so we have found problems with it and we have tweaked the roles for certain activities.*

She thought that having mixed ability groups afforded the opportunity to spread out more challenging students between the groups:

We all have badly behaved children but its spread out more [....] in Year 7 its across four classes so that you can really isolate the difficult children and you can work on that in Year 7 to improve it. Year 8 and 9 you've got two groups which have some of those elements in and you've already spent time working with them in an environment of learning where everyone else wants to learn so their resistance is less and its easier.

However, she stated that putting students in mixed ability groups was not on its own sufficient and had to be coupled with engaging activities:

> [...] *The younger teachers do find it difficult and some of the kids are very challenging but I've always said to them 'well if you plan these engaging activities, they won't challenge you because they want to do it whereas if you're trying to make them write stuff in their book, in a formal way and it's got to be quiet, they will challenge you more because they don't want to do it because it's boring.*

Teacher CI-2 described how establishing good working relationships with and between students can take a long time and much effort on the part of the teacher and is, in part, contingent on groups staying together with the same teacher for all of Key Stage 3:

> *Years 8 and 9 you have the same class, they stay together so by the end of year 9 you have these groups of children who automatically work together and support each other and its lovely to watch, they don't need you anymore they're now independent learners and when that works, [....] it is just a joy to see them but that takes a lot of effort getting there. A lot of control aspects, getting them to accept each other and being open and supportive and not judge other students because they can't do it and be tolerate, it's all stressful at the beginning and it takes a lot of effort.*

Teacher CI-3, a relatively inexperienced teacher, thought that most of the bad behaviour had previously come from the lowest attaining students and putting students into sets exacerbated it. In a more mixed ability environment she felt that behaviour had improved and with students being more supportive of each other, students had a more positive 'can do' attitude towards maths:

> *I think when they are in a setted situation there was a few things going on, it tends to be the less able ones showed the worst behaviour so of course you push them all together and it magnified that as they all feed off each other don't they? I think it is the label to be honest, a lot of it is labelling and they felt like failures.*

Extrinsic factors

Reference to exam system and National Curriculum content coverage

Teacher CI-1, working at a school with low GCSE performance, was keen to improve upon these results and within the maths department they were looking at strategies to improve GCSE results including early entry. On the basis of her analysis of recent Year 7 test results, she felt confident that using the CI approach was not holding back the high attaining students, but had no evidence for improvement in her lower attaining students:

It's not holding my better ones back because they obviously get involved to a higher degree in the discussion, I mean they've just sat another test and I marked it and put their scores in yesterday and missing out one traditional lesson a week has not held them back at all, they're still improving. The lower end, I haven't seen a great shift yet but we haven't been doing it for very long.

She felt that an increase in mathematical discussion via the CI approach had enabled her to make better on-going assessment of her students understanding of mathematics compared to her 'normal' lessons:

They're talking about what they're doing now and I think that's better because they're more used to talking in ordinary lessons when I go round they're quite happy to communicate and they talk to each other.

Teacher CI-2 said that she personally placed other learning objectives over GCSE results:

I may be wrong and they probably think that I'm wrong and that I've got it completely out of order and it should all be about segmenting and putting them into little boxes but I see each child as an individual person, if we can set them off in the world so that they have the skills to learn for themselves then it doesn't matter how we do it as long as they are able to move forward and use it......we don't teach for the test.

Nevertheless, she was very aware of being accountable and the expectations of her to assess students and ensure that they are prepared for examinations. Hence she continued to assess students in conventional ways through marking of exercise books, end of module tests and National Curriculum test papers. She assigns National Curriculum levels to students accordingly. By having such evidence, she felt confident about using her methods:

We need to assess them and give information on particular strengths in maths content. Yes when they do this [Complex Instruction] because people would be against us and be saying 'well you can't do this….they are still assessed at GCSE, I feel we have a commitment to them to make sure they can cover the content [....] if you're going to make me accountable for it I want evidence to back up what I did because when you complain about me I want to be able to say 'no actually, we're doing our job we know what we're doing'… I've done that because what they want is by levels and so I've organised it by level.

However, she was keen to broaden assessment criteria and wanted to see how Complex Instruction could fit in with the changes to the National Curriculum in relation to a broader assessment of students' skills:

> *If you take the new national curriculum at its word where you actually see it and do it and use it as you want, because all the process aspects of maths are in there and are in the APP statements then that should be included...so we're just going to look at our whole Year 7 curriculum and say 'well what are we doing' and part of that will be 'which functional skills and process targets can we actually see in this first half term, how can we assess some of the skills of that rather than the content and build that into our process?'*

Nevertheless, rigorous exam practice was still part of her department's repertoire:

> *Part of it is me, trying to train them, especially for their exams, I mean the Year 11s are just into their exams and every time we've had revision, we've had revision to death since January.*

Teacher CI-3 believes that the broader grade range of the Maths GCSE higher paper has been a strong motivator for their improved results. They now put all their students in for the higher paper and that has improved morale:

> *As long as you can teach them and let them understand that they haven't got to get 100% in that paper, that they probably will only be able to do the first few questions on it and it doesn't freak them out they actually do a lot better on it, silly really…*

She worries that there is a tension between using the CI approach and her students covering sufficient content as well as being able to do the style of questions found on exam papers:

> *Yes that is a big worry. Because they have got to be able to do those style questions and sometimes there is ways of doing that in the groups still but occasionally I feel that I need one lesson every now and again where they just do worksheets or doing something as a whole groups instead of individual groups and just making sure that they are all there [....] it was my fear that 'Oh God, I haven't ticked this box' I have ticked loads of other boxes and gone off on a tangent but I hadn't done what I was supposed to be doing which panicked me.*

Although she had discovered that teaching her Year 7 classes using the CI group work approach with rich tasks was far more motivating, she was concerned that if she only taught in this way she would not meet the expectations of her in the time allowed. Hence, she was drawn towards teaching content before giving students a problem solving group activity:

Part of it as well is that it takes longer, if your teaching them a new concept then they are going to discover themselves through an activity much better but then you spend twice as long because they deduce by finding it, they consolidate it themselves and so it takes a lot longer than presenting it saying 'right, these are our results' taking them through it and even with interactive examples, one lesson doing that and then having a rich activity to consolidate is a lot quicker and you can keep up with the scheme of work…

References to National Strategy/Ofsted expectations, including levels and targets

Whilst Teacher CI-1 welcomed the removal of the KS3 National Curriculum test in terms of taking the pressure off students to perform in examinations, she was concerned about evidencing students' attainment according to Strategy guidelines:

If they have written the learning objectives into their book which they do in normal lessons and I highlight those, they know that they've achieved them, and there could be no evidence of any work. There is just the learning objective, which I've highlighted because they've either done a worksheet or we've done a game or something but how do I evidence that?

Anxiety about Ofsted expectations has led this teacher to adapt her work with the students using the CI approach and one of her three lessons is taught along Strategy guidelines on the three part lesson:

What's happening now, myself and my TA who is kind of trained to this as well and if we go round and have a dialogue in a lesson we tap the pupils' pages they're working on in the book and ask them to write a little sentence underneath to what we've talked about so its evidence for Ofsted or evidence for whatever.

She stated that if she had an Ofsted inspection she probably wouldn't do group work with her classes on the basis that she was unsure of how she could convince the inspectors of evidence of student learning, based upon a recent experience of a visit by a local authority inspector:

We had a maths inspector in the other day [....] he saw a group work lesson and although he said he thought it was brilliant, he said 'I'm not sure about the learning'. Well I don't understand how he didn't see the learning because they were all talking about what they were doing and learning so we had a chat about it but we can't change their minds [....] they all did have a worksheet, so they all had *something that they were writing on because it was bearings [...] so they all had to get their protractors out and they all had to measure so I couldn't understand why he said he couldn't see the learning but you can't argue with them so I just let it go.*

Teacher CI-2 talked about the kind of lesson she thought most teachers of mathematics adhered to based on what she had observed as a consultant teacher and how it conformed to the National Strategy guidelines of a three-part lesson:

[...] *everyone in the UK now has an expectation of three-part lessons I think…So people's idea is, you start with some activity, and then you do the main activity, which may be unrelated to the first activity, and then you do something else at the end which may also be unrelated to everything. And that's what I've seen as a consultant, [...] the good teachers go 'well today we're going to use fractions so we'll have an introduction with fractions in it and then at the end we'll have a few extra questions that sort of apply what we're doing' so that's the 'good' lesson.*

She explains how her idea of a 'good' lesson differs to this:

It's that we talk about what we're doing and why. And we talk at the end about why we did it and what we learnt and all that reflection.

Teacher CI-2 illustrated the pressure she and her department were under to meet National Strategy guidelines with regard to assessment of students. She felt that the pressure on her department was even greater because she has to justify her different approach:

[Teacher name] *and I were looking at all the APP stuff coming from the Strategy [....] I understand that we have to be accountable, [...] we'll need to take some steps towards showing that we're covering our assessment criteria because someone is going to come and look and ask [...] and so we spend a lot of time doing paperwork because of our approach to show that we are conforming to what they want in some way.*

She stated that, of necessity but with some reluctance, assessment of the students must be converted into NC levels:

A test we've written…this is linked to the APP system now so that we can look at which APP systems it relates to and from that we give them a percentage, because we don't want to pin-point because we test across many different levels, we don't just test level 3 and then stop, we do loads of different stuff, so we say 'well on this assessment you got 100% level 3, this much on Level 4' and then from that because we have to we say 'you're about 5b' because we have to do *that [....] For our profiles and reports to parents we are told to give a specific level which we don't agree with...*

Teacher CI-3 explained how, whilst she had discovered that she would much rather teach through rich activities using the ideas of Complex Instruction, finding it far more motivating, she still felt anxious that she hadn't met the national expectations:

It is all about those, making sure they have fulfilled all the objectives they should have done, now over a year I could probably use rich activities to get everything done anyway but of course we've got to use our APP to do some sort of summative work as well, we got to be able to compare the groups, so we need to have decided and covered very similar things otherwise they are not going to be able to do them.

Fear in teachers - non-specific

Each of these teachers expressed in non-specific ways concerns about changing their practice indicative of there being a risk involved which may be to the detriment of their current performance:

[Referring to teachers' concerns about the demands of the CI approach] *How can you mix all these things together?* (Teacher CI-2)

[Describing her feelings when teaching using the CI approach] *Oh God, I haven't ticked this box. I've ticked loads of others.* (Teacher CI-3)

5.3 Findings from lead mathematics teacher at two contrasting schools

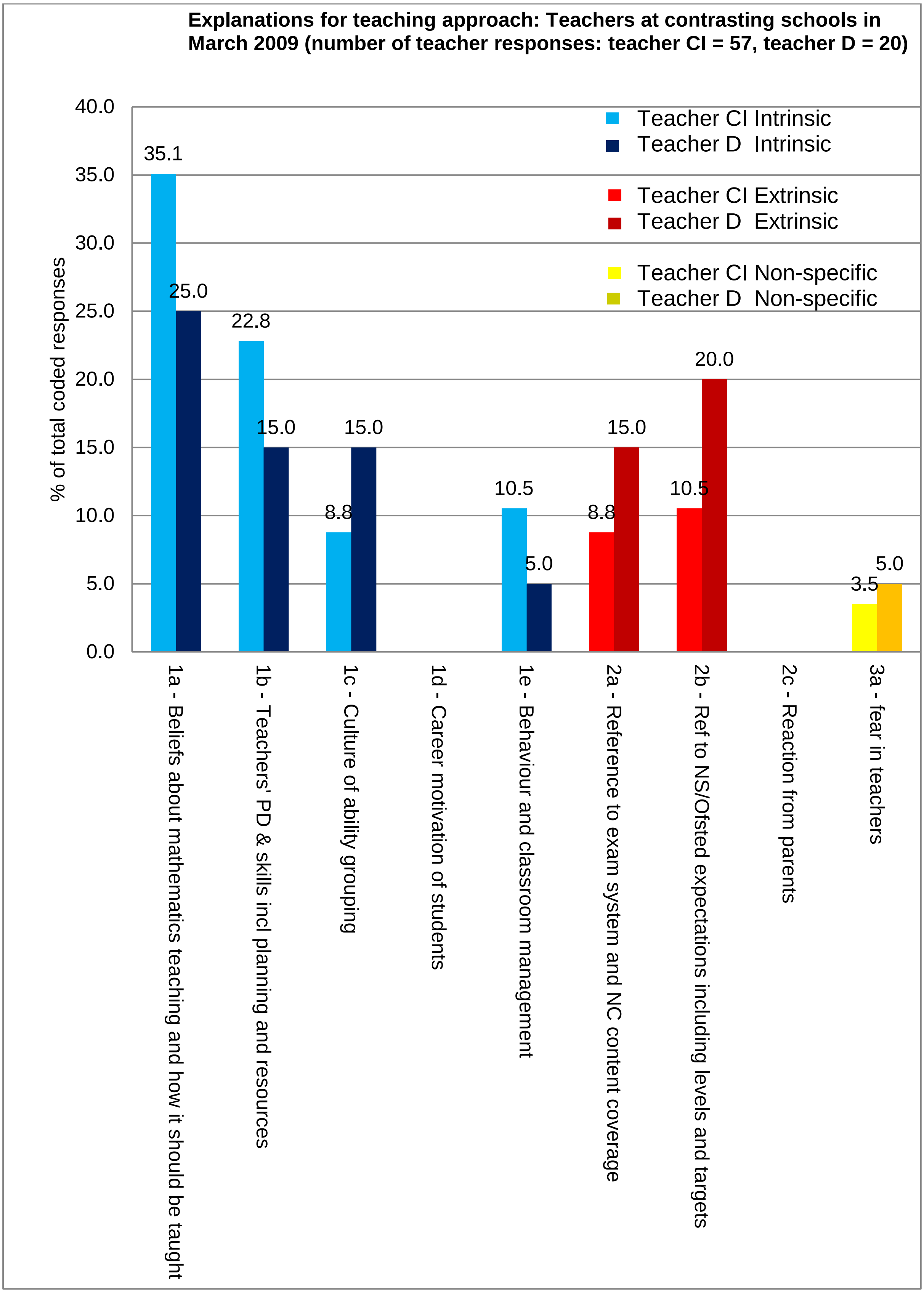
At the time of selecting the teachers for this study, Teacher D taught in a mathematics department at School D1 where the students within each year group were taught in ability groups (sets). Year 7 was divided into six sets and Teacher D taught set 3. She had no experience of Complex Instruction. Teacher CI taught in a mathematics department at School D2 where students were in mixed ability groups in Year 7 and 8 and in sets thereafter. Teacher CI taught two of the three Y7 mixed ability groups. She had attended a workshop on Complex Instruction in June 2008 and had subsequently begun to implement the pedagogy in one of the three lessons per week with her Y7 students.

Both of them worked in schools that had, at the time of selection, below average GCSE results (bases on 5 A*-C GCSE, including mathematics and English: D1=31%, D2=19%), a high percentage of low SES students (based on the DCSF tax credit indicator: D1= 61%, D2=69%) and had been given grade 3 (satisfactory) for overall effectiveness in their last Ofsted inspection. School D1 and D2 are in the same local authority in England.

At the time of interviewing, Teacher D at school D1 had been teaching for 6 years and had only been a school teacher. Teacher CI at school D2 had been a teacher for 10 years and had entered the profession as a mature student. Both had had experience in the primary school sector before becoming teachers of mathematics in the secondary phase of education.

The second level open coded analysis of these teachers' responses (see figure 6.1) divided into the categories as previously defined in figure 3.1, shows the different emphases of each of the teachers:

Figure 6.1: Interviews with two teachers at contrasting schools



N.B. Teacher CI in this section is Teacher CI-1 in the previous section, therefore, to save repetition, but for the purpose of comparison with Teacher D, I will only summarise her responses under each of the category headings and not include supporting quotations.

Intrinsic factors

Pedagogical factors that I have defined as being intrinsic to the teacher's school and classroom accounted for 77.2% of Teacher CI's total coded references, (mixed ability/CI) compared to 60% of Teacher D's total coded references (sets/no CI).

Beliefs about mathematics and how it should be taught

Teacher CI has three lessons per week with each of her Year 7 classes. In one lesson the students are taught along the lines of the National Strategy three-part lesson where the students are given differentiated work, according to their prior attainment, in the main part of the lesson to practice the concepts modelled by the teacher. In the second, the students work individually on the computer using a web-based resource called 'My Maths' to give further practice of concepts taught. In the third they do group work based on the ideas of Complex Instruction.

This teacher, recently influenced by the work of Dweck, saw children as individuals who learn in their own unique ways. She felt that she didn't really come across theories of learning in any depth until she started her MA and also when she went to a conference featuring the work of Dweck. She describes herself as 'a lifelong learner' who is open to new ideas, whose judgement on whether or not to stick with new ideas was based on how the students responded. She was enjoying group work, and, based on her students' disappointment if they didn't have their group work lesson; she thought that the students were enjoying doing group work too. She said that initially she had been more of a traditional teacher because that was what she was taught at university and saw on teaching practice but her experience in the primary school sector she thought had contributed to her more flexible approach.

Nevertheless, she continued to teach one of the three lessons, which she referred to as the 'normal' lesson, in more traditional ways, and talked about the expectations on her of providing differentiated work in these lessons for students of different attainment. She contrasted this with her group work lessons where she didn't feel the need to do this. She thought that she had changed her practice in all of her lessons since trying out Complex Instruction group work lessons and was now more likely to encourage her students to wrestle with difficulties they were experiencing in their mathematics rather than quickly show them how to do it.

She didn't think that working with the CI approach had, in her opinion, been to the detriment of any of her students, but with a notable improvement in the higher attaining students' test scores. Furthermore, she felt that, using this approach, she was better able to assess students' progress because the students were communicating more with her and each other. She thought that this was assisted by her views on classroom atmosphere where she was accepting of a certain level of noise providing it was as a result of students discussing the work and helping each other. In this regard, she thought that students were getting used to helping each other in ways that hadn't happened before, although this wasn't without difficulty. She thought that a challenge to working with her Y7 students in non-traditional ways was that the students themselves expected to work in more traditional ways, including working individually on work set by the teacher.

Teacher D had trained as a middle years' teacher (Key Stage 2-3) and although she taught mixed ability classes of primary school children she had grouped them by attainment on different tables within the class for mathematics, given the students on each table different learning objectives and saw this as the accepted norm. She was, therefore, comfortable with grouping students into sets at secondary school:

> *So there's still an element of setting within the primary schools on different table groups as well and I think they generally set them different objectives, like this table should be able to do this calculation and this group should be able to do that calculation so it's like still formally there.*

Her rationale for setting her Year 7 students into ability groups was that it helped her to differentiate the work appropriately to the level of the students in the class. Within the set class, her students tended to sit with each other on the basis of their ability and she was content with this. Acknowledging that, although set, there was quite a wide range of ability in her Year 7 class, she added that sometimes she encouraged students to do different work to others in the group. It is interesting to also note how she infantilises the lowest attaining students in this class:

> *Like yesterday when we were doing percentages the ones at the back were going 'oh yeah' and the little ones at the front don't know how to make eighty, they've got all the things in front of them but they couldn't connect it together [....] If things get really tough for them I tend to give them, not in front of everybody, I write in their books, try these ones first.*

She organised master classes for students with level 5 mathematics, (above the expected national average of level 4 at that age), from the local primary feeder schools where, she said, 'we do more practical work'.

She believed that one of the reasons that students found maths boring and irrelevant was that they didn't feel it related to 'real life', so she was trying to introduce more lessons that addressed that point, once every half term:

> *We're just starting to build it up, I'd say, the aim is once every half term, whether we're being as good as that, 'cos there's time constraints and sometimes you tend to rush things, the aim is once every half term and then build it up after.*

Professional development and skills required of the teachers, including planning and resources

Teacher CI thought that teachers needed to be open to new ideas and flexible in their approach. She thought that teachers had to have a particular kind of personality to take on ideas like Complex Instruction and that, unlike some teachers, she hadn't been teaching long enough to become set in her ways. She thought that the dominance of a more traditional approach to teaching mathematics in secondary schools came from initial teacher education courses and what happens in most secondary schools that you see on teaching practice. She suggested that secondary schools could learn from her experience of practice in the primary sector, based on more freedom, play and enjoyment.

She thought that teachers needed to have professional development which showed them the effect of setting by ability on students' learning and teachers needed to be shown how to cater for a wide range of ability in the class to get them away from thinking that teaching maths is only manageable through setting. She didn't feel these issues were covered in her own teacher training and thought that was still the case based upon her experience of mentoring PGCE students. She also suggested that teachers need to be shown how to ask key questions; how to get the children to explain their thinking and in connection with this, she sometimes questioned her own subject knowledge. She thought that teachers needed to think about where they put their energy when planning a lesson; that they should move away from setting worksheets at several levels towards having good questions that the students can engage with at a lot of different levels in order to meet Ofsted requirements of differentiation.

She thought it was important to have good relationships with the students to be able to work in less traditional ways and to understand what she termed 'non-confrontational methods of behaviour management'. She feels that again her primary school experience has helped with this and along with her professional development course on Dweck she was more inclined to see students as individual learners. In addition, she felt that teachers had to learn to give over more responsibility to the students for their learning.

She talked about the difficulties she had of finding appropriate resources for group work and had begun to draw upon the Cognitive Acceleration in Mathematics Education (CAME) resources, with which she was not previously familiar.

Essentially, as Teacher D explained, the department at her school followed government guidelines, with her colleagues stating that there was no time to develop other approaches because of behaviour issues and suggesting that schools that do otherwise must be very well resourced. Nevertheless, Teacher D was keen to further her professional development and had recently attended a course for gifted and talented students and at the local maths network meeting had heard about different ways of grouping students and getting students into roles.

She has recently introduced an idea to try and get her class to work with students with whom they would not normally work and to encourage more group work about which she was quite anxious:

I think that in maths we have this worry that in group work it's not going to go right. I've put it on my development that I want to do group work. That's my personal development and then I will disseminate it to the rest of the department.

Talking about professional development within the department and access to resources, she said that she was working with colleagues to develop a scheme of work that incorporated richer mathematical tasks:

Since I have taken over we have got a scheme of work in place and then with that we are now looking at our rich tasks and units and trying to bring those in and my second in department he is trying to work with a group of teachers…across the county who have all been teaching 3 or 4 years and they meet up once a term and discuss different ideas they've had and they create resources and from that we get the resources that the county have created and we get that dispersed amongst us.

A culture of ability grouping for mathematics

Teacher CI taught in a relatively small mathematics department, (only 3 classes in Y7), that had mixed ability groups in Years 7 and 8 and set groups in Years 9, 10 and 11. She explained her feelings about mixed ability teaching which had changed over the years. She used to think that setting, especially in mathematics, was the right way because it enabled her to prepare and teach within a narrower range of ability. Though she acknowledged that she found mixed ability teaching hard work initially, influenced by the beliefs of her head teacher whose background is in SEN, having attended the CI workshop and having been to a professional development course on the ideas of Dweck (2000) and Hattie (2003), she had became more enthusiastic about it.

Although Teacher CI gave a rationale for supporting mixed ability teaching in mathematics for Key Stage 3 students, based largely on issues of equity relating to the labelling and holding back low attaining students, she was happy to accept that Key Stage 4 students (Years 10 and 11) should be in sets for maths.

Teacher D taught in a school where students were placed in ability sets for mathematics from the outset in Year 7 and throughout the year groups. She explained that previously the Year 7 classes had been placed into two bands according to their KS2 National Curriculum test results with sets 1-3 in both bands, where set 1 would be the top, 2 would be the middle and 3 would be the lower group in each. Now they set into 6 classes according to Cognitive Ability Tests (CATs) taken by all the students prior to starting Year 7, with two parallel top groups, three set middle groups and then the SEN group adding that:

> *The range of levels is quite wide [within each group]. Unfortunately with this system the grouping is quite rigid and it's not so easy to move them.*

She shared her thoughts about setting. Apart from some leeway in her thinking about Year 7, where she thought a settling in period might be advantageous; she conformed to her school's policy of setting for maths:

> *I do agree with it in a subject like maths – especially like with my Year 9s, 10s and 11s when they're entering different tiers and so on. [...] Obviously it's just how it fits in with school policy.*

This teacher had worked in a primary school previously and explained how her views of setting for maths sat comfortably with her experience of teaching a mixed ability class in primary school:

> *Even when I go into primary schools now they always point out who's on each table like, 'this is the top one'. So there's still an element of setting within the primary schools on different table groups as well and I think they generally set them different objectives, like this table should be able to do this calculation and this group should be able to do that calculation so it's like still formally there.*

Student behaviour and classroom management

Describing herself as a 'firm but fair' teacher, Teacher CI thought that issues of behaviour management were not necessarily related to working in mixed or set groups and she based this on her experience of more challenging behaviour from a few students in a high set group in Year 9. She didn't agree that behaviour management was a reason for setting children. She thought that behaviour management was about how you respond to children and the kind of work that you give to them. Hence, for her, the challenge was to set a positive tone in her classroom and throughout the school. She thought that using the roles in group work with her Year 7 classes enabled the students to work with her to achieve what she described as acceptable behaviour in the classroom.

She described the difference between the noise level in her group work lessons and that in her ‘normal’ or ‘ordinary’ lessons and how the ‘noise’ was beginning to take the form of constructive discussion between the students, with students helping each other. She is, however, reluctant to use the CI approach with older students, expressing an anxiety about the likelihood of adapting older students’ behaviour and the time lost in trying to do so.

Teacher D had reservations about behaviour management when doing group work, suggesting that this was particular to mathematics teachers. However, she was keen to resolve this:

> *I think that in maths we have this worry that in group work it’s not going to go right. I’ve put it on my development that I want to do group work. [.....] I think maybe it’s special to mathematicians. I think that chaos can ensue and there’s always that worry that they’re not on task all the time.*

She also felt that, with the pressure of meeting government guidelines, there was no time to be sidetracked by behaviour issues:

> *...there are behaviour issues. It’s OK with Y11 top set for group work. Teachers that do this must be well resourced.*

Extrinsic factors

Pedagogical factors that I have defined as being extrinsic to the teacher’s school and classroom accounted for 19.3% of Teacher CI’s total coded responses (mixed ability/CI) and 35% of Teacher D’s total coded references (set/no CI).

Reference to exam results and National Curriculum content coverage

Teacher CI, working at a school with low GCSE performance, was keen to improve these results and within the maths department they were looking at strategies to improve GCSE results in maths, including early entry. On the basis of her analysis of recent Y7 test results, she felt confident that using the CI approach was not holding back the high attaining students, but had no evidence for improvement in her lower attaining students. She did however feel that the CI approach had enabled her to make better on-going assessment of her students understanding of mathematics compared to her ‘normal’ lessons.

Teacher D has seen GCSE exam results across the school, previously quite low, improve dramatically over the four years she has been at the school and attributes this to the new Head Teacher. She said that the maths results had not improved as much as the rest of the school, but with a now more stable maths department with fewer staff changes, they were showing improvement, but were under pressure to match the A*-C grades achieved by the English department. In addition to routine marking, tests are done each term and National Curriculum test papers are used for end of term assessment:

> *We follow government guidelines re the National Curriculum...no time to develop other approaches.*

References to National Strategy/Ofsted expectations, including levels and targets

Whilst Teacher CI welcomed the removal of the National Curriculum test at the end of Key Stage 3 in terms of taking the pressure off students to perform in examinations, she was concerned about evidencing students' attainment according to Strategy guidelines were she to adopt CI wholesale. Anxiety about Ofsted expectations has led this teacher to adapt her work with the students using the CI approach and one of her three lessons with them is taught along Strategy guidelines of the three part lesson.

She stated that if she had an Ofsted inspection she probably wouldn't do group work with her classes. Based upon a recent experience of a visit by a local authority inspector she was unsure of how she could convince the inspectors of evidence of student learning doing a CI group work lesson.

Teacher D explained how she is trying to adapt some of her teaching approach to meet the requirements of the new National Curriculum:

> *Sometimes [the students work] in pairs sometimes in small groups. We've taken a lot of our ideas from the Standards Box. We've found those ideas quite interesting and at the moment this is our mission and vision that we want activities like this for development of skills and maths – it fits in well with the new curriculum. We're mainly focussing on Y7 at the moment but we're going to be trying other years as well.*

Nevertheless she expresses anxiety about doing group work which she believes is a common problem for maths teachers and relates to teachers being judged by whether or not their students are perceived by observers to be ‘on task’. She had been exploring ways of dealing with this at her local maths teachers’ network meeting:

> *I think that chaos can ensue and there’s always that worry that they’re not on task all the time. We were talking about this last week, that maybe they’ll go off task for a little bit but not to panic and if they go off for a while to bring them back. The ideas we were talking about last week was getting the group to grade each other on how well they worked.*

She talked about how she follows National Strategy guidelines for student self-assessment and target setting:

> *We do talk a lot to students about targets and they set their own personal targets for what they do and they all have books [goes to get one] what we’re training them to do. Before we do a section of work they go through what they can and can’t do and then at the end of the unit of work they do it again and they evaluate. [....] So they’re levelling themselves.*

5.4 Discussion and conclusion

The findings from the interviews with the three teachers who were trialling CI suggest that each of them, to greater or lesser extent, still adhered to the dominant cultural script of grouping students by ability for mathematics. Although they are teaching mixed ability groups of younger Key Stage 3 students, Year 7 and sometimes Year 8, they each, nevertheless, presented a rationale for putting older students into sets especially those in Key Stage 4 as they approach their GCSE examinations. Notably, there remained an anxiety about putting students at the extreme ends of the attainment range together regardless of the method used for grouping them. This again supports the concerns found in the literature about the potential detriment to the progress of the highest attaining students, (DfEE, 1997), and general anxieties teachers have about classroom behaviour management, (Muijs & Reynolds, 2005).

Whilst each of these teachers began their teaching careers with an acceptance of ability grouping for mathematics as the norm, and influenced by their prior experience and professional education (Even & Loewenberg Ball, 2009), significant others or events subsequently affected their thinking about how students should be grouped. In the case of Teacher CI-1 it was getting a post at a school with a Head Teacher who was strongly in favour of mixed ability grouping and then attending professional development courses which illuminated for her the effects of setting on students. In the case of CI-2, it was the critical incident of developing ‘Thinking Maths’ lessons at her school in collaboration with King’s College (Adey & Shayer, 1994), which demonstrated to her the benefits of mixed ability grouping. In the case of Teacher CI-3, as a newly qualified teacher, she had joined a department which had recently changed to mixed ability teaching for mathematics. This had come about because of changes implemented by the Head of Mathematics as a result of unexpected critical incidents at her school, which had demonstrated the benefits of mixed ability grouping, coupled with attendance at a professional development course on Complex Instruction. Only teacher CI-2 had been involved in the decision to change the grouping of her students to mixed ability, both CI-1 and CI-3 were the subject of others’ decisions. These findings again lend weight to the importance of teachers continuing professional development, and, in the case of these teachers, leadership and collaboration both within their schools and with university departments of education.

The findings from the interviews with these teachers along with visits to observe their lessons, suggest that the deviation from other aspects of the dominant script, as described in Chapter 4, varies from teacher to teacher. Teacher CI-2, the most experienced of the three teachers with 16 years of experience, had a pedagogy that was most consistently different to the accepted norm, with the greatest use of rich tasks, group work and mathematical discussion. Teacher CI-3, a newly qualified teacher (NQT), is the least different. Both Teachers CI-1 and CI-3 refer to their ‘normal’ or ‘formal’ lessons which adhere to the dominant script of the three part-lesson in the form of model and practice, with differentiation of tasks by input, of which the latter, Watson (2011b) suggests, reifies teachers’ perceptions about students’ capabilities. Only teacher CI-2, who claims to not follow Strategy guidelines in her teaching approach, began her teaching career before the introduction of the National Numeracy Strategy: Framework for Teaching Mathematics in 1999.

Each of these teachers has developed a rationale for their pedagogical approach. Both Teacher CI-1 and CI-3 thought that their initial teacher education at university had fostered traditional views on teaching mathematics consistent with the dominant script described: set groups, teacher led, model and practice lessons, and differentiated work. Yet subsequent sources of shifts in their beliefs, for all three of these teachers, had to some extent emanated from their schools' engagement with research initiatives from university education departments. Whilst professional development has long been noted as important in teacher effectiveness (Sammons et al, 1995; Day et al 2005; Barber & Mourshed, 2007), perhaps the nature of the professional development requires further elaboration.

Teacher CI-3, the NQT, with least experience of mixed ability and group work was still teaching most of her lessons in traditional ways. Teacher CI-1 was still teaching some of her lessons in traditional ways but thought that her experience in primary schools and her more recent exposure and enthusiasm for continuing professional development had changed her more traditional views. Teacher CI-2, who was teaching most of her lessons in non-traditional ways, explains the reasons for this in terms of a reaction to her own disappointing experience of traditional maths lessons at school, a supportive Head Teacher and involvement with initiatives like 'Thinking Maths' some 10 years previously and more recently Complex Instruction.

Teachers CI-1 and CI-2, being more experienced teachers, were both mentoring PGCE mathematics trainees. Both of them commented that they thought these trainees came to them on teaching practice with traditional views of maths pedagogy. They also thought that, in line with Teacher CI-1 and CI-3's experiences, NQTs had little, if any, exposure to approaches to teaching mathematics other than that described by the dominant cultural script. Hence, there is some evidence here to suggest that the dominant script is either maintained by initial teacher education providers or initial teacher education does little to modify trainee teachers' preconceptions of their model for teaching mathematics.

These teachers described some of the qualities they thought teachers needed to break the mould. Teacher CI-1 thought that, in addition to good subject knowledge, being receptive to new ideas was important. Teacher CI-2 suggested that any teaching approach was only as good as the teacher doing it and in this regard teachers needed to be confident in their approach. All agreed that to teach differently to the accepted norm required a strong supportive department with collaborative sharing of resources. Also raised as a factor was good humoured, non-confrontational relationships with the students; seeing them as actively involved in the learning process. What are described by these teachers are factors affecting their pedagogy which are largely intrinsic to their school and classroom. Whilst they were initially shaped by their experiences prior to taking up a teaching post, including initial teacher education, they were reshaped by the environment of the school in which they were working and by opportunities for professional development and collaboration with peers. Hence, whilst there is strong evidence in the literature that supports the relative stability of teachers' beliefs, (Brophy & Good, 1974; Ruthven, 1987; Pajares, 1992; Swan, 2000; Gates, 2006), there appears to be room for manoeuvre.

Extrinsic factors appear to have a varying effect on how these teachers sustain their teaching approach. All of them expressed some anxiety about being accountable and vulnerable in terms of examination results and inspection. In the extreme case, Teacher CI-1 stated that she would not teach a group work lesson during an Ofsted inspection. Both CI-1 and CI-3 continued to teach in traditional ways much of the time because of such pressures. CI-3 worried that she was not meeting national expectations unless she did so and also had concerns about parental pressure. Teacher CI-2, who thought that her lessons differed most of the time from most mathematics teachers, based on her experience as a consultant teacher and PGCE mentor, put extra effort into collecting evidence to demonstrate that her approach did no damage to her students' attainment. As Gates (2006) states, beliefs can sit separately from dominant practices because practice is affected by other factors, both contextual and situational. Hence, the dominant discourse of accountability of teachers linked to student assessment may hinder the introduction and maintenance of teaching approaches which address the very changes in mathematics classrooms that the policymakers (Ofsted, 2008a, Vorderman et al, 2011) call for.

Comparing the findings from the lead teachers at the two contrasting schools it can be seen that there are both similarities and differences between Teacher CI and Teacher D. One works in a culture of setting students by ability and one works in a culture of mixed ability grouping for mathematics in Years 7 and 8, over which neither of them had any direct control. Despite the age and experience difference, both of them come from a starting point in their teaching careers of believing that

setting by ability is the norm for teaching mathematics in secondary schools. Thus, they both conformed to the enduring dominant script of ability grouping for secondary school mathematics (Ruthven, 1987; DfEE, 1997; Watson, 2011).
As Even & Loewenberg Ball (2009) state, teachers' knowledge, beliefs and actions are a product of their experiences before and after entering the teaching profession. Prior experiences can affect the development of new competencies (Speer, 2005; Maas & Schloglmann, 2009). Both of these teachers have a background of working in the primary school phase, yet each of them has arrived at a different rationale for the current grouping of their students based partly on this experience. Whilst Teacher CI wants to remain more flexible with the grouping of the younger students, based on her primary experience, the influence of the views of her Head Teacher and recent professional development, Teacher D, on the other hand, with some reservation about grouping by ability at the start of Year 7, largely references her experience in primary schools as a reason for accepting ability grouping of students as the norm. The increase in setting students for maths in primary schools (Kyriacou, 2000; Hallam et al, 2003; National Union of Teachers, 2009) since the introduction of performance tables for primary schools based on KS2 NC test results, would have been experienced more by Teacher D, being younger and more recently qualified.

Both teachers were quite comfortable with grouping students by ability in Years 9, 10 and 11. Teacher D, in her four years at school D1, has seen her department move from a more flexible banding system to more rigid setting of students for maths as part of the school's development plan to improve attainment. Ultimately, they both adhere to their school policy on the mode of grouping students.

The professed beliefs of both these teachers about the mode of grouping students is therefore based upon a combination of prior experience, professional development, school leadership and accountability in the form of examination performance. In the case of the latter, their willingness to be flexible in the mode of grouping wanes with the age of the students and as public examinations approach.

Both of these teachers, regardless of whether their students were grouped by ability or not, started teaching mathematics using pedagogy that followed government guidelines; largely teacher-led, three-part, model and practice lessons with differentiated levels of work; indicative of the influence of national policy via the

National Strategy. Initial teacher education does not appear to have influenced them in deviating from this approach.

Teacher D, when describing her current pedagogy, mostly focused on the National Strategy guidelines for teaching mathematics: three-part, model and practise, lessons and work differentiated by students' NC level. She also emphasised her involvement in accelerating the most able: master classes for level 5 students from her primary feeder schools, group work for top set Y11 and attendance at meetings for gifted and talented students. She gave time, resources and behaviour problems, notably the fear of students being 'off task', as her reasons for not deviating from this approach. However, a proposed change in the mathematics National Curriculum (DCSF, 2007) had prompted her to consider making changes to her pedagogy, particularly in the form of more group work and problem solving, with which she was finding support from her local mathematics network useful. Hence, the force behind making these changes was linked to accountability manifested in fears about students' performance in their GCSEs, if the changes were not implemented.

Teacher CI, though not having given up the National Strategy approach altogether; she taught one of the students' three lessons as a three-part, model and practise, lesson with differentiated work, had persevered with CI group work with, she felt, some success in terms of student enjoyment, better assessment of her students' understanding and no overall detriment to their performance. Nevertheless, by the end of the year she still had reservations about the extent to which she could sustain the approach, given both the pressures of performativity, accountability and her feeling of isolation in using the approach. Evaluations by Ragbir-Day et al (2008) of the Teacher Effectiveness Enhancement programme, (TEEP), showed that successful implementation required a whole school initiative, time for it to become embedded, networking with other teachers and having a critical mass of teachers trained in the approach.

Group work raises anxieties for both of these teachers. The Royal Society (2010) reported that group work was found infrequently in secondary schools largely because of teachers' concerns about classroom control issues. Individuals' judgements about their ability to execute a particular task are argued to be strong predictors of human motivation (Bandura, 1986; Maas & Schloglmann, 2009). With the help of the CI approach, which acknowledges the need to train students to work collaboratively for group work, (Stevenson & Stigler, 1992; Kutnick et al 2005), Teacher CI, was now less anxious about doing group work, but still concerned about sourcing appropriate tasks. She had also noticed how some students remained reluctant to work together in group work, often expecting and wanting to work individually and she was unsure about whether the lower attaining students had improved their performance. Teacher D had noticed that the students in her Year 7 set 3, which she said, still had a wide range of ability within it, tended to gravitate towards sitting with students of similar attainment. This demonstrates the need to look more deeply at the part that students play in the maintenance of the dominant script, either in their reluctance to work with each other at all or in forming their own within-class ability groups.

Both these teachers are keen to develop professionally and have attended courses outside of school hours and are members of their local mathematics teachers' network group. Teacher effectiveness studies have highlighted the importance of CPD (Hay McBer, 2000; Barber & Mourshed, 2007). However, whilst hitherto teacher CI's professional development opportunities have focused on enhancing teaching for all students, based on the research of Dweck (2000) and Boaler (2008a), Teacher D's professional development has focused on accelerating the most able. As previously mentioned, it has been the introduction of the new mathematics curriculum (2007) and the associated fear of damage to her students' future GSCE success that had prompted this teacher to look towards professional development which will help her introduce and manage more group work with her students, but still grouped by ability.

Teacher CI and Teacher D are both are under pressure to improve their school's performance and raise their students' GCSE results further. Both of them feel the pressure of evidencing students' work to meet National Strategy guidelines on assessing student levels and achieving targets. Thus, whilst Teacher CI has deviated to some extent from the dominant cultural script for teaching mathematics in English secondary schools, strong elements remain, arguably out of fear of being accountable through the examination and inspection process. Teacher D has largely adhered to it for the same reasons.

The power of accountability linked to student assessment in the public arena presents a powerful resistance to these teachers changing their pedagogy either in part or wholesale. There is a further resistance in the form of fears about the management of students' behaviour when working in groups both in terms of the daily running of their classroom and in terms of how their classroom organisation might be perceived by others; hence once again linked to accountability. Even Teacher CI, who felt that she had achieved some success doing group work with her Y7 classes with the assistance of CI, expressed anxiety about doing group work with older students; concerned that she would not be able to adapt their behaviour.

The availability and nature of continuing professional development featured strongly in both these teachers' professional biographies. It has helped them reflect upon their current pedagogy and to consider alternatives. Both of them express a willingness to adapt their teaching approach in the light of new evidence. However, whilst professional development may lead them to adapt their beliefs, the extent to which they enact these changes, or indeed sustain them, is balanced against other pressures. As Gates (2006) states, inconsistencies arise between teacher's professed beliefs and practices because of situational and contextual factors as well as the degree of reflection upon beliefs and practice. Both these teachers have alluded to situational factors such as time and resources and aspects of school infrastructure. They have also emphasised the policy context, both at school and national level, as a factor in terms of the pressure of accountability via examination performance.

There is, however, another emergent issue which wasn't revealed in Chapter 4, probably due to the fact that most of the teachers discussed in that chapter taught in schools that put their students into ability groups for maths. This emergent issue may present a further resistance to teachers breaking out of the mould of the dominant cultural script for teaching mathematics. It comes from the students themselves. All three of the teachers working with mixed ability Year 7 classes express some reservation about the very high attaining students working with the lowest attaining students as they progress through the school. This may, in part, be due to the pressure of extrinsic factors upon teachers as previously mentioned, such as examination performance. It does appear however, that regardless of how these teachers perceived their students, there was concern amongst these teachers that some students have difficulty accepting each other, of being open and supportive of each other and not being judgemental. Even in a set group situation, Teacher D found that students of similar attainment tended to gravitate towards each other. Also, as teacher CI-1 discovered when trying to implement more group work, the students often expected and wanted to work individually. This may be due to the students being in need of more training in how to work in groups (Kutnick et al, 2005; Banerjee, 2008) or to the way many students perceive success in mathematics; that of finding the answer quickly and independently, (Boaler, 1997). Therefore, whilst the teachers, who are willing to trial a previously unfamiliar approach, though mindful of exam performance and inspection, also hold other beliefs and goals for their students, these beliefs and goals are not necessarily shared by the students. Hence, whilst on one hand these teachers have accepted a rationale for working with mixed ability groups based on matters such as equity, a ‘can do’ approach, or to ameliorate behaviour problems in low sets, students may feel otherwise. Indeed, they too may be subject to the pressure of extrinsic factors identified in the dominant script for mathematics in schools.

In the next chapter I will explore these emergent issues from both the teachers’ and students’ perspective. Using Carol Dweck’s entity-theory and incremental-theory frameworks for understanding intelligence, personality and achievement (Dweck, 2000), I will examine whether, in the context of teaching mathematics to Year 7 students in two English schools, these theories provide additional explanation for the persistence of a dominant cultural script and a resistance to previously unfamiliar approaches such as Complex Instruction.

6 Are teachers' and students' beliefs about the nature of intelligence and personality a key component in revising the 'script' for teaching mathematics?

6.1 Introduction

In the context of teaching mathematics to Y7 students, this chapter presents and discusses the findings from the next dataset (see Table 3.1):

5. Mathematics teachers' and their students' beliefs about the nature of intelligence and personality and their associated learning goals in two contrasting schools.

It responds and leads to some conclusions about the third research question:

> *Are the teachers' and students' beliefs about the nature of intelligence and their associated learning goals a key component in revising the 'script' for teaching mathematics?*

The data was collected from two cohorts of Y7 students and their mathematics teachers. One cohort was taught in mixed ability groups and one of their teachers was trialling the CI pedagogy during the academic year 2008-9. The other cohort was taught in sets without CI.

6.2 Findings from the analysis of the Y7 student questionnaires

6.2.1 Descriptive statistics - the two Year 7 student cohorts

(See Appendix 4 – Tables 1-6)

As shown in section 6.1, the two schools, in the same local authority, were, at the time of starting the study, chosen according to their comparability in terms of socio-economic, GCSE performance and Ofsted report data.

Across the academic year 2008-9, the Year 7 students at School D1 were taught mathematics in ability sets without CI. Those at D2 were taught mathematics in mixed ability groups. Only one teacher, Teacher CI at School D2 had received training in the CI approach. She was trialling the CI approach with her Y7 students in one of their three mathematics lessons per week.

The questionnaires were administered at the end of this academic year. 221 students across the two cohorts completed the questionnaire out of a possible 239, a response rate of 92%. 151 students at School D1 completed the questionnaire out of a possible 156, a response rate of 97%. 70 students at School D2 completed the questionnaire out of a possible 83, a response rate of 84%.

Across the survey of the two schools there were slightly more boys (115) than girls (106) in Y7. However, although the gender of the Y7 cohort at School D1 was evenly balanced between boys and girls (72:79) there were significantly more boys than girls in Y7 at School D2 (43:27). At School D1, only set 2 had the same number of boys and girls. Sets 3 and 4 had only one or two more girls than boys and set 1 had more girls than boys in the ratio 3:2. Sets 5 and 6 had more boys than girls. At School D2, all of the mixed ability groups had more boys than girls. One of them (7MA, Teacher CI) had only two more boys than girls, one had almost twice the number of boys to girls (7MB, Teacher CI) and the third had more boys than girls in the ratio 3:2 (7MC, Teacher I).

The size of each Y7 teaching group varied from 18 to 30. At School D1, the highest sets had the most students (30) and the lowest sets had the fewest (18-20). At School D2 there were between 21 and 25 students in each mixed ability group.

One of the teachers at School D1, Teacher A, taught two of the six Y7 mathematics classes (sets 1 and 2), but with different co-teachers (Teachers B and C) and one of the teachers at School D2, Teacher CI, the only teacher that attended the workshop on Complex Instruction in June 2008, taught two of the three mixed ability Y7 mathematics classes (7MA and 7MB).

6.2.2 Descriptive analysis of questionnaire responses - all Y7 students

(See Appendix 4 – Tables 7-31)

Informed by Dweck's (2000) guidance, this questionnaire (see Appendix 3) was designed as described in section 3.5.2 and analysed by clusters of questions as described in section 3.5.3. Each cluster provided a measure of Dweck's theory of self as described in the literature review, section 2.4.

The findings show that 35.9% of all the Y7 students surveyed agreed, to some extent, with the notion of fixed intelligence. 39.5% had, to some extent, low confidence in their intellectual ability, 61.7% agreed, to some extent, with the notion of fixed personality and 49.7% were more drawn to performance than challenge goals of learning.

In relation to their work in mathematics, 53.4% preferred to do problems that did not pose a challenge, 28.5% would not try a mathematics problem in which they did not expect to do well, 47.6% were more motivated by doing well in mathematics than learning a lot, 36.6% thought that getting the best level in mathematics was more important than learning new things. Asked if they had to chose, 74.6% would chose getting a good level over being challenged in mathematics.

6.2.3 Initial comparative analysis between the two schools

Table 6.1 below summarises where significant differences in the data were initially found in the four areas of inquiry, (see Appendix 4, Tables 32 - 51):

No significant differences were found in any of the four areas of inquiry when the students' responses at the two schools, D1 and D2, were compared as two whole groups. However, significant differences were found, both within and between the schools, when the students were stratified into sub-groups and these will be explored under the headings of each area of inquiry.

Table 6.1: Significant differences found in the comparative analysis of Y7 mathematics students' responses to 'theory of self and others' questionnaires by research school, gender, mathematics group, mathematics teacher and KS2 National Curriculum level

Comparison	Implicit theory of intelligence	Confidence in one's own intelligence	Implicit theory of personality	Learning goal choices
Between School D1 and D2 – all students				
Across both schools by gender		$p<.001$	$p<.005$	$p<.01$
Between School D1 and D2 - boys			$p<.05$	
Between School D1 and D2 - girls	$p<.05$			
Across both schools by mathematics group	$p<.001$	$p<.05$	$p<.001$	
Across both schools by mathematics Teacher	$p<.001$	$p<.05$	$p<.001$	
Across both schools by KS2 NC level	$p<.005$	$p<.001$	$p<.001$	

(The tables referred to in this section, unless stated otherwise, can be found in Appendix 4).

Implicit theory of intelligence

Although no significant difference was found when comparing the students from each school as two whole cohorts, significant differences were found when they were stratified by gender, teaching group, mathematics teacher and KS2 level.

Whilst no significant difference was found when comparing all the boys with all the girls surveyed at both schools, and no significant difference was found when comparing the boys at the two schools, Table 84 shows that significantly more girls at D2 (62.9%) agreed with the notion of fixed intelligence than the girls at D1 (31.6%).

Table 34 shows that the mixed ability group 7MA at School D2 had a greater percentage of students with a fixed view of intelligence than either of the other two mixed ability groups (54.1% compared to 38.1% and 37.6%). It also shows that students in the low set groups at School D1 had a greater percentage of students with a fixed view of intelligence than those in the high sets, (16.6% in set 1 compared to 45% in set 6). However, the set groups' responses do not correlate completely with their set position, for example, set 4 (62.9%) had a higher percentage of students with fixed view of intelligence than all the other teaching groups.

Looking at the relationship of the students' theory of intelligence against mathematics teacher, (Table 35), similar patterns are found to that of teaching group in all cases except Teacher CI at School D2. This teacher is the only teacher responsible for more than one group. 45% of Teacher CI's students demonstrated a more fixed view of intelligence, the second highest of all the groups and second only to set 6 at School D1.

Table 36 shows that a more fixed notion of intelligence is associated with the KS2 NC level of the student. More students with the below average levels of 2 and 3, (75% and 47.3%), demonstrated a fixed view of intelligence than those with levels 4 and 5, (33.7% and 22.9%).

Confidence in one's own intelligence

Significant differences were found between the students' confidence in their own intelligence and each of the comparison variables of gender, mathematics group, mathematics teacher and KS2 NC level.

Table 38 shows that across the two schools 70.2% of boys were confident in their own intelligence compared to only 50% of the girls.

Table 39 shows that at School D1 proportionately more students in the high sets (80.0% in set 1) were confident in their intelligence than students in low sets (53.0% in set 6). Set 4 (30.8%) had the lowest percentage of students that were confident in their intelligence. The mixed ability groups 7MA (69.5%) and 7MB (71.5%) had a higher percentage of students that were confident about their intelligence than all the other groups except set 1. Mixed ability 7MC (60.0%) had a higher percentage of students that were confident about their intelligence than sets 3-6.

Table 40 shows that with the exception of students in set 1 at School D1 (80%), a higher percentage of students (70.4%) taught by Teacher CI in School D2 in mixed ability groups were confident in their intelligence.

Comparing students by KS2 NC levels (Table 41), students' confidence in their own intelligence correlates with their level. Proportionately less students with levels 2 and 3 (16.7% and 41.7%) have confidence in their intelligence than students with levels 4 and 5 (58.6% and 85.9%).

Implicit theory of personality

Significant differences were found between the students' implicit theory of personality and each of the comparison variables of gender, mathematics group, mathematics teacher and KS2 NC level.

Table 43 shows that across the two schools, proportionately more girls (67.0%) than boys (56.6%) agreed with a fixed view of personality and with a greater strength of agreement. However, Table 86 shows that significantly less boys at School D2 (47.5%) agreed with the notion of fixed personality than the boys at D1 (62%).

Table 44 shows that whilst more students at School D1 in the low sets (77% in set 6) have a fixed view of personality than those in the high sets (60% in set 1), there is no clear pattern. Set 4 once again stands out with the highest percentage of all the groups, (85.1%) and set 2 (30%) is much lower than set 1. Whilst the mixed ability groups 7MB (52.6%) and 7MC (41.6%) have a lower percentage of students with a fixed view of personality than all the other groups, group 7MA (75%) ranks fourth out of the nine groups.

For the same reasons as explained previously, when analysing the variable of teacher, similar findings to teaching group are observed.

Table 46 shows that the proportion of students with fixed views of personality is related to KS2 level, with a considerably lower percentage of high level students (42.9% level 5) having such views compared to the students with the lowest levels (83.3% level 2).

All teaching groups have a higher percentage of students that have fixed views of personality compared to fixed views of intelligence.

Learning goal choice

Only the comparison variable of gender (Table 48) showed a significant difference across all the questions relating to this area of inquiry. Across the two schools, 42.2% of the boys showed preference for performance over challenge compared to 57.3% of all the girls.

6.2.4 Further comparative analysis within the schools

As noted in 6.3.1, the composition of the two schools vary considerably in terms of their gender distribution, with School D1 having an equal balance overall and School D2 having significantly more boys than girls. Furthermore, the distribution of boys and girls within the teaching groups at both schools was noted to be imbalanced in some cases. Therefore, given the significant findings found in the previous section in relation to both students' gender and KS2 NC level, the data were interrogated further in these two areas in order to make comparisons between the teaching groups within each school on the basis of these two variables.

Table 6.2 demonstrates the distribution of the students in each teaching group by gender and KS2 level. Teaching groups 7MB, 7MC and set 1 are the most notably imbalanced with regard to gender. It is also notable that at School D1 level 4 students are to be found in any one of the sets 1-6. Similar patterns of unequal dispersion between the sets can be observed for students achieving the other KS2 NC levels.

Table 6.2 Distribution of Y7 students at each research school by mathematics group, gender and KS2 NC level

Mathematics Group			KS2 National Curriculum Level					Total
			Not known	Level 2	Level 3	Level 4	Level 5	
7MA	Gender	Male	1	0	2	5	5	13
		Female	3	1	0	3	4	11
	Total		4	1	2	8	9	24
7MB	Gender	Male	0		2	4	8	14
		Female	1		2	3	1	7
	Total		1		4	7	9	21
7MC	Gender	Male	0	0	3	8	5	16
		Female	1	1	0	7	0	9
	Total		1	1	3	15	5	25
Set 1	Gender	Male	1			3	7	11
		Female	0			3	16	19
	Total		1			6	23	30
Set 2	Gender	Male	1		0	8	6	15
		Female	0		1	10	4	15
	Total		1		1	18	10	30
Set 3	Gender	Male			0	11	1	12
		Female			2	12	0	14
	Total				2	23	1	26
Set 4	Gender	Male	0		2	11		13
		Female	3		4	7		14
	Total		3		6	18		27
Set 5	Gender	Male	1		7	2		10
		Female	0		5	3		8
	Total		1		12	5		18
Set 6	Gender	Male	1	3	4	3		11
		Female	0	3	4	2		9
	Total		1	6	8	5		20

No significant differences were found between the two schools when comparing the students by KS2 NC level on each field of inquiry.

However, Table 6.3 below shows that significant differences were found when comparing the students within each school on the basis of their teaching group and gender against each field of inquiry.

Table 52 (Appendix 4) shows that set 4 at school D1 accounts for the significant difference between the boys in the set groups at this school. 61.6% of these boys agree to some extent with the notion of fixed intelligence compared to 20% – 30.6% in the other sets. In the case of the girls at D1, the female students in the lower sets are more likely to have a fixed theory of intelligence than those in the higher sets (e.g. in set 1, 5.3% of the girls agree compared to set 6 where 55.5% agree). Like the boys, the girls in set 4 also record the highest proportion of agreement (64.2%).

Table 6.3: Significant differences found in the comparative analysis of Y7 mathematics students' responses to 'theory of self' questionnaires within each research school by teaching group and gender

Comparison by:	Implicit theory of intelligence	Confidence in one's own intelligence	Implicit theory of personality	Learning goal choices
Set teaching groups at D1 Boys	$p<.01$		$p<.05$	
Set teaching groups at D1 Girls	$p<.005$	$p<.005$	$p<.05$	
Mixed ability groups at D2 Boys				
Mixed ability groups at D2 Girls				

Table 53 (Appendix 4) shows that a greater proportion of girls in the high sets are confident about their intelligence than those in the low sets, (e.g. 78.9% of girls in set 1 compared to 37.5% in set 6). Confidence amongst the girls progressively diminishes from set 1 to set 4.

With regard to their theory of personality, whilst for the boys at D1 there is no observable pattern between the sets (Table 54, Appendix 4), those in the middle sets, sets 3 and 4, expressed the highest agreement with the notion of fixed personality, 83.2% and 92.4% respectively. The girls in sets 1 and 2, by contrast, expressed notably lower agreement with the notion of fixed personality than those in sets 3-6.

No significant differences were found between the boys and girls in the three mixed ability teaching groups at School D2.

Table 6.4 below shows the significant differences found when comparing the students within each school on the basis of their teaching group and their KS2 National Curriculum level against each field of inquiry.

Table 6.4: Significant differences found in the comparative analysis of Y7 mathematics students' responses to 'theory of self' questionnaires within each research school by teaching group and KS2 NC level

Comparison by:	Implicit theory of intelligence	Confidence in one's own intelligence	Implicit theory of personality	Learning goal choices
Set teaching groups at D1 NC level 3				
Mixed ability teaching groups at D2 NC level 3				
Set teaching groups at D1 NC level 4	p<.05		p<.05	
Mixed ability teaching groups at D2 NC level 4				
Set teaching groups at D1 NC level 5				
Mixed ability teaching groups at D2 NC level 5	p<.01		p<.05	

Significant differences were only found amongst level 4 students at School D1 and level 5 students at School D2 against two of the areas of inquiry. These were their theory of intelligence and their theory of personality.

The significant difference in theory of intelligence of the level 4 students at D1, noted in Table 6.2 as having the widest distribution across the sets, is accounted for by the high percentage (61.1%) of students in set 4 compared to the other groups who agree with the notion of fixed intelligence (see Table 60, Appendix 4). The significant difference in their theory or personality is accounted for by the low percentage (27.9%) of students in set 2 compared to the other groups, who agree with the notion of fixed personality (see Table 62, Appendix 4).

With regard to the significant differences between the level 5 students at School D2, there is a notable difference between these students in each of the mixed ability groups, 7MA, 7MB and 7MC, in terms of their agreement with fixed intelligence, 66.6%, 22.1% and 0% respectively, (see Table 72, Appendix 4). Their agreement with the notion of fixed personality follows a similar pattern, 55.5%, 25% and 0%

respectively (see Table 74, Appendix 4). However, as shown in Table 6.2, the distribution of level 5 boys and girls between these teaching groups is also unequal with 7MA having the most level 5 girls and 7MC having none at all.

6.3 Findings from the analysis of Y7 mathematics teacher questionnaires

6.3.1 Descriptive statistics

(See Appendix 5 – Tables 1-4)

Five teachers completed the questionnaire out of a possible nine, a response rate of 56%. Three were from School D1 where the students were in ability sets for mathematics and two were from School D2 where the students were in mixed ability groups. Only one of the teachers, Teacher CI at School D2, had attended a course on Complex Instruction and was trialling the approach.

Two of the teachers were male (Teacher G at School D1 and Teacher I at School D2), three were female (Teachers A and D at School D1 and Teacher CI at School D2).

6.3.2 Comparative analysis

(See Appendix 5 – Tables 5 - 20)

Informed by Dweck's (2000) guidance, this questionnaire (see Appendix 2) was designed as described in section 3.5.2 and analysed by clusters of questions as described in section 3.5.3. Each cluster provided a measure of Dweck's theory of others as described in the literature review, section 2.4.

N.B. The sample is small and hence does not lend itself to significance testing

The analysis shows that all of the teachers disagreed to some extent with the notion of fixed intelligence. Teacher CI, at School D2, (the only teacher to attend the Complex Instruction workshop) was, however, the only teacher to strongly disagree with all four questions on this concept.

Whilst all the teachers across the four questions tended to disagree with the notion of fixed personality, their disagreement with the notion of fixed personality was not as strong as that of fixed intelligence. The strength of disagreement with the notion of fixed personality was greater for Teacher D than Teachers A and G at School D1. The strength of disagreement of both Teacher CI and Teacher I at School D2 was also greater than Teachers A and G and comparable with Teacher D at School D1. Both Teacher A and G at School D1 agreed to some extent with one of the statements on fixed personality.

Across the five questions on this area of inquiry, all the teachers tended to prefer challenge over performance for their students. All of the teachers responded that in mathematics lessons they most often gave students problems that they learnt a lot from even if they wouldn't look so clever. Only one teacher, Teacher G, at School D1, agreed that if they knew students weren't going to do well in a mathematics problem, they probably wouldn't give it to them even if they might learn a lot from it. The other four disagreed with this statement.

All of the teachers disagreed to some extent with the statement that they sometimes would prefer students to do well in mathematics than learn a lot. Teacher CI, at School D2, most strongly disagreed.

The teachers were completely split on the statement that it is much more important for students to learn new things in mathematics than it is for them to get the best level with one strongly agreeing (Teacher G), one agreeing (Teacher CI), one mostly agreeing (Teacher A), one mostly disagreeing (Teacher D) and one strongly disagreeing (Teacher I). Asked if they had to choose between students getting the best level and students being challenged in their mathematics lessons, two chose best level (Teachers G and I) and three chose being challenged (Teachers A, D and CI). Hence, all the female teachers chose being challenged and all the male teachers chose getting a good level.

6.4 Findings from the post-study interview with each lead teacher

Both teachers reported that the GCSE results at their schools had improved significantly since my initial interviews with them. Both the schools had received letters of commendation from the local authority in recognition of this improvement. However, both felt under pressure to improve further.

Teacher CI stated that with the pressure of levels and GCSE results she found it increasingly difficult to justify mixed ability and group work but still did Complex Instruction with her Year 7 one of their three lessons a week.

> *I love group work and I couldn't go back to my old practice. The kids love it too and are always asking to do group work. But I couldn't do all group work. It's too much of a risk.*

Teacher D expressed some anxiety about the changes in the mathematics National Curriculum and was concerned that there would be a need for students to do more problem solving/group work and as her students were not very used to working in that way, it might impact on GCSE results. Hence she was introducing more group work/problem solving lessons into Year 7 so they would be used to working in that way by the time they were in Key Stage 4. By comparison, Teacher CI felt well placed with the changes in the National Curriculum with the students going through the school being more used to group work and problem solving activities.

Teacher CI commented that one of the problems she foresaw in trying to embed a different approach like Complex Instruction, was that the groups often had a different teacher year on year and she often feels like 'a lone ship' even though her Head Teacher was supportive. Staffing changes was also of concern to Teacher D. Her department, she said, tended to teach in mostly traditional ways before she became Head of Department and the students found problem solving work difficult. She added that if the students are not used to working in that way it can be difficult for the teacher to introduce it so you have to begin with Year 7 and 8. The mathematics department at her school was now more stable. All members of the department were now permanent maths teachers; previously they had had a high turnover of staff and a range of supply teachers. The members of the department were now working better as a team with shared expectations. The students were no longer taught in rows but around tables in groups of four or five. Although all the teaching groups were still set, she was planning to put the next cohort of Year 7 students into mixed ability groups, for at least one term, influenced by collaboration with her local mathematics teachers' network. Whilst her Head Teacher was cautious, she was prepared to let her try this out.

Looking at the findings from the students' theory of self questionnaires, Teacher CI was concerned about the unequal distribution of students within the Year 7 teaching groups in terms of both attainment and gender, which she hadn't been aware of. As far as the unequal distribution of students by prior attainment, she explained that this probably occurred because the students were allocated to groups by a Teaching Assistant.

She talked about the nature of the school's catchment of students by way of explaining some of the findings. They are drawn from just three primary schools in the town which has suffered from generations of high unemployment with many of the children having low aspirations. She explained the difficulty of undoing students' previous six years of schooling in terms of low self-esteem, motivation and attainment.

Teacher D wasn't aware of the distribution of gender and attainment within the Year 7 mathematics sets either. She explained that this would have been done by the Senior Management Team and that students had been allocated by CAT scores rather than KS2 National Curriculum levels. She added that as the students stayed in these groups for other subjects, the effects could be quite far reaching.

Looking at the proportion of boys to girls in set 1, she commented that although there are more girls than boys in the group, it was mostly the boys who got the A/A* grades at the school.

Only she and Teacher G, who taught Year 7 students at the time of the survey, were still at the school. She explained that set 4, the one that didn't fit the pattern of responses of the other groups, had had a very disruptive year with supply teachers due to long term absence of a colleague.

Both of these teachers were concerned that the low attaining students and the girls tended to have a lower self opinion regarding their ability to change. Neither of these teachers had had a say in how the teaching groups, whether mixed ability or set, were composed, nor were they aware of the imbalances. Both were keen to raise the issues emerging from the questionnaires and to look at both between and within class groupings with their school management team.

6.5 Discussion and conclusion

The students

Initial comparative analysis of the two Y7 cohorts' questionnaire data showed no significant difference in the exploration of the students' 'theories of self and others' (Dweck, 2000) under each of the four fields of inquiry, (implicit theory of intelligence, confidence in one's own intelligence, implicit theory of personality and learning goal choice). Further analysis also showed no significant difference between these two cohorts when the data were stratified according to their KS2 NC level. Hence these findings afford no evidence to support differences between the two Y7 cohorts in relation to either the mode of grouping students or the pedagogic approach for mathematics in each school.

However, whilst the mode of grouping students for mathematics is an established distinguishing feature of both these cohorts, the difference in pedagogic approach is not well established at School D2. The CI approach was only trialled for one academic year in two of the three groups at this school and then for only one of their three lessons per week. Furthermore, the students will have come to these schools with established theories of self and others, which may have been influenced both by the mode of grouping and/or pedagogic practices experienced for mathematics in their primary schools and which have tended towards ability grouping and the three-part, teacher led lesson, (The National Strategies, 2008). Hence it is unsurprising that differences were not found between the two cohorts against these two variables.

The data, nevertheless, do reveal some interesting findings both across and within the two schools from which lessons may be learnt in relation to students' progress and performance, which have been indicated in recent reports to be matters of concern (Smith, 2004; Ofsted, 2008a, 2008b, Royal Society, 2008, 2010, Vorderman et al, 2011). If, in order to address these concerns, changes are made to the teaching approach adopted, for example, towards a more collaborative group work approach, the findings of this study are indicative of issues which need to be considered in implementing such changes.

The descriptive statistics for the combined Y7 students surveyed at the two schools demonstrate that a significant proportion of these students displayed what are described as ‘entity theory’ characteristics: fixed frameworks of intelligence or personality (Dweck, 2000). Just over a third of these students had to some degree a fixed notion of intelligence and lacked confidence in their own intelligence, and nearly two-thirds of them had a fixed notion of personality.

This difference in the findings between fixed intelligence and fixed personality could be due to the National Strategy’s promotion in schools of the concept of variation in learning styles and multiple intelligences (DfES, 2002). Nevertheless, having *either* a fixed notion of intelligence *or* a fixed notion of personality, that is an entity framework of self, is unlikely to lead to mastery orientated qualities in students, which have been found to be a key factor for progress in attainment (Dweck, 2000). Instead, for this kind of learner there is an expectation of low challenge since failure becomes an indictment of ability leading to disengagement. Furthermore, such students are more likely to see peers as competitors thus creating a resistance to a collaborative learning approach. However, encouragingly Dweck has demonstrated that incremental theory frameworks can be taught to students. In line with Adey et al (2007), with a focus on effort and perseverance and with guidance, all learners can increase their intellectual attainment. Since both lead teachers at school D1 and D2 reported that they still had low, though improved, examination performance in mathematics at the time of completing this research, these findings offered a possible area for development at both schools.

The findings that almost 50% of the students surveyed preferred performance over challenge in mathematics and almost 75% of them would choose achievement of a good NC level over challenge in mathematics lend weight to the concerns expressed in the literature about the lack of challenge in school mathematics lessons (e.g. Ofsted 2008a) and teaching to the test, (e.g. Royal Society, 2010). Performance goal orientated students seek positive judgements of competence, avoid negative ones and measure personal success against the performance of others (Dweck, 2000). Thus they will choose tasks that are easy for them and avoid tasks which create periods of confusion and error; the challenging tasks that lead to the greatest learning opportunities. These findings are arguably indicative of the power the discourse of performativity currently has on young people in schools and the way success in mathematics is perceived by students; that of procedural fluency (Askew et al, 2010).

Deeper analyses of the questionnaire data achieved by stratifying the students into sub-groups revealed some further interesting findings in relation to students' gender, prior attainment and modes of grouping both across and within the two schools and suggestive of further investigation in relation to students' performance and progression in mathematics.

A gender difference between students in relation to their attitude towards mathematics has been highlighted in the literature (Boaler, 1997; Mendick, 2005; Royal Society, 2008). The findings from this study show that the girls across the two schools expressed more agreement with the notion of fixed personality, were less confident in their intelligence and were more inclined to choose performance over challenge goals of learning. These findings are in line with Dweck's findings, reported in section 2.4, that students with fixed notions of intelligence or personality are more likely to endorse performance goals of learning and that girls were more likely to display these entity-theory characteristics. Hence they offer further explanation of the findings in the literature that girls tend to be more negative towards the subject and also less confident in their ability than boys. Encouragingly, as stated previously, students' theories in relation to intelligence, personality and their associated learning goal choices can be influenced.

Differences were also found by gender between the two schools. More girls at School D2 than School D1 demonstrated fixed frameworks of intelligence and fewer boys at School D2 than School D1 demonstrated fixed frameworks of personality. It is impossible to speculate as to the causes of this difference on the basis of these data alone. However, since the schools are known to differ quite dramatically in terms of their gender intake; D1 is evenly balanced between the genders whilst D2 has considerably more boys than girls, this finding lends another dimension to the debate (Sammons et al, 2005; Goe et al, 2008) as to whether contextual factors, in this case students' characteristics in terms of their gender, should be taken into consideration in school effectiveness studies.

Similarly, the allocation of students to teaching groups, either sets or mixed ability, is also worthy of further consideration. At School D1, the Y7 students were taught in ability sets for mathematics based upon CAT (Cognitive Attainment Test) scores collected at the beginning of Y7. For students and their parents, however, at this age it is the KS2 NC level that informs them of their attainment, and which, for many, has become indicative of the students' ability.

As shown in Table 6.2, the dispersion of these students by prior attainment, as measured by their KS2 NC level and gender adds to the concerns raised in the literature (e.g. Hallam, 2005, Dunne et al, 2007) that students can be placed in ability sets for reasons other than prior attainment with detrimental effect upon them. The issue here, at School D1, is that some of the students were placed into the groups by a measure that did not necessarily reflect what they perceived as their prior attainment.

When analysing the within-school groups by gender, whilst the girls follow the pattern of the low sets having more fixed characteristics than high sets, it is the boys in the middle sets that display more than all other groups fixed personality characteristics. Indeed, Set 4 students had notably higher agreement with fixed characteristics than other groups. It was discovered when subsequently discussing these findings with the lead mathematics teacher at this school, that this group had suffered many changes of teacher across the year. It is not possible to precisely determine what has led to this outcome for this set, or investigate further since all except Teachers D and G had left by the time I returned. It might, for example, be related to the staffing problems experienced, in which case this could lend weight to the teacher having an effect on students' theory of self. It could be due to students in the middle sets being particularly affected by being placed in a lower set than others for reasons other than their received indication of prior attainment.

At school D2, the Y7 students are taught in mixed ability groups. However, as shown in Table 6.2, these groups too are neither evenly distributed in terms of students' prior attainment nor gender. There is no clear pattern when comparing these groups as a whole. The students in 7MA, compared to both 7MB and 7MC, were more likely to agree with fixed intelligence and personality and students in 7MA and 7MB were more confident in their intelligence than 7MC. However, when the analysis of the groups was adjusted for gender there were no significant differences found between the three teaching groups on any of the four areas of inquiry. This, therefore indicates, that the differences between the groups were based upon the unequal distribution of boys and girls.

As previously noted, it was only Teacher CI at School D2 that taught more than one group of students. Therefore, with this exception, the statistics for teaching group matched that of teacher. However, when the students of this teacher were combined, (i.e. groups 7MA and 7MB), their agreement with the notion of fixed intelligence was greater than all groups across both schools except set 6, but their confidence in their own intelligence was also greater than all groups across both schools except set 1. However, when the composition of these two teaching groups combined is analysed, it had significantly more boys than girls and almost all of the high level boys in the whole cohort. Hence, given that these groups represent two thirds of the whole Y7 cohort of this school, they tend to reflect again the gender differences across and between the schools that were previously identified.

Thus, analysis of the data by gender within teaching groups suggests that the combination of boys and girls generally and specifically the combination of high level boys with low level girls in mixed ability groups may also be worthy of further investigation in relation to concerns about students performance in mathematics and the introduction of more challenge and collaborative group work in mathematics lessons. It is also indicative again of the need for further consideration of the contextual factors in the context-process-product paradigm of teacher effectiveness (Sammons et al, 2005; Goe et al, 2008).

Given that no overall difference was found between the students at the two schools with the same KS2 NC level, yet clear patterns were found between the students in sets, with more of them in the low sets demonstrating entity-theory characteristics than those in the high sets, these findings neither support nor refute those of Blatchford et al, (2008) that ability grouping per se can have a detrimental effect on students' affective outcomes. Rather, the findings from both schools in this study suggest that *ability labelling*, however it has come about, and reflected in the assignation of KS2 NC levels, has had an effect on students' affective outcomes in the form of their theory of self. Across both schools, students' entity-theory characteristics were found to be related to their KS2 NC level. Students with low NC levels demonstrated more fixed intelligence and personality characteristics and less confidence in their intelligence than those with the high NC levels.

The other notable difference was found between the level 5 students at School D2 with students in 7MA demonstrating more fixed intelligence and personality characteristics than those in 7MB, who in turn demonstrated more fixed characteristics than those in 7MC. Again, this reflects the gender imbalances between these groups and, as previously noted, from the girls tending to have more fixed characteristics than boys.

The mathematics teachers

Across the two schools, the analysis of the teachers' questionnaires showed that overall they did not display what Dweck (2000) describes in her 'entity theory' as fixed frameworks of intelligence, although, like the students, on average there was less flexibility on personality than intelligence. Two of the teachers A and G at School D1 displayed the most fixed framework of personality of the five teachers. Teacher CI at School D2, in line with her interview responses and in which she said she had been influenced by her professional development on the research of Dweck, demonstrated more than the others what Dweck (2000) describes in her 'incremental theory' as a malleable framework of intelligence. Holding entity theories of either intelligence *or* personality can have an effect not only on the labelling and judging of oneself but also of others. By contrast, incremental theorists believe in the potential for change.

On performance versus challenge in mathematics, the teachers are not in such harmony across all the questions in this area. Teacher G at School D1 particularly stands out. He taught the lowest of the sets, set 6, in that cohort and demonstrated some fixed characteristics of personality. He stated that he wouldn't give students problems that he thought they might not do well at, even though they might learn a lot from them. Working with the lowest attaining Year 7 students at school D1 and set against the pressure of exam performance and targets, upon which both teachers and students are measured, this teacher may have been protecting them from failure in this choice by avoiding higher expectations of them than that which he perceived them capable (Stevenson & Stigler, 1992). Watson, (2006) has demonstrated how low attaining students are often given work with low level challenge. Since the beliefs teachers hold about their students' proclivity towards mathematics and their ability to learn mathematics may lead them to be selective about their choice of teaching approach (van der Sandt, 2007) the student's entity theory characteristics are thus maintained.

Whilst Teacher G placed learning new things over getting the best level, if he had to choose between challenge and best level, he would choose best level. There seems to be some conflict here, reflective perhaps of the pull between intrinsic and extrinsic factors as suggested in Chapter 3 and the power of the discourse of performativity or indeed the conflict between teachers' ideal and what they actually do with the particular groups that they are given to teach (van der Sandt, 2007).

Only Teacher CI at School D2 consistently placed challenge over performance across all questions in this area, which is also consistent with her interview responses and perhaps indicative of her professional development in CI. The teachers were split in their ultimate choice of best level or challenge with both the male teachers choosing best level and the three female teachers choosing challenge. These findings do not correlate with the findings from the students where, whilst 75% of them ultimately chose good level over challenge, the majority of the boys preferred challenge over performance. This again highlights gender differences in the consideration of teacher effectiveness contextual factors. It also raises concerns about possible mismatches between teachers and students and their goals for learning mathematics.

In conclusion, a significant proportion of the students, boys and girls, at both schools demonstrated a heavy focus on performance over challenge in their mathematics lessons. The findings from the teachers' questionnaires demonstrated that some of the teachers also placed more emphasis on performance goals than challenge. Individually, these findings offer strong evidence for potential resistance to the introduction of teaching approaches which call for more challenge and collaborative group work in mathematics lessons as a way of enhancing student progress. Collectively, the combination of both students and teachers holding entity-theory frameworks, arguably sustains the dominant cultural script for teaching mathematics since the potential for change is not seen as an option by either party.

The findings from the students' questionnaires lend weight to the consideration of students' theory of self and others characteristics, which in this study are shown to be related to both gender and prior attainment as measured by KS2 NC levels, within the contextual factors of teacher effectiveness.

There is much in the literature that points towards a consideration of the effect of ability grouping on student outcomes, (Venkatakrishnan & Wiliam, 2003; Kutnick et al, 2005, Watson, 2006; Dunne et al, 2007; Blatchford et al, 2008; Boaler, 2009). This study suggests that in the case of these two schools, the differences between the students' at the two schools do not appear to be related to the mode of student grouping or teaching approach but are related to their gender and student's KS2 NC attainment levels. However, a causal relationship cannot be inferred since this relationship may have been influenced by these students' prior experience in their primary schools in terms of the mode of grouping and/or the teaching approach used or indeed other contextual factors.

The findings in this chapter, in relation to the introduction of an alternative teaching approach such as Complex Instruction, do offer some insight into the resistances that could be encountered. They also lend some weight to the very need for such an approach.

First, in the case of the resistances, with the notable emphasis students give to performance, an approach like CI may not appear self-evidently linked to the notion of increasing performance in the same way as the dominant approaches previously identified.

Secondly, as Dweck (2000) has found, holding an entity-theory not only effects judgements of self but also of others. Given that particular groups of students in this study are shown to hold an entity-theory framework more than others, these groups of students may find it difficult to work with each other because of such judgements. Teachers at both schools reported in their interviews that students tended to gravitate towards other students that they perceived to be of similar ability.

Thirdly, the findings from the teacher questionnaires show that these teachers' theory of others tends to be less flexible in relation to personality than intelligence. Hence, their judgements of students in relation to this construct may inhibit their perception of student's ability to change. As interviews with both of the lead teachers demonstrated, there was anxiety for both of them about doing collaborative group work with some of their students due to concerns about adapting students' behaviour.

In the case of affordances, research (Dweck, 2000) has shown that an incremental-theory of self leading to mastery orientated goals of learning can be fostered in students. Furthermore, students with an incremental theory of self derive self-esteem through effort and by co-operating with and helping others. Hence, taking a longer-term approach to improving students' progress in mathematics in English schools, signalled as a need by the policymakers, pedagogy such as CI, which has been shown to benefit students in terms of their self-esteem and collaboration skills leading to higher attainment (Boaler & Staples, 2008; Cohen, 1994), offers a possible solution.

7 Reflections on the study

7.1 Introduction

In this chapter, in relation to the introduction of a previously unfamiliar approach to teaching mathematics in English secondary schools, in this case Complex Instruction, I will first reflect upon the methodology of the study across the three stages of its development: teachers' current practice, teachers willing to trial the approach and the comparative analysis of the two schools. Then, by reflecting upon the findings across these three stages, I will consider the ways in which this study either informs or supports or contradicts the conceptual frameworks introduced at the beginning of the thesis. Finally, I will consider the study's implications for the future in terms of policy, professional development and research.

7.2 Research methodology

In Chapter 3, I described my methodological approach as that of social constructivism on the basis that it recognises the difficulty in social science research of capturing an observable, measurable reality from which causal relationships can be identified and generalisations made. Instead social constructivism takes a relativist stance and accepts that there is no objective reality outside the meanings humans bring to it. Hence, it acknowledges the local, social and experiential nature of the phenomenon being studied. It also acknowledges that the phenomenon can be true to the holder and can be commonly shared amongst groups and cultures; yet it is malleable and can be shaped and reshaped through the interplay between the individual and the social.

Thus, in exploring the concept of a cultural script for teaching mathematics (Stigler & Hiebert, 1999; Gates, 2006; Royal Society; 2008), a social constructivist stance is appropriate since, whilst it accepts the somewhat deterministic aspects of teachers' beliefs and behaviour brought to bear by dint of their personal history and the constraints of society's structures, it also accepts individual agency and hence the potential for change.

This research, therefore, in the spirit of social constructivism, through interpretation of the data collected, comparing and contrasting the various constructions that the teacher and student participants have provided, achieves the aim of making a contribution to a more informed construction of the concept of a cultural script for teaching mathematics in English secondary schools (see section 7.3).

Given this aim I chose a multi-strategy design, since I argued that it was the best option to address the research questions. Being informally aware of barriers to introducing a previously unfamiliar pedagogy, in this case Complex Instruction, I began with the analysis of qualitative data collected from three distinct samples of teachers in order to explore their scripts for teaching mathematics. Collecting data from three separate groups of teachers afforded the opportunity to triangulate the interpretation of these data for convergence and trustworthiness (Robson, 2011).

Altogether these data were from 76 different teachers representing in excess of 50 different secondary schools from across the country. However, in terms of the total population of teachers and secondary schools, there are 3,127 maintained secondary schools in England (DfE, 2010); this is a very small and not necessarily representative sample.

The interview data collected, in this case teacher's detailed accounts of their teaching practices, are fictions both in terms of what is and what is not told (Goodson and Sikes, 2001). Hence, the resultant quality of the data is partly contingent upon the relationship formed between the researcher and the participants. I endeavoured, as described in Chapter 3, through whole day visits to selected teachers and communications by email, to build such relationships. Observation of their lessons and further discussions with these teachers also created further opportunities to test the data for convergence and trustworthiness.

Using the methods of open-coding and constant comparison to analyse the teachers' scripts served the purpose of exhausting the categories generated and enabling a theoretical model of the participating teachers' scripts to emerge, as shown in figure 3.1. Informed by the conceptual framework of a dominant cultural script for teaching mathematics (Stigler & Hiebert, 1999) and then applying quantitative values to the eight emergent categories presented the opportunity to look at the model in terms of both micro insights: what is most focal in the minds of these teachers and macro insights: the relative situational pressures they are under.

This emergent model also provided a framework within which to compare the scripts of a sample of teachers who were willing to trial the previously unfamiliar pedagogy. As explained in Chapter 3, this sample was unavoidably small at the time. The findings from these teachers' scripts gave the opportunity to test further the applicability of the model in relation to the introduction of this previously unfamiliar approach to teaching mathematics and, unexpectedly, led to new insights in relation to possible barriers or resistances from the students of these teachers. Hence, the comparative analysis of the two Y7 cohorts of students and their mathematics teachers began.

This comparative analysis presented both affordances and limitations. It enabled further testing of the limits of applicability of the emergent model on the basis of the differences between the two cohorts, namely the mode of student grouping and the pedagogical approach used in mathematics. Further, it enabled the opportunity to test the theoretical framework of Dweck (2000), which at the time was exerting some local influence in teacher professional development (Lucas & Claxton, 2010), as a further possible explanation for the perceived barriers to the introduction of previously unfamiliar teaching approaches. In both these affordances, it creates opportunities for others in the education arena to learn from these cases (Bell, 2005; Shulman, 1992).

The limitations of this comparative analysis are that despite careful matching on the basis of a range of indicators, all schools are essentially unique and these two schools, within the same local authority, had substantial differences in relation to, for example, their size, staffing, student gender ratios and school leadership and policy. Also, given that teachers do not work in a vacuum, there is no control as to the degree of teachers' awareness of either the ideas of Complex Instruction or the ideas of Dweck. Further, the students do not begin their secondary school education in a vacuum either and will have been previously influenced in their constructions of mathematics education on both a micro and macro level.

In addition to the limitations, outlined in Chapter 3, of using questionnaires to collect data, and despite good response rates, the overall richness, convergence and trustworthiness of the data would have benefited from additional data from interviews with the students and more from the mathematics teachers at both of the schools.

Further, whilst the study could be considered to some extent to be longitudinal, being conducted across a period of one academic year, it is arguably not longitudinal enough to detect any noticeable differences in the constructs being examined.

Whilst at all times throughout the research I have adhered to the received university guidelines on research ethics regarding the involvement and anonymity of participants and the confidentiality of data collected, there remains some doubt about the ethics surrounding the analysis of secondary data that were collected for concurrent research projects. Whilst all the other data collected for this research project was with direct permission from the participants this was not the case for the first sample of teachers, although permission to use it was granted from the original researcher, Boaler. As I explained in the introduction, at the start of this study, I was her research assistant and contributed to the findings of two of the research projects for which she was the Principal Investigator, which are now in the public domain and to which my name is attached. Since the intention of my study was not to be critical of the teachers, but rather explore further and understand the explanations given for their pedagogical approach to teaching mathematics and, from their perspective, theorise about issues that might lie in the way of introducing an approach which has been shown to be successful elsewhere, I consider that I have not perverted the purpose for which the data were originally collected and I have maintained the integrity of it. In hindsight, however, to avoid the concerns and in line with the latest university research ethics guidelines, I might have been advised to return to these participants to seek their specific permission for this study before proceeding further.

In all stages of the research project, I have questioned whether I have taken a critical theoretical stance (Drake & Heath, 2008). Stepping out of one's preconceptions is a challenge. As I stated in my introduction, from my past experience as a teacher of mathematics and as a teacher educator I held a position about how I thought mathematics should be taught in schools. In addition, as a research assistant to Professor Boaler, I was associated with other research projects related to mathematics pedagogy in schools. In each case it could be interpreted that I am promoting any of one of mixed ability grouping of students for mathematics, problem solving group work generally or Complex Instruction specifically within mathematics lessons and arguably, therefore, the data and the findings are compromised. Rather, as stated above, and although Complex Instruction has been used as the example, I have attempted instead to look at factors which need to be considered when calls are made for mathematics teachers to change their pedagogy by the policymakers. In this respect, I am arguably able to bring my experience of working in the field to both enhance the collection and analysis of the data. Nevertheless, this study is one that is largely based upon teachers' professed beliefs and practices which is subject to attribution by the researcher. Within the time frame available, I have attempted to verify these attributions by the use of a range of research methods to collect data from a variety of sources and where possible to check my findings with the teachers.

7.3 Contribution to knowledge

Reports on the teaching and learning of mathematics in English schools, (Smith, 2004; Ofsted, 2006, 2008a; Williams, 2008, Royal Society, 2008; 2010; Vorderman et al, 2011), have expressed concern about students' performance and enjoyment as well as their progression into studying mathematics post-16. Ofsted (2008a) stated that too often students were expected to follow rules and procedures without mastering underlying concepts and connections, and hence without developing their mathematical understanding. Each report, with considerable agreement, has made recommendations for improvement. They include the employment of teaching approaches which develop students' understanding of mathematics whatever their level of attainment and investment in teachers' continuing professional development to provide opportunities for reflection on alternative approaches and share good practice. However, such recommendations are made within the context of an enduring debate about two powerful, interrelated discourses for teaching and learning; that of how students should be grouped and that of what constitutes effective teaching.

In Chapter 2 it was demonstrated how the discourse relating to grouping strategy is rooted in a range of deep-seated, socio-cultural beliefs about the nature of intelligence, about how children learn, about the goals of schooling, about the best way to support students with differing levels of attainment and about the effect of labelling students, (Chitty, 2007). It was also demonstrated how, on examining a range of teacher effectiveness studies, (Sammons et al, 1995; Muijs & Reynolds, 2003; Hay McBer, 2000; Ofsted, 2002; Hattie, 2003; Day et al, 2006; Harris & Rutledge, 2007; Barber & Mourshed, 2007; Goe et al, 2008), whilst there appears to be some lack of consensus about both the desired outcome and the means of measurement, there is a strong focus on the outcome of student attainment as measured by standardised assessment tests. The majority of the references to effectiveness factors relate to the teacher's individual classroom practice. These are identified in terms of their contribution to students' cognitive progress via the quality of the teacher's planning, teaching method and assessment coupled with high student expectations. Whilst there is mention of affective factors, which are contained within the categories of classroom climate and development of students' self-regulation, self-efficacy, and self-esteem, these are referred to rather less frequently.

The affective characteristics of teachers have been considered over many years in relation to their beliefs about mathematics and the models of teaching and learning, (e.g. Plowden, 1967; Ernest, 1989; Askew et al, 2010, Royal Society, 2010). However, factors such as teachers' attitudes towards, for example, the nature of intelligence, and the characteristics of their students as learners appear to have been given less weight in policymakers' analysis of the situation. Yet, it has been long recorded that teachers' attitudes can have a powerful effect on students' performance, (Plowden, 1967), and recent studies (e.g. Adey et al 2004; 2007; Hart et al, 2004; Dweck, 2000, Watson & De Geest, 2005) demonstrate how challenging teachers' conceptions of intelligence and the notion of fixed ability opens up broader opportunities for raising levels of achievement.

Koehler & Grouws (1992) argue that outcomes of learning are based on learners' own self-belief, their beliefs about mathematics and what teachers say or do within the classroom. Van der Sandt (2007) has expanded this with a focus on teacher's beliefs and attitudes towards students. Thus, if a teacher believes that groups of students, or individuals within a group, do not have the capability to learn mathematics in a problem solving manner then they might, for example, choose to teach mathematics as a set of rules and procedures. Teachers are more likely, van der Sandt (ibid) also argues, to be enthusiastic and confident with students that they like teaching which may be affected by factors such as perceived ability, gender, socio-economic background or even appearance. Thus, although teachers in their ideal world with their ideal learners may have a coherent model for teaching and learning mathematics, there may be other influences, of which they may be more or less conscious, over the model they actually enact in the classroom. These influences can take the form of individual learner or group attributes or the imposition of school or national policy.

The government has taken great interest in international comparisons (e.g. Barber & Mourshed, 2007; Mourshed et al, 2010) in terms of improving the nation's performance in mathematics as measured by standardised tests. In these reports, teachers' expectations are highlighted as a key factor in effective teaching. These are hinged upon a collective belief in the common ability to make a difference. However, analysis of international comparative studies in mathematics (Stevenson and Stigler, 1992; Askew et al, 2010) shows that nations may have different collective beliefs about matters such as goals of education, the nature of intelligence and ways of grouping students in addition to differing beliefs about pedagogical approaches. The significance here is that an emphasis on an 'ability' as opposed to an 'effort' model tends to lead to the categorisation of children and determine what kind of education students allocated to each category will receive (Ruthven, 1987; Hart et al 2004).

The studies by Adey et al (2007) and Dweck (2000) shed light on the relationship between these perceptions of intelligence and the subsequent effect this has on expectations and attainment. Adey et al, whilst acknowledging the political, cultural and social barriers, state that the key is in appreciating the plasticity of intelligence and the way it accounts for individual differences, intellectual development and learning and the necessary design of approaches for raising academic achievement. From their research evidence they concluded that long-term intervention programmes in schools can significantly influence the development of general intelligence.

Dweck's research findings demonstrate that, whilst acknowledging individual differences between learners, holding incremental-theory framework beliefs focus on the idea that, with effort and guidance, all learners can increase their intellectual attainment. This has implications for the classroom and may explain some of the difficulties students face as they progress through school. A diminishing student attitude has been noted as a particular feature of mathematics, (e.g. Royal Society, 2008; 2010). She found that that the framework of intelligence and personality that one holds can have an effect not only on the labelling and judging of self but also of others. Arguably, therefore, teachers' beliefs about intelligence and personality will have an effect on both what they think students are capable of and how they should be taught. A further significant finding identified by Dweck (2000) is that a more cooperative atmosphere between students can be fostered within an incremental framework because it enables all students to feel successful when applying their intellectual abilities to the task presented.

However, whilst Dweck states that beliefs about intelligence, personality and goals of learning can be taught, there is considerable evidence to show that mathematics teachers' beliefs are highly resistant to change even in the face of strong evidence, (Pajares, 1992; Swan, 2000). Beliefs about the fixed nature of students' capability in mathematics, for example, appear to be both dominant and relatively stable (Brophy and Good, 1974; Ruthven 1987; Boaler et al, 2000). Gates (2006) suggests that there is a coherent set of beliefs that is maintained and reproduced by English mathematics teachers which manifests in a dominant script in the form of teacher centred, model and practice lessons with a focus on remembering and practising rules and procedures. Pajares (1992) states that changes in behaviour will only occur if there is dissatisfaction with existing beliefs and the change is consistent with other beliefs held. There is also strong evidence that the social context both influences and maintains beliefs, (Ernest, 1989; Gates, 2006). Thus, the professional discourse of 'ability', a dominant discourse, becomes sustained by a whole set of occupational practices.

7.3.1 A dominant cultural script

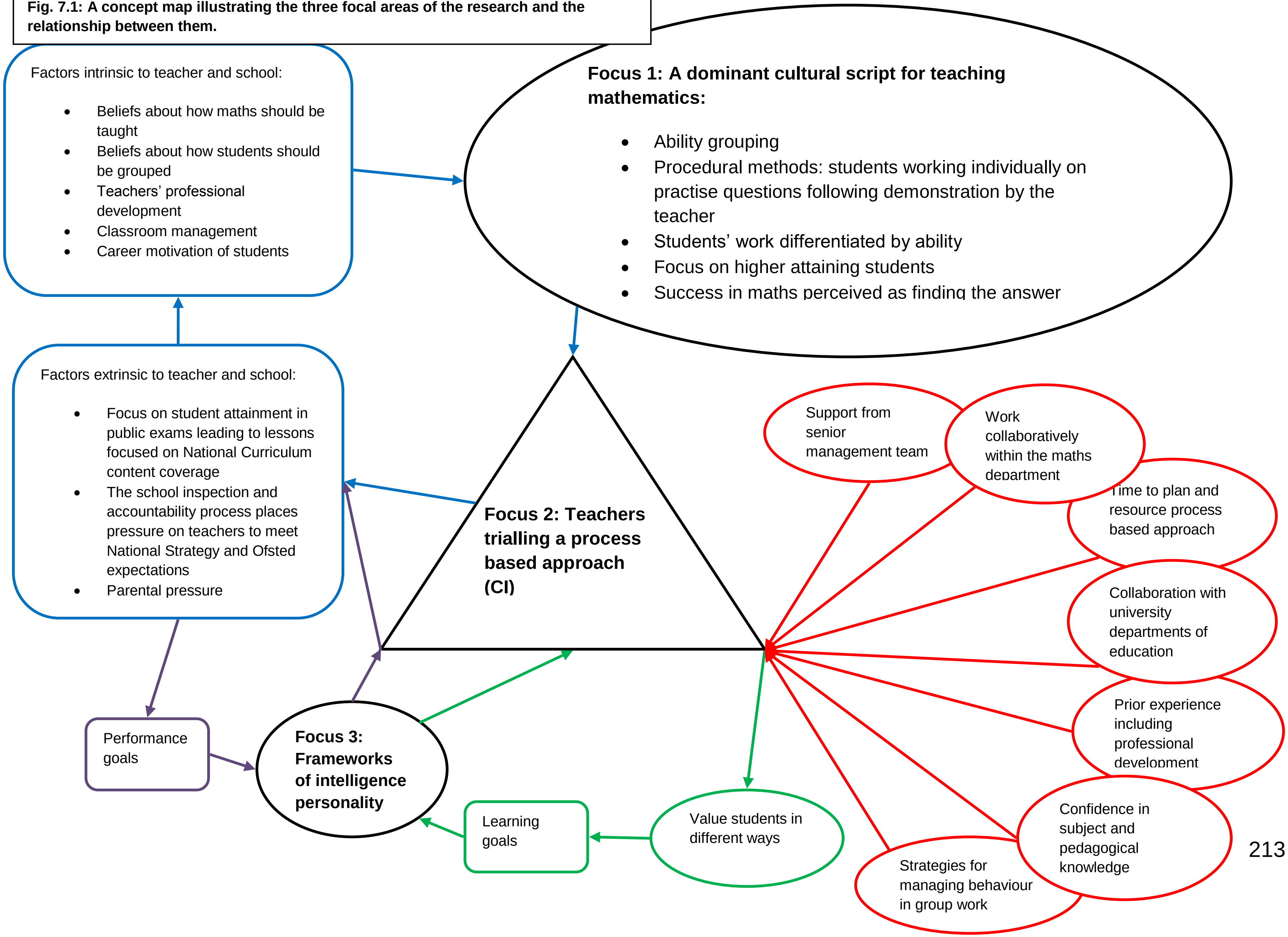
The concept of a 'dominant cultural script' for teaching mathematics sourced from the research of Stigler and Hiebert (1999) continues to be a concept referred to in the literature on mathematics education in English schools, (Gates, 2006; Royal Society, 2008). A key finding of Stigler & Hiebert's international comparative study was the notable homogeneity of mathematics teaching methods within each culture and the marked differences between cultures. Hence, they introduced the concept of a ‘cultural script’ for teaching mathematics. This concept provided a conceptual framework in which to explore potential resistances to alternative approaches to teaching mathematics and the apparent stability of ‘traditional’ methods. If changes are to be made in both initial teacher education and serving teachers’ professional development, Stigler and Hiebert suggest that prevalent cultural assumptions about teaching mean that the introduction of ‘non-traditional’ teaching methods in schools, for example those that appear to be successful in other cultures, are unlikely to be adopted quickly or easily without prior attention to the cultural beliefs and assumptions of the teachers expected to implement them.

The findings from the analysis of the interviews with teachers at schools with high post-16 participation in mathematics, the analysis of teachers’ responses to Boaler’s’ presentations of her research into the CI approach, and the analysis of CI workshop participants support this concept of a ‘dominant cultural script’ for teaching mathematics in English secondary schools. Reference is made to ‘expected national norms’, where the expectations are driven by the teachers’ understanding of government policy guidelines and the judgements made upon them are based on students’ public examination performance. The ‘script’ largely takes the form of ability grouping (sets) and teacher led, whole-class lessons with students’ work differentiated to suit their perceived ability. This performance goal orientated model, coupled with teachers’ anxieties about unacceptable behaviour in the classroom together with concerns about finding time to plan and resource a different approach, offers strong reasons for teachers’ reluctance to change. As Pajares (1992) suggests, changes in teachers’ behaviour will only occur if there is dissatisfaction with existing beliefs. In this scenario, teachers are selective in their teaching approach to match performance goals and hence they need to be firmly convinced that an alternative approach will benefit or at minimum do no harm to student attainment, particularly to those students with the highest attainment, since this will be used to measure teacher effectiveness. Hence, the characteristics of the ‘dominant cultural script’ for teaching mathematics have become internalised by the majority of these mathematics teachers, they have become intrinsic factors which shape how mathematics is mostly taught. Further, they are sustained by extrinsic factors in the form of teacher accountability through examination and inspection success.

However, dominance does not equal all and this research shows that the scripts of the mathematics teachers that contributed to it do vary and can change depending upon individual, local and national circumstances. Teacher CI-2 is a good example of this. Her initial motivation for teaching mathematics her way was driven by her own disappointing experience of mathematics in school. However, whilst she initially conformed to teaching mathematics in ability groups, she changed her opinion when she became involved in a university research-led mathematics education initiative. Whilst she and her mathematics department, in her opinion, continue to work in ways that are different to many others she has observed, she is nevertheless mindful of national expectations and works extra hard to ensure that she meets them in the knowledge that pressure will be put on her to return to the dominant script if she fails to do so.

In this research, the analysis of the teachers' scripts derived from their explanations for their teaching approach goes beyond the previous definitions of the concept of a dominant cultural script as derived from a detailed analysis of lesson observations of mathematics teachers in different countries (Stigler & Heibert, 1999; Andrews, 2010) to reveal further core components, as previously illustrated in figure 3.1, and to which the teachers gave more or less emphasis. Hence, in relation to the appeal to mathematics teachers to incorporate more opportunities for their students to investigate open-ended problems, discuss and explain their ideas (Ofsted, 2008a) these findings reveal some micro insights in terms of what is the most focal in these teachers' minds. They also reveal some macro insights in terms of the relative situational pressures these teachers are under. Figure 7.1 below presents a concept map to illustrate the connections between these micro and macro insights.

Fig. 7.1: A concept map illustrating the three focal areas of the research and the relationship between them.



With increased exposure to the ideas of Complex Instruction, on a micro level, the teachers tended to shift their focus from their beliefs about how mathematics should be taught towards concerns about classroom behaviour management and professional development in terms of both time to collaborate with colleagues and develop resources. On a macro level, their concerns about curriculum content coverage and external accountability also increased.

The findings from the interviews with the teachers who were willing to trial CI with their Y7 students support the importance of contextual and situational factors in teachers adapting their pedagogical approach (Ernest, 1989; Gates, 2006; Kennedy, 2010). In line with the findings of Ragbir-Day et al (2008), and in addition to self-efficacy beliefs that they have the subject and pedagogical knowledge to teach mathematics in this way, these take the form of supportive senior management, supportive members of their mathematics department who are willing to work collaboratively, and professional development opportunities to reflect upon beliefs and practices. These findings also lend weight to the barriers they face in sustaining a change in their pedagogy which take the form of external accountability via examination performance, inspection and parental pressure.

Thus, with reference to Figure 7.1, unless the supporting factors for change, highlighted in red, are evident, the teacher is likely to remain in the cycle maintained by the factors that led to the dominant cultural script, highlighted in blue.

7.3.2 Theory of self and others

The decision to conduct an inquiry at two contrasting schools into students' and teachers' 'theory of self and others', (Dweck, 2000), was made for the following reasons. Following initial exposure to the CI approach, an imperative of which is that students with different levels of attainment work together in small groups, a common response from the teachers related to concerns about whether students with a wide difference in perceived ability would be able to work together and without detriment to the highest attaining students. This was reiterated by the teachers that were trialling the approach. However, whilst the teachers in receipt of the most input on the CI approach demonstrated a shift in their pedagogy towards looking at different ways in which they could measure and value students' success in mathematics, see Figure 7.1, highlighted green, the teachers trialling the approach also reported some resistance to the approach from the students themselves, who expected and wanted to work individually in mathematics lessons.

The findings from this comparative study revealed no evidence to support a difference in ‘theory of self and others’ between the two cohorts of Y7 students overall on the basis of either the mode in which they were grouped for mathematics lessons; sets or mixed ability, or the teaching approach used. However interesting findings were revealed that have implications for requests for teachers to adapt their pedagogy in order to address the concerns expressed by the policymakers.

Dweck’s research has shown that holding entity-theory frameworks are unlikely to lead to mastery-orientated goals of learning, a key factor, she claims, to enhancing students’ progress. Furthermore, holding such an entity-theory framework can have an effect not only on the labelling and judging of oneself but also of others. By contrast, incremental-theorists believe in the potential for change. Encouragingly, she argues that students’ ‘theories of self and others’ can be influenced; though for how long she is unsure, claiming that college students who learned the incremental approach made a marked improvement in their achievement.

With regard to the teachers in this study, although none of them demonstrated strong entity-theory frameworks across all the constructs measured; there was some variation particularly in relation to their perceptions of fixed personality and goals of learning. The former may have some bearing on teachers’ concerns about introducing collaborative group work and behaviour management. The latter offers some evidence for the power of performativity on some teachers, as reflected in accountability through public examinations.

The findings of this study show that at both of these two schools there were a significant proportion of students with entity-theory frameworks and who preferred performance over challenge. This resonates with concerns raised in the literature about the lack of challenge in mathematics classrooms (Ofsted, 2008a). However, the locus for improvement in this Ofsted report tends to lie with the teacher rather than the student. The findings of this study suggest that on a macro level, the power of the discourse of performativity on young people as well as the teachers requires further examination, particularly in relation to success in mathematics being perceived as procedural fluency (Askew et al, 2010). In figure 7.1 this emphasis on performativity is highlighted in the purple cycle, which in turn could lead to the maintenance of the dominant cultural script.

This study also provides evidence across both schools for a relationship between students’ gender and students’ KS2 NC level and their ‘theory of self and others’ characteristics. The girls more than the boys and the low attaining more than high attaining students demonstrated entity-theory frameworks and performance over challenge goals of learning. Although no difference was found overall between the two schools in terms of their current mode of grouping students for mathematics, the high incidence of entity-theory characteristics found amongst the lower attaining students at both schools adds another dimension to the findings from research studies on ability grouping, (Hallam, 1999; Venkatakrishnan & Wiliam, 2003; Kutnick et al, 2005), in terms of the effect of ability labelling on students' self esteem. The difference between the boys and girls, particularly in terms of girls' confidence in their mathematical ability, also confirms and adds insight to the findings in the literature (Royal Society, 2008).

These findings highlight the need to reconsider contextual factors in teacher effectiveness studies in relation to mathematics, in terms of a school's composition according to both gender and prior attainment as measured by KS2 NC levels. With significant proportions of students within a cohort holding entity-theory characteristics there is a danger that future attainment will be hampered if this is not attended to.

Further, students holding entity-theory characteristics may themselves present a considerable resistance to the introduction of the alternative approaches called for in mathematics education. First, because such students are more likely to make judgements of themselves and others, they may resist collaboration with others. Secondly, given that they are more likely to be performance goal orientated, they will need to be convinced that a collaborative approach, like CI, can lead to better performance in the long run. As Dweck (2000) states there is nothing intrinsically wrong with either performance or mastery goals, the danger is when the former takes precedence over the latter. In this way the purple cycle in Figure 7.1 is maintained and indirectly maintains the dominant script.

Finally, the combination of students and their teachers should be considered. If both hold entity-theory characteristics then arguably the dominant cultural script for teaching mathematics is maintained since the potential for change in not perceived as an option.

The beliefs teachers hold about their students' ability to learn mathematics may lead them to be selective about their choice of teaching approach (van der Sandt, 2007). In this regard, it was notable that Teacher CI-1, the teacher with the most professional development related to CI, demonstrated the strongest incremental-theory characteristics when her questionnaire was analysed. In interview, she spoke about how she had begun to value her students in different ways beyond quickly getting the answer right and how the students were beginning to respond in different ways: more collaboration, discussion and perseverance when given challenging tasks. Teacher CI-2, with the most experience of teaching mathematics using process-based approaches, from CAME to CI, spoke of the many ways in which she valued her students. This was highly evident in the observation of her lessons where she used rich problem-solving tasks to encourage students to ask good questions, collaborate with each other and discuss their work, see problems in different ways and give reasons for the solutions. In line with Dweck's (2000) theory, this way of valuing students is more likely to lead to learning goals, which, in Figure 7.1 is shown in the green cycle. Thus if this cycle, supported by the factors highlighted in red, is maintained the possibility of breaking away from the dominant script is facilitated.

7.4 Implications for the future

I began this thesis by outlining enduring concerns expressed by the policymakers (Smith, 2004; Ofsted, 2008a) about the state of mathematics education in English secondary schools. Reform of mathematics teaching was called for then and has been reiterated since by the new government elected in 2010, (Vorderman et al, 2011).

The concerns expressed by Ofsted (2008a), and echoed in the two Royal Society Reports (2008, 2010), centred on students' unsatisfactory performance, enjoyment and post-16 participation in mathematics with particular concerns about too much emphasis being placed on students memorising methods, rules and facts at the expense of opportunities to investigate open-ended problems, discuss, reason and generalise.

The key recommendations of Ofsted (2008a) was that, in addition to improving their subject and pedagogical knowledge, serving mathematics teachers should engage in continuing professional development which facilitates reflection upon alternative approaches to teaching mathematics and the sharing of good practice. In the case of the former they suggested approaches which developed students' understanding of mathematics, whatever their level of attainment, which encouraged collaborative inquiry, critical reasoning and discussion rather than teaching to the test.

The Complex Instruction approach is demanding; emphasising effort over 'ability', it challenges beliefs that only some students can do mathematics and that they should be taught in 'ability' groups. It is an approach which promotes group work properly designed with rich tasks appropriate for students with a wide range of prior attainment, instructional strategies that incorporate the use of norms and roles and teacher interventions which hold both individuals and groups accountable for learning (Cohen & Lotan, 1997). The outcomes claimed of this approach, are that it supports the learning of key mathematical concepts and skills, develops autonomy and independence and raises the status and attainment expectations of all learners. Boaler (2006) has researched this approach in the US to show that significant gains can be made with its application. Though not without its critics, the Complex Instruction approach arguably addresses the deficits outlined in the Ofsted (2008a) report. Interestingly, this approach is also featured as an example of effective practice in the report on mathematics education to the Conservative Party, with a forward from the current Secretary of State for Education, Michael Gove, (Vorderman et al, 2011). Hence CI provides a good example for investigating what barriers lie in the way of reform and of teachers taking on the kind of approaches suggested in these reports.

In the introduction, drawing upon the research of Stigler and Hiebert (1999), it was argued that teachers have a shared mental picture of what teaching is like, a ‘cultural script’. Hence to improve mathematics teachers’ pedagogy, as called for in the reports, it is necessary to adapt the cultural script for teaching mathematics rather than focus on the skills of individual teachers. However, a prerequisite for that is an understanding of the form the script takes. The findings of this research confirms the dominant script to be, as reported in the literature review, one of ability grouping, traditional teacher-led pedagogy with a focus on the highest attaining students. Further, by revealing the components of the script in more detail, this research also shows how teachers shift their emphasis upon its various components when they are exposed to a more collaborative approach. Arguably, this needs to be taken into account by the policymakers in their requests for a change in mathematics teachers’ pedagogy towards this kind of approach.

Also demonstrated in the review of the literature, the component of ability grouping for mathematics is both dominant and stable. It is featured highly amongst the teacher participants in this research. The very difficulty of finding secondary schools with mixed ability classes to take part in trialling CI, with its imperative of mixed ability groups, bears testimony to this. Furthermore, even participating teachers were reserved about teaching mixed ability classes with their older students. An argument here could be, therefore, that the teachers’ resistance in this study is due to the mixed ability imperative of CI rather than collaborative group work per se.

However, the teachers’ shift to increasing concerns about behaviour management when exposed to CI, offers general insight into the resistance to collaborative group work. As Watson and De Geest (2005) have demonstrated, improvement for low attaining students in mathematics is contingent upon a collection of teachers' beliefs and commitments which include a rejection of the notion of students' fixed ability and learning style and a dominant belief in the worth of all students; that they could learn more mathematics, get better at it and feel better about themselves as students of mathematics. The findings in this thesis show that a significant proportion of the students and some of their teachers, hold entity-theory beliefs to some extent whether the students are taught in sets or mixed ability groups. Since holding such beliefs has been shown to lead to the labelling and judging of self and others, the beliefs that students cannot change coupled with concerns about behaviour management provides an explanation, from both the teachers' *and* the students' perspective, for potential resistance to collaborative inquiry in mathematics.

A further shift noted was the teachers' increased concerns about curriculum content coverage and external accountability through the mechanisms of inspection and examination performance. Hence, this research offers some insight into what is the most focal in the minds of the teachers when considering alternative teaching approaches in relation to the situational pressures they are under at both a micro and macro level. In so doing it reveals some contradictions within prevailing policy for mathematics education in secondary schools. The call for a change in pedagogy is clear, but it is against a backdrop of a over a decade of government policy guidelines and influential teacher effectiveness reports (e.g. Hay McBer, 2000) which, sustained by Ofsted inspections and league tables of examination performance, has led to considerable uniformity in the format of mathematics lessons in schools deemed to be effective. Thus, in the context-process-product paradigm of effective teaching, described in Chapter 2, there has been a heavy focus upon the process, the teacher's individual classroom practice, related to a one-dimensional product; that of examination performance sustained by teacher accountability. However, a change in teachers' pedagogy to that which has been called for; one which encourages collaborative inquiry, critical reasoning and discussion rather than teaching to the test, not only requires a change in the process within the paradigm, it also requires the product to be multi-dimensional to incorporate students' skills in working collaboratively. Thus, more focus needs to be placed on student's affective progress with assurances of no expense to their exam performance.

The reports on mathematics education in English secondary schools reviewed suggest that to achieve the desired changes in mathematics teachers' pedagogy investment should be made in teachers' professional development to provide opportunities to reflect on alternative approaches and share good practice. The issue of professional development opportunities as an important factor for pedagogical change has featured strongly in the scripts of the teachers in this research and supports the findings in the literature (Sammons et al, 1995; Day et al, 2006; Barber & Mourshed, 2007). However, it would appear to be the nature of the professional development rather than professional development opportunities per se which is important. There is some convergence of opinion of the serving teachers interviewed that trainee teachers begin their teaching practice with a pedagogical approach that largely matches the dominant script described. Whether that is as a result of the stable set of beliefs that prospective teachers bring with them at the start of their training, or whether it reflects ITE providers' programmes, or trainees' experiences in school whilst on teaching practice, is not clear. However, since the shifts in the serving teachers' pedagogy noted in this thesis has come about as a result of more local factors, particularly in the form of collaboration with university research-led initiatives with information and assistance from project staff, this is also worthy of further examination by the policymakers.

Such initiatives, for example, Complex Instruction (Boaler et al, 2010), the Teacher Effectiveness Enhancement Programme (Ragbir Day et al, 2008), Improving Attainment in Mathematics Project (Watson & De Geest, 2005) and Cognitive Acceleration in Mathematics Education (Adey and Shayer, 1994) have been shown to have a local impact. However, reports on these initiatives have also shown that implementation is contingent upon other factors. These include the time for intensive professional development in the form of introducing the programme as a whole school initiative, allowing time for it to become embedded, networking with other teachers and having a critical mass of teachers trained in the approach. In addition to professional development of teachers in awareness of the conceptual - pedagogical change, appropriate activities that offer challenge need to be designed and used and a collaborative work ethic established between students.

From 2008 to 2011, in addition to this thesis, I have been involved in two consecutive projects which have researched the introduction of the CI approach in English schools. Whilst Boaler and Staples (2008) research into the approach in the US was across five years, each of these other research projects has been conducted across one academic year. Each has had some local impact and attracted some interest from other schools across the country. However, in the space of one academic year, and as previously stated, with few teachers adopting the approach wholesale, whilst some changes in both teachers' and students' attitudes have been noted, no clear advantage in students' attainment has been established. Hence, a further study which returns to the schools which have adopted the approach either partially or wholesale may be helpful.

As demonstrated in this thesis, concerns in teachers' minds about students' examination performance, and hence their accountability, coupled with teachers or students or both holding entity-theory beliefs leading to performance goals present a powerful resistance to change. Furthermore, they reproduce and maintain a cultural identity of the successful learner of mathematics as being competitive, individualistic and elitist. Hence, in this current climate, both teachers and students need to be convinced that a change in mathematics pedagogy in English schools from the dominant cultural script to one of collaborative inquiry, critical reasoning and discussion, as called for by the policymakers, is not detrimental to students' performance in public examinations.

In my introduction, I outlined my journey in education since 1976 and events that triggered my pursuit of research evidence on student grouping and effective pedagogy in mathematics. Engaging with this thesis has developed further my understanding of the discourses which inform these constructs. It has also provided me with insight into the nature of the resistance to the reform of mathematics education in English schools signalled by the policymakers. Thus, as a teacher educator on a secondary mathematics PGCE programme, this thesis offers a number of implications for my own practice with a focus on creating opportunities for both trainees and serving teachers to reflect upon a range of approaches to teaching mathematics, share good practice and challenge their frameworks of intelligence and personality.

Watson (2011a) pragmatically accepts that the norm for mathematics in secondary schools is to group students into sets. In relation to my own practice, I now see advantages to this stance in relation to adapting the cultural script for teaching mathematics. Informed by the additional insight this thesis has provided and without eliminating altogether the debate about mixed ability grouping versus setting for mathematics, my focus is now turned towards the effects of ability labelling on students whether they are in sets or mixed ability groups.

For many teachers of mathematics, both in training and in service, an approach like CI requires a shift in at least two constructs: notably collaborative groupwork and the mode of grouping students. Since teachers work within their school's policy framework where, for most of them, the mode of grouping students is fixed and in the form of sets, understandably, an approach like CI approach can be rejected on the basis of its mixed ability imperative alone. Thus, in the current climate, it seems appropriate to first decouple the teaching approach from the mode of student grouping.

Secondly, more professional development opportunities, either at the university or in a host school, are required for both training and serving teachers to examine together the national policy imperatives in the light of recent research. Such opportunities should first disseminate the findings of recent mathematics education research projects that have had a local impact on the policymakers' requests for approaches which develop students' understanding of mathematics, whatever their level of attainment, and which encourage collaborative inquiry, critical reasoning and discussion. Secondly they should provide a forum to discuss the critical factors required for the successful implementation of such approaches, as identified in this thesis.

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Appendices

Appendix 1

Complex Instruction Workshop June 2008 – Evaluation Sheet

What is the most significant thing you have learned in this workshop?

Do you intend to use anything learned in your teaching? Yes/No

If so, please explain

What are your questions or concerns about incorporating any of the CI methods in to your practice?

Do you intend to change the grouping of any students so that attainment is more mixed? Yes/No

If so, which students?

Are you interested in being involved in further research in this area? Yes/No

If so, please give your contact details below:

Appendix 2

The following three-part questionnaire was used with teachers under the three conditions of:

1. Teachers using the CI approach with Y7 students learning mathematics in a mixed ‘ability’ class,
2. Teachers not using the CI approach with Y7 students learning mathematics in a mixed ‘ability’ class
3. Teachers not using the CI approach with Y7 students learning mathematics in a setted class.

The sections of the questionnaire are replicated from Dweck’s (2000) questionnaire (permission granted in her book) and slightly adapted for teachers in England to take account of variances in the use of the English language. They cover the areas of:

- **Implicit Theories of Intelligence**
- **Implicit Theories of Personality**
- **Learning Goal choices**

Questionnaire (Y7 Mathematics Teachers)

The University of Sussex

Your replies will be kept completely confidential.

Name:	School:
Are you male or female? (please cross one out)	My Y7 class is mixed ability/setted (please cross one out)

This questionnaire has been designed to investigate ideas about intelligence and personality. There are no right or wrong answers. I am interested in your ideas.

Using the scale below, please indicate the extent to which you agree or disagree with each of the following statements by writing the number that corresponds to your opinion in the box next to each statement.

1	2	3	4	5	6
Strongly Agree	Agree	Mostly Agree	Mostly Disagree	Disagree	Strongly Disagree

Everyone has a certain amount of intelligence, and you can't really do much to change it.	
People's intelligence is something about them that they can't change very much.	
To be honest, people can't really change how intelligent they are.	
People can learn new things, but they can't really change their basic intelligence.	

The kind of person someone is, is something very basic about them and it can't be changed very much.	
People can do things differently, but the important parts of who they are can't really be changed.	
As much as I hate to admit it, you can't teach old dogs new tricks. People can't really change their deepest attributes.	
Everyone is a certain kind of person, and there is not much that can be done to really change that.	

Please turn over and complete the next page

In mathematics lessons, which kinds of problems do you <u>most</u> often give students to work on?

	Tick only *one* box
Problems that aren't too hard, so they don't get many wrong	
Problems that they learn a lot from, even if they won't look so clever	
Problems that are pretty easy, so they do well	
Problems that they're pretty good at, so they can show that they're clever	

Using the scale below, please indicate the extent to which you agree or disagree with each of the following statements by writing the number that corresponds to your opinion in the box next to each statement.

1	2	3	4	5	6
Strongly Agree	Agree	Mostly Agree	Mostly Disagree	Disagree	Strongly Disagree

If I knew students weren't going to do well at a mathematics problem, I probably wouldn't give it to them even if they might learn a lot from it	
Although I hate to admit it, I sometimes would prefer students to do well in mathematics lessons than learn a lot	
It is much more important for students to learn new things in mathematics lessons than it is for them to get the best level	

If I *had* to choose between students getting a good level and being challenged in mathematics lessons I would choose.....(Circle one)

"good level" "being challenged"

Thank you for completing this questionnaire.

Appendix 3

The following four-part questionnaire was used with students under the three conditions of:

4. Y7 students learning mathematics with teacher using CI approach in a mixed ‘ability’ class,
5. Y7 students learning mathematics with teacher not using CI approach in a mixed ‘ability’ class
6. Y7 students learning mathematics with teacher not using CI in a setted class.

The sections of the questionnaire are replicated from Dweck’s (2000) questionnaire (permission granted in her book) and slightly adapted for students in England to take account of variances in the use of the English language and to make the questions specific to mathematics. They cover the areas of:

- **Implicit Theories of Intelligence**
- **Confidence in One’s Intelligence**
- **Implicit Theories of Personality**
- **Learning Goal choices**

Questionnaire (Year 7 students)

The University of Sussex

Your replies will be kept completely confidential.

Name:	School:
Mathematics Teacher:	Mathematics group:
Are you male or female? (please cross one out)	

This questionnaire has been designed to investigate ideas about intelligence and personality. There are no right or wrong answers. I am interested in your ideas.

Read each sentence below and then circle the *one* number that shows how much you agree with it.

1. You have a certain amount of intelligence, and you really can't do much to change it.

1	2	3	4	5	6
Strongly Agree	Agree	Mostly Agree	Mostly Disagree	Disagree	Strongly Disagree

2. Your intelligence is something about you that you can't change very much.

1	2	3	4	5	6
Strongly Agree	Agree	Mostly Agree	Mostly Disagree	Disagree	Strongly Disagree

3. You can learn new things, but you really can't change your basic intelligence.

1	2	3	4	5	6
Strongly Agree	Agree	Mostly Agree	Mostly Disagree	Disagree	Strongly Disagree

Please turn over and complete the next page

4. Tick *one* sentence that is the most true for you.

____ I usually think I'm intelligent

____ I wonder if I'm intelligent

Now, show how true the statement you chose is for you

very true for me	true for me	sort of true for me

5. Tick *one* sentence that is most true for you

____ When I get new work in mathematics, I'm usually sure I will be able to learn it.

____ When I get new work in mathematics, I often think I may not be able to learn it.

Now, show how true the statement you chose is for you.

very true for me	true for me	sort of true for me

6. Tick *one* sentence that is the most true for you

____ I'm not very confident about my intellectual ability

____ I feel pretty confident about my intellectual ability

Now, show how true the statement you chose is for you.

very true for me	true for me	sort of true for me

Please turn over and complete the next page

Read each sentence below and then circle the *one* number that shows how much you agree with it.

7. You can't really change what kind of personality you have. Some people have a good personality and some don't and you can't change much

1	2	3	4	5	6
Strongly Agree	Agree	Mostly Agree	Mostly Disagree	Disagree	Strongly Disagree

8. Your personality is a part of you that you can't change very much

1	2	3	4	5	6
Strongly Agree	Agree	Mostly Agree	Mostly Disagree	Disagree	Strongly Disagree

9. You can do things to get people to like you, but you can't change your real personality

1	2	3	4	5	6
Strongly Agree	Agree	Mostly Agree	Mostly Disagree	Disagree	Strongly Disagree

10. In mathematics lessons, which kinds of problems do you most like to work on?

	Tick only *one* box
Problems that aren't too hard, so I don't get many wrong	
Problems that I learn a lot from, even if I won't look so clever	
Problems that are pretty easy, so I do well	
Problems that I'm pretty good at, so I can show that I am clever	

Please turn over and complete the next page

Read each sentence below and then circle the *one* number that shows how much you agree with it.

11. If I knew I wasn't going to do well at a mathematics problem, I probably wouldn't do it even if I might learn a lot from it

1	2	3	4	5	6
Strongly Agree	Agree	Mostly Agree	Mostly Disagree	Disagree	Strongly Disagree

12. Although I hate to admit it, I sometimes would prefer do well in mathematics lessons than learn a lot

1	2	3	4	5	6
Strongly Agree	Agree	Mostly Agree	Mostly Disagree	Disagree	Strongly Disagree

13. It is much more important for me to learn new things in my mathematics lessons than it is to get the best level

1	2	3	4	5	6
Strongly Agree	Agree	Mostly Agree	Mostly Disagree	Disagree	Strongly Disagree

14. If I *had* to choose between getting a good level and being challenged in mathematics lessons I would choose.....(Circle one)

"good level" "being challenged"

Thank you for completing this questionnaire.

Appendix 4

Descriptive Statistics – Y7 Student questionnaires

Table 1. **School Name**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	D1	151	68.3	68.3	68.3
	D2	70	31.7	31.7	100.0
	Total	221	100.0	100.0	

Table 2. **Gender School D1 and D2**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	115	52.0	52.0	52.0
	Female	106	48.0	48.0	100.0
	Total	221	100.0	100.0	

Table 3. **Mathematics Teacher**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	A/B	30	13.6	13.6	13.6
	A/C	30	13.6	13.6	27.1
	CI	45	20.4	20.4	47.5
	D	26	11.8	11.8	59.3
	E	27	12.2	12.2	71.5
	F	18	8.1	8.1	79.6
	G	20	9.0	9.0	88.7
	I	25	11.3	11.3	100.0
	Total	221	100.0	100.0	

Table 4. **Mathematics Group**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	7MA	24	10.9	10.9	10.9
	7MB	21	9.5	9.5	20.4
	7MC	25	11.3	11.3	31.7
	Set 1	30	13.6	13.6	45.2
	Set 2	30	13.6	13.6	58.8
	Set 3	26	11.8	11.8	70.6
	Set 4	27	12.2	12.2	82.8
	Set 5	18	8.1	8.1	91.0
	Set 6	20	9.0	9.0	100.0
	Total	221	100.0	100.0	

Table 5. **Mathematics Group and Teacher**

				Count
Mathematics Group	7MA	Mathematics Teacher	CI	24
	7MB	Mathematics Teacher	CI	21
	7MC	Mathematics Teacher	I	25
	Set 1	Mathematics Teacher	A/B	30
	Set 2	Mathematics Teacher	A/C	30
	Set 3	Mathematics Teacher	D	26
	Set 4	Mathematics Teacher	E	27
	Set 5	Mathematics Teacher	F	18
	Set 6	Mathematics Teacher	G	20

Table 6. **Mathematics group by gender**

		Gender	
		Male	Female
		Count	Count
Mathematics Group	7MA	13	11
	7MB	14	7
	7MC	16	9
	Set 1	11	19
	Set 2	15	15
	Set 3	12	14
	Set 4	13	14
	Set 5	10	8
	Set 6	11	9

Table.7 You have a certain amount of intelligence, and you really can't do much to change it

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	8	3.6	3.6	3.6
	agree	35	15.8	15.8	19.5
	mostly agree	42	19.0	19.0	38.5
	mostly disagree	43	19.5	19.5	57.9
	disagree	58	26.2	26.2	84.2
	strongly disagree	35	15.8	15.8	100.0
	Total	221	100.0	100.0	

Table 8. Your intelligence is something about you that you can't change very much

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	6	2.7	2.7	2.7
	agree	28	12.7	12.7	15.5
	mostly agree	36	16.3	16.4	31.8
	mostly disagree	30	13.6	13.6	45.5
	disagree	84	38.0	38.2	83.6
	strongly disagree	36	16.3	16.4	100.0
	Total	220	99.5	100.0	
Missing	no response	1	.5		
	Total	221	100.0		

Table 9. You can learn new things, but you really can't change your basic intelligence

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	16	7.2	7.2	7.2
	agree	40	18.1	18.1	25.3
	mostly agree	42	19.0	19.0	44.3
	mostly disagree	38	17.2	17.2	61.5
	disagree	58	26.2	26.2	87.8
	strongly disagree	27	12.2	12.2	100.0
	Total	221	100.0	100.0	

Table 10. **Tick one sentence that is most true for you**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I usually think I'm intelligent	99	44.8	45.6	45.6
	I wonder if I'm intelligent	118	53.4	54.4	100.0
	Total	217	98.2	100.0	
Missing	no response	4	1.8		
	Total	221	100.0		

Table 11. **Now, show how true the statement you chose is for you**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Closest to very true for me	42	19.0	22.0	22.0
	Closest to true for me	111	50.2	58.1	80.1
	Closest to sort of true for me	38	17.2	19.9	100.0
	Total	191	86.4	100.0	
Missing	no response	30	13.6		
	Total	221	100.0		

Table 12. **Tick one sentence that is most true for you**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	When I get new work in mathematics, I'm usually sure I'll be able to learn it.	145	65.6	66.5	66.5
	When I get new work in mathematics, I often think I may not be able to learn it	73	33.0	33.5	100.0
	Total	218	98.6	100.0	
Missing	Undecided	1	.5		
	no response	2	.9		
	Total	3	1.4		
	Total	221	100.0		

Table 13. **Now show how true the statement you chose is for you**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Closest to very true for me	45	20.4	24.5	24.5
	Closest to true for me	102	46.2	55.4	79.9
	Closest to sort of true for me	37	16.7	20.1	100.0
	Total	184	83.3	100.0	
Missing	no response	37	16.7		
	Total	221	100.0		

Table 14. **Tick one sentence that is most true for you**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I'm not very confident about my intellectual ability	82	37.1	37.6	37.6
	I feel pretty confident about my intellectual ability	136	61.5	62.4	100.0
	Total	218	98.6	100.0	
Missing	no response	3	1.4		
	Total	221	100.0		

Table 15. **Now show how true the statement you chose is for you**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Closest to very true for me	46	20.8	26.0	26.0
	Closest to true for me	106	48.0	59.9	85.9
	Closest to sort of true for me	25	11.3	14.1	100.0
	Total	177	80.1	100.0	
Missing	no response	44	19.9		
	Total	221	100.0		

Table 16. You can't really change what kind of personality you have. Some people have a good personality and some don't and you can't change much

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	22	10.0	10.4	10.4
	agree	42	19.0	19.9	30.3
	mostly agree	49	22.2	23.2	53.6
	mostly disagree	44	19.9	20.9	74.4
	disagree	28	12.7	13.3	87.7
	strongly disagree	26	11.8	12.3	100.0
	Total	211	95.5	100.0	
Missing	no response	10	4.5		
	Total	221	100.0		

Table 17. Your personality is a part of you that you can't change very much

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	30	13.6	14.2	14.2
	agree	49	22.2	23.2	37.4
	mostly agree	40	18.1	19.0	56.4
	mostly disagree	37	16.7	17.5	73.9
	disagree	34	15.4	16.1	90.0
	strongly disagree	21	9.5	10.0	100.0
	Total	211	95.5	100.0	
Missing	no response	10	4.5		
	Total	221	100.0		

Table 18. You can do things to get people to like you, but you can't change your real personality

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	33	14.9	15.8	15.8
	agree	64	29.0	30.6	46.4
	mostly agree	45	20.4	21.5	67.9
	mostly disagree	30	13.6	14.4	82.3
	disagree	23	10.4	11.0	93.3
	strongly disagree	14	6.3	6.7	100.0
	Total	209	94.6	100.0	
Missing	undecided	2	.9		
	no response	10	4.5		
	Total	12	5.4		
	Total	221	100.0		

Table 19. In mathematics lessons, which kinds of problems do you most like to work on?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Problems that aren't too hard, so I don't get many wrong	53	24.0	25.9	25.9
	Problems that I learn a lot from, even if I won't look so clever	103	46.6	50.2	76.1
	Problems that are pretty easy, so I do well	25	11.3	12.2	88.3
	Problems that I'm pretty good at, so I can show that I am clever	24	10.9	11.7	100.0
	Total	205	92.8	100.0	
Missing	undecided	2	.9		
	no response	14	6.3		
	Total	16	7.2		
	Total	221	100.0		

Table 20. If I knew I wasn't going to do well at a mathematics problem, I probably wouldn't do it even if I might learn a lot from it

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	7	3.2	3.4	3.4
	agree	21	9.5	10.1	13.5
	mostly agree	31	14.0	15.0	28.5
	mostly disagree	30	13.6	14.5	43.0
	disagree	74	33.5	35.7	78.7
	strongly disagree	44	19.9	21.3	100.0
	Total	207	93.7	100.0	
Missing	undecided	1	.5		
	no response	13	5.9		
	Total	14	6.3		
	Total	221	100.0		

Table 21. Although I hate to admit it, I sometimes would prefer to do well in mathematics lessons than learn a lot

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	15	6.8	7.3	7.3
	agree	42	19.0	20.4	27.7
	mostly agree	41	18.6	19.9	47.6
	mostly disagree	37	16.7	18.0	65.5
	disagree	41	18.6	19.9	85.4
	strongly disagree	30	13.6	14.6	100.0
	Total	206	93.2	100.0	
Missing	undecided	1	.5		
	no response	14	6.3		
	Total	15	6.8		
	Total	221	100.0		

Table 22. It is much more important for me to learn new things in my mathematics lessons than it is to get the best level

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	28	12.7	13.7	13.7
	agree	58	26.2	28.3	42.0
	mostly agree	44	19.9	21.5	63.4
	mostly disagree	31	14.0	15.1	78.5
	disagree	27	12.2	13.2	91.7
	strongly disagree	17	7.7	8.3	100.0
	Total	205	92.8	100.0	
Missing	undecided	1	.5		
	no response	15	6.8		
	Total	16	7.2		
	Total	221	100.0		

Table 23. If I knew I wasn't going to do well at a maths problem, I probably wouldn't do it even if I might learn a lot from it

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	agree	59	26.7	28.5	28.5
	disagree	148	67.0	71.5	100.0
	Total	207	93.7	100.0	
Missing	undecided	1	.5		
	no response	13	5.9		
	Total	14	6.3		
	Total	221	100.0		

Table 24. Although I hate to admit it, I sometimes would prefer to do well in maths lessons than learn a lot

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	agree	98	44.3	47.6	47.6
	disagree	108	48.9	52.4	100.0
	Total	206	93.2	100.0	
Missing	undecided	1	.5		
	no response	14	6.3		
	Total	15	6.8		
	Total	221	100.0		

Table 25. It is much more important for me to learn new things in my maths lessons than it is to get the best level

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	agree	130	58.8	63.4	63.4
	disagree	75	33.9	36.6	100.0
	Total	205	92.8	100.0	
Missing	undecided	1	.5		
	no response	15	6.8		
	Total	16	7.2		
	Total	221	100.0		

Table 26. If I had to choose between getting a good level and being challenged in mathematics lessons I would choose

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Good level	153	69.2	74.6	74.6
	Being challenged	52	23.5	25.4	100.0
	Total	205	92.8	100.0	
Missing	no response	16	7.2		
	Total	221	100.0		

Table 27. **Summary Statistics – the four areas of investigation**

		Implicit theory of fixed intelligence	Confidence in one's own intelligence	Implicit theory of fixed personality	Learning goal choices
N	Valid	220	215	209	193
	Missing	1	6	12	28
	Mean	11.91	4.25	9.62	7.65
	Median	12.00	4.00	9.00	8.00
	Mode	15	3	6	7
	Std. Deviation	3.569	1.059	3.939	1.270

Table 28. **Implicit theory of fixed intelligence**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3 strongly agree	3	1.4	1.4	1.4
	4	1	.5	.5	1.8
	5	3	1.4	1.4	3.2
	6 agree	9	4.1	4.1	7.3
	7	9	4.1	4.1	11.4
	8	13	5.9	5.9	17.3
	9 mostly agree	21	9.5	9.5	26.8
	10	20	9.0	9.1	35.9
	11	20	9.0	9.1	45.0
	12 mostly disagree	25	11.3	11.4	56.4
	13	23	10.4	10.5	66.8
	14	9	4.1	4.1	70.9
	15 disagree	28	12.7	12.7	83.6
	16	13	5.9	5.9	89.5
	17	5	2.3	2.3	91.8
	18 strongly disagree	18	8.1	8.2	100.0
	Total	220	99.5	100.0	
Missing	99	1	.5		
	Total	221	100.0		

Table 29. **Confidence in one's own intelligence**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very high	66	29.9	30.7	30.7
	high	64	29.0	29.8	60.5
	low	51	23.1	23.7	84.2
	very low	34	15.4	15.8	100.0
	Total	215	97.3	100.0	
Missing	missing	5	2.3		
	System	1	.5		
	Total	6	2.7		
	Total	221	100.0		

Table 30. **Implicit theory of fixed personality**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3 strongly agree	13	5.9	6.2	6.2
	4	3	1.4	1.4	7.7
	5	10	4.5	4.8	12.4
	6 agree	29	13.1	13.9	26.3
	7	13	5.9	6.2	32.5
	8	22	10.0	10.5	43.1
	9 mostly agree	22	10.0	10.5	53.6
	10	17	7.7	8.1	61.7
	11	14	6.3	6.7	68.4
	12 mostly disagree	20	9.0	9.6	78.0
	13	10	4.5	4.8	82.8
	14	6	2.7	2.9	85.6
	15 disagree	15	6.8	7.2	92.8
	16	1	.5	.5	93.3
	17	1	.5	.5	93.8
	18 strongly disagree	13	5.9	6.2	100.0
	Total	209	94.6	100.0	
Missing	99	12	5.4		
Total		221	100.0		

Table 31. **Learning goal choices**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5 performance goal score very strong	1	.5	.5	.5
	6	39	17.6	20.2	20.7
	7	56	25.3	29.0	49.7
	8	48	21.7	24.9	74.6
	9	28	12.7	14.5	89.1
	10 learning goal score very strong	21	9.5	10.9	100.0
	Total	193	87.3	100.0	
Missing	no response	28	12.7		
	Total	221	100.0		

Table 32. Comparison 'Implicit theory of fixed intelligence' by school

		School Name	
		D1	D2
		Column N %	Column N %
Implicit theory of fixed intelligence	3 strongly agree	1.3%	1.4%
	4	.7%	.0%
	5	.7%	2.9%
	6 agree	4.6%	2.9%
	7	2.0%	8.7%
	8	6.0%	5.8%
	9 mostly agree	9.9%	8.7%
	10	7.3%	13.0%
		32.5%	43.9%
	11	11.3%	4.3%
	12 mostly disagree	13.2%	7.2%
	13	11.9%	7.2%
	14	4.6%	2.9%
	15 disagree	11.9%	14.5%
	16	5.3%	7.2%
	17	3.3%	.0%
	18 strongly disagree	6.0%	13.0%

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Implicit theory of fixed intelligence is the same across categories of School Name.	Independent-Samples Mann-Whitney U Test	.932	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Table 33. Comparison Implicit theory of fixed intelligence by gender

		Gender	
		Male	Female
		Column N %	Column N %
Implicit theory of fixed intelligence	3 strongly agree	2.6%	.0%
	4	.9%	.0%
	5	1.8%	.9%
	6 agree	.9%	7.5%
	7	1.8%	6.6%
	8	6.1%	5.7%
	9 mostly agree	7.0%	12.3%
	10	11.4%	6.6%
		32.5%	39.6%
	11	8.8%	9.4%
	12 mostly disagree	10.5%	12.3%
	13	12.3%	8.5%
	14	5.3%	2.8%
	15 disagree	8.8%	17.0%
	16	7.0%	4.7%
	17	3.5%	.9%
	18 strongly disagree	11.4%	4.7%

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Implicit theory of fixed intelligence is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	.075	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Table 34. **Comparison Implicit theory of fixed intelligence by Mathematics Group**

		Mathematics Group								
		7MA	7MB	7MC	Set 1	Set 2	Set 3	Set 4	Set 5	Set 6
		Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %
Implicit theory of fixed intelligence	3 strongly agree	.0%	.0%	4.2%	.0%	.0%	.0%	7.4%	.0%	.0%
	4	.0%	.0%	.0%	.0%	.0%	.0%	3.7%	.0%	.0%
	5	.0%	9.5%	.0%	.0%	.0%	.0%	.0%	.0%	5.0%
	6 agree	4.2%	4.8%	.0%	.0%	.0%	7.7%	7.4%	5.6%	10.0%
	7	20.8%	.0%	4.2%	.0%	.0%	.0%	7.4%	.0%	5.0%
	8	8.3%	.0%	8.3%	3.3%	6.7%	3.8%	11.1%	5.6%	5.0%
	9 mostly agree	12.5%	9.5%	4.2%	10.0%	6.7%	7.7%	11.1%	16.7%	10.0%
	10	8.3%	14.3%	16.7%	3.3%	3.3%	7.7%	14.8%	5.6%	10.0%
		54.1%	38.1%	37.6%	16.6%	16.7%	26.9%	62.9%	33.5%	45%
	11	4.2%	4.8%	4.2%	6.7%	13.3%	19.2%	11.1%	5.6%	10.0%
	12 mostly disagree	16.7%	4.8%	.0%	10.0%	16.7%	15.4%	11.1%	.0%	25.0%
	13	8.3%	9.5%	4.2%	10.0%	10.0%	34.6%	7.4%	.0%	5.0%
	14	4.2%	.0%	4.2%	10.0%	10.0%	.0%	.0%	5.6%	.0%
	15 disagree	12.5%	19.0%	12.5%	20.0%	16.7%	.0%	.0%	22.2%	15.0%
	16	.0%	14.3%	8.3%	3.3%	6.7%	.0%	7.4%	16.7%	.0%
	17	.0%	.0%	.0%	6.7%	6.7%	3.8%	.0%	.0%	.0%
	18 strongly disagree	.0%	9.5%	29.2%	16.7%	3.3%	.0%	.0%	16.7%	.0%

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Implicit theory of fixed intelligence is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Table 35. **Comparison Implicit theory of fixed intelligence by Mathematics Teacher**

		Mathematics Teacher							
		A/B	A/C	CI	D	E	F	G	I
		Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %
Implicit theory of fixed intelligence	3 strongly agree	.0%	.0%	.0%	.0%	7.4%	.0%	.0%	4.2%
	4	.0%	.0%	.0%	.0%	3.7%	.0%	.0%	.0%
	5	.0%	.0%	4.4%	.0%	.0%	.0%	5.0%	.0%
	6 agree	.0%	.0%	4.4%	7.7%	7.4%	5.6%	10.0%	.0%
	7	.0%	.0%	11.1%	.0%	7.4%	.0%	5.0%	4.2%
	8	3.3%	6.7%	4.4%	3.8%	11.1%	5.6%	5.0%	8.3%
	9 mostly agree	10.0%	6.7%	11.1%	7.7%	11.1%	16.7%	10.0%	4.2%
	10	3.3%	3.3%	11.1%	7.7%	14.8%	5.6%	10.0%	16.7%
		16.6%	16.7%	46.5%	26.9%	62.9%	33.5%	45.0%	37.6%
	11	6.7%	13.3%	4.4%	19.2%	11.1%	5.6%	10.0%	4.2%
	12 mostly disagree	10.0%	16.7%	11.1%	15.4%	11.1%	.0%	25.0%	.0%
	13	10.0%	10.0%	8.9%	34.6%	7.4%	.0%	5.0%	4.2%
	14	10.0%	10.0%	2.2%	.0%	.0%	5.6%	.0%	4.2%
	15 disagree	20.0%	16.7%	15.6%	.0%	.0%	22.2%	15.0%	12.5%
	16	3.3%	6.7%	6.7%	.0%	7.4%	16.7%	.0%	8.3%
	17	6.7%	6.7%	.0%	3.8%	.0%	.0%	.0%	.0%
	18 strongly disagree	16.7%	3.3%	4.4%	.0%	.0%	16.7%	.0%	29.2%

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Implicit theory of fixed intelligence is the same across categories of Mathematics Teacher.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Table 36. **Comparison Implicit theory of fixed intelligence by KS2 NC level**

		Not known	Level 2	Level 3	Level 4	Level 5
						KS2 Level
		Column N %	Column N %	Column N %	Column N %	Column N %
Implicit theory of fixed intelligence	3 strongly agree	.0%	.0%	.0%	2.9%	.0%
	4	.0%	.0%	2.6%	.0%	.0%
	5	.0%	.0%	2.6%	1.0%	1.8%
	6 agree	.0%	.0%	10.5%	4.8%	.0%
	7	7.7%	12.5%	2.6%	3.8%	3.5%
	8	7.7%	12.5%	7.9%	6.7%	1.8%
	9 mostly agree	15.4%	25.0%	5.3%	8.7%	10.5%
	10	23.1%	25.0%	15.8%	5.8%	5.3%
		53.9%	75%	47.3%	33.7%	22.9%
	11	.0%	.0%	18.4%	6.7%	10.5%
	12 mostly disagree	15.4%	12.5%	13.2%	11.5%	8.8%
	13	.0%	.0%	2.6%	16.3%	8.8%
	14	7.7%	.0%	.0%	6.7%	1.8%
	15 disagree	15.4%	12.5%	10.5%	9.6%	19.3%
	16	.0%	.0%	5.3%	6.7%	7.0%
	17	.0%	.0%	.0%	1.9%	5.3%
	18 strongly disagree	7.7%	.0%	2.6%	6.7%	15.8%

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Implicit theory of fixed intelligence is the same across categories of KS2 Level.	Independent-Samples Kruskal-Wallis Test	.002	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Table. 37 Comparison ‘confidence in one’s own intelligence’ by school

		School Name	
		D1	D2
		Column N %	Column N %
Confidence in one's own intelligence	very high	29.5%	33.3%
	high	28.1%	33.3%
		57.6%	66.6%
	low	24.7%	21.7%
	very low	17.8%	11.6%

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Confidence in one's own intelligence is the same across categories of School Name.	Independent-Samples Mann-Whitney U Test	.234	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Table 38. Comparison of 'confidence in one's own intelligence' by gender

		Gender	
		Male	Female
		Column N %	Column N %
Confidence in one's own intelligence	very high	42.3%	18.3%
	high	27.9%	31.7%
		70.2%	50.0%
	low	16.2%	31.7%
	very low	13.5%	18.3%

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Confidence in one's own intelligence is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Table 39 **Comparison of 'confidence in one's own intelligence' by Mathematics Group**

		Mathematics Group								
		7MA	7MB	7MC	Set 1	Set 2	Set 3	Set 4	Set 5	Set 6
		Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %
Confidence in one's own intelligence	very high	30.4%	28.6%	40.0%	43.3%	43.3%	23.1%	15.4%	35.3%	5.9%
	high	39.1%	42.9%	20.0%	36.7%	23.3%	30.8%	15.4%	17.6%	47.1%
		69.5%	71.5%	60.0%	80.0%	66.6%	53.9%	30.8%	52.9%	53.0%
	low	21.7%	23.8%	20.0%	10.0%	23.3%	19.2%	42.3%	29.4%	29.4%
	very low	8.7%	4.8%	20.0%	10.0%	10.0%	26.9%	26.9%	17.6%	17.6%

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Confidence in one's own intelligence is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.025	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Table 40 **Comparison of 'confidence in one's own intelligence' by Mathematics Teacher**

		Mathematics Teacher							
		A/B	A/C	CI	D	E	F	G	I
		Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %
Confidence in one's own intelligence	very high	43.3%	43.3%	29.5%	23.1%	15.4%	35.3%	5.9%	40.0%
	high	36.7%	23.3%	40.9%	30.8%	15.4%	17.6%	47.1%	20.0%
		80.0%	66.6%	70.4%	53.9%	30.8%	52.9%	53.0%	60.0%
	low	10.0%	23.3%	22.7%	19.2%	42.3%	29.4%	29.4%	20.0%
	very low	10.0%	10.0%	6.8%	26.9%	26.9%	17.6%	17.6%	20.0%

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Confidence in one's own intelligence is the same across categories of Mathematics Teacher.	Independent-Samples Kruskal-Wallis Test	.014	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Table. 41 **Comparison of 'confidence in one's own intelligence' by KS2 NC Level**

		KS2 Level				
		Not known	Level 2	Level 3	Level 4	Level 5
		Column N %	Column N %	Column N %	Column N %	Column N %
Confidence in one's own intelligence	very high	25.0%	.0%	13.9%	26.9%	52.6%
	high	8.3%	16.7%	27.8%	31.7%	33.3%
		33.3%	16.7%	41.7%	58.6%	85.9%
	low	33.3%	66.7%	33.3%	25.0%	8.8%
	very low	33.3%	16.7%	25.0%	16.3%	5.3%

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Confidence in one's own intelligence is the same across categories of KS2 Level.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Table 42. Comparison of 'implicit theory of fixed personality' by School

		School Name	
		D1	D2
		Column N %	Column N %
Implicit theory of fixed personality	3 strongly agree	7.7%	3.0%
	4	1.4%	1.5%
	5	4.2%	6.0%
	6 agree	13.4%	14.9%
	7	4.2%	10.4%
	8	11.3%	9.0%
	9 mostly agree	10.6%	10.4%
	10	11.3%	1.5%
		64.1%	56.7%
	11	9.2%	1.5%
	12 mostly disagree	10.6%	7.5%
	13	4.9%	4.5%
	14	2.8%	3.0%
	15 disagree	5.6%	10.4%
	16	.0%	1.5%
	17	.0%	1.5%
	18 strongly disagree	2.8%	13.4%

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Implicit theory of fixed personality is the same across categories of School Name.	Independent-Samples Mann-Whitney U Test	.199	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Table 43. Comparison of 'implicit theory of fixed personality' by Gender

		Gender	
		Male	Female
		Column N %	Column N %
Implicit theory of fixed personality	3 strongly agree	6.6%	5.8%
	4	.0%	2.9%
	5	4.7%	4.9%
	6 agree	7.5%	20.4%
	7	6.6%	5.8%
	8	8.5%	12.6%
	9 mostly agree	14.2%	6.8%
	10	8.5%	7.8%
		56.6%	67.0%
	11	3.8%	9.7%
	12 mostly disagree	9.4%	9.7%
	13	6.6%	2.9%
	14	1.9%	3.9%
	15 disagree	9.4%	4.9%
	16	.9%	.0%
	17	.9%	.0%
	18 strongly disagree	10.4%	1.9%

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Implicit theory of fixed personality is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	.005	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Table 44. **Comparison of 'implicit theory of fixed personality' by Mathematics Group**

		Mathematics Group								
		7MA	7MB	7MC	Set 1	Set 2	Set 3	Set 4	Set 5	Set 6
		Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %
Implicit theory of fixed personality	3 strongly agree	8.3%	.0%	.0%	6.7%	.0%	8.0%	14.8%	5.9%	15.4%
	4	.0%	5.3%	.0%	.0%	.0%	4.0%	3.7%	.0%	.0%
	5	4.2%	10.5%	4.2%	3.3%	.0%	4.0%	7.4%	11.8%	.0%
	6 agree	25.0%	10.5%	8.3%	10.0%	10.0%	12.0%	14.8%	29.4%	7.7%
	7	12.5%	10.5%	8.3%	6.7%	3.3%	4.0%	3.7%	5.9%	.0%
	8	8.3%	10.5%	8.3%	10.0%	6.7%	8.0%	22.2%	5.9%	15.4%
	9 mostly agree	16.7%	.0%	12.5%	13.3%	3.3%	24.0%	7.4%	.0%	15.4%
	10	.0%	5.3%	.0%	10.0%	6.7%	16.0%	11.1%	5.9%	23.1%
		75.0%	52.6%	41.6%	60.0%	30.0%	80.0%	85.1%	64.8%	77.0%
	11	.0%	.0%	4.2%	6.7%	13.3%	8.0%	7.4%	5.9%	15.4%
	12 mostly disagree	4.2%	15.8%	4.2%	6.7%	26.7%	4.0%	3.7%	17.6%	.0%
	13	.0%	5.3%	8.3%	3.3%	6.7%	4.0%	.0%	11.8%	7.7%
	14	4.2%	5.3%	.0%	6.7%	3.3%	.0%	3.7%	.0%	.0%
	15 disagree	16.7%	5.3%	8.3%	10.0%	13.3%	4.0%	.0%	.0%	.0%
	16	.0%	.0%	4.2%	.0%	.0%	.0%	.0%	.0%	.0%
	17	.0%	.0%	4.2%	.0%	.0%	.0%	.0%	.0%	.0%
	18 strongly disagree	.0%	15.8%	25.0%	6.7%	6.7%	.0%	.0%	.0%	.0%

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Implicit theory of fixed personality is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Table 45. **Comparison of 'implicit theory of fixed personality' by Mathematics Teacher**

		Mathematics Teacher							
		A/B	A/C	CI	D	E	F	G	I
		Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %
Implicit theory of fixed personality	3 strongly agree	6.7%	.0%	4.7%	8.0%	14.8%	5.9%	15.4%	.0%
	4	.0%	.0%	2.3%	4.0%	3.7%	.0%	.0%	.0%
	5	3.3%	.0%	7.0%	4.0%	7.4%	11.8%	.0%	4.2%
	6 agree	10.0%	10.0%	18.6%	12.0%	14.8%	29.4%	7.7%	8.3%
	7	6.7%	3.3%	11.6%	4.0%	3.7%	5.9%	.0%	8.3%
	8	10.0%	6.7%	9.3%	8.0%	22.2%	5.9%	15.4%	8.3%
	9 mostly agree	13.3%	3.3%	9.3%	24.0%	7.4%	.0%	15.4%	12.5%
	10	10.0%	6.7%	2.3%	16.0%	11.1%	5.9%	23.1%	.0%
		60.0%	30.0%	65.1%	80.0%	85.1%	64.8%	77.0%	41.6%
	11	6.7%	13.3%	.0%	8.0%	7.4%	5.9%	15.4%	4.2%
	12 mostly disagree	6.7%	26.7%	9.3%	4.0%	3.7%	17.6%	.0%	4.2%
	13	3.3%	6.7%	2.3%	4.0%	.0%	11.8%	7.7%	8.3%
	14	6.7%	3.3%	4.7%	.0%	3.7%	.0%	.0%	.0%
	15 disagree	10.0%	13.3%	11.6%	4.0%	.0%	.0%	.0%	8.3%
	16	.0%	.0%	.0%	.0%	.0%	.0%	.0%	4.2%
	17	.0%	.0%	.0%	.0%	.0%	.0%	.0%	4.2%
	18 strongly disagree	6.7%	6.7%	7.0%	.0%	.0%	.0%	.0%	25.0%

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Implicit theory of fixed personality is the same across categories of Mathematics Teacher.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Table 46. **Comparison of 'implicit theory of fixed personality' by KS2 NC level**

		KS2 Level				
		Not known	Level 2	Level 3	Level 4	Level 5
		Column N %	Column N %	Column N %	Column N %	Column N %
Implicit theory of fixed personality	3 strongly agree	8.3%	.0%	9.1%	5.9%	5.4%
	4	.0%	.0%	3.0%	2.0%	.0%
	5	8.3%	.0%	6.1%	5.9%	1.8%
	6 agree	33.3%	16.7%	21.2%	11.8%	8.9%
	7	.0%	.0%	9.1%	6.9%	5.4%
	8	25.0%	16.7%	15.2%	7.8%	8.9%
	9 mostly agree	.0%	33.3%	6.1%	14.7%	5.4%
	10	8.3%	16.7%	6.1%	8.8%	7.1%
		83.2%	83.3%	75.9%	63.8%	42.9%
	11	8.3%	16.7%	9.1%	5.9%	5.4%
	12 mostly disagree	.0%	.0%	12.1%	11.8%	7.1%
	13	.0%	.0%	3.0%	4.9%	7.1%
	14	.0%	.0%	.0%	2.0%	7.1%
	15 disagree	8.3%	.0%	.0%	4.9%	16.1%
	16	.0%	.0%	.0%	.0%	1.8%
	17	.0%	.0%	.0%	1.0%	.0%
	18 strongly disagree	.0%	.0%	.0%	5.9%	12.5%

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Implicit theory of fixed personality is the same across categories of KS2 Level.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Table 47 **Comparison of 'Learning goal choice' by School**

		School Name	
		D1	D2
		Column N %	Column N %
Learning goal choices	5 performance goal score very strong	0.8%	0.0%
	6	23.1%	14.3%
	7	30.0%	27.0%
		53.1%	41.3%
	8	22.3%	30.2%
	9	13.8%	15.9%
	10 learning goal score very strong	10.0%	12.7%

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Learning goal choices is the same across categories of School Name.	Independent-Samples Mann-Whitney U Test	.101	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Table 48. **Comparison of 'Learning goal choice' by Gender**

		Gender	
		Male	Female
		Column N %	Column N %
Learning goal choices	5 performance goal score very strong	1.0%	.0%
	6	14.4%	26.0%
	7	26.8%	31.3%
		42.2%	57.3%
	8	23.7%	26.0%
	9	18.6%	10.4%
	10 learning goal score very strong	15.5%	6.3%

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Learning goal choices is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	.006	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Table 49. **Comparison of 'Learning goal choice' by Mathematics Group**

		Mathematics Group								
		7MA	7MB	7MC	Set 1	Set 2	Set 3	Set 4	Set 5	Set 6
		Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %
Learning goal choices	5 performance goal score very strong	.0%	.0%	.0%	.0%	3.6%	.0%	.0%	.0%	.0%
	6	13.0%	18.8%	12.5%	30.0%	17.9%	29.2%	22.7%	17.6%	11.1%
	7	17.4%	37.5%	29.2%	16.7%	25.0%	37.5%	45.5%	17.6%	55.6%
		30.4%	56.3%	41.7%	46.7%	46.5%	66.7%	68.2%	35.2%	66.7%
	8	26.1%	31.3%	33.3%	30.0%	28.6%	16.7%	18.2%	17.6%	11.1%
	9	21.7%	6.3%	16.7%	10.0%	17.9%	12.5%	9.1%	17.6%	22.2%
	10 learning goal score very strong	21.7%	6.3%	8.3%	13.3%	7.1%	4.2%	4.5%	29.4%	.0%

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Learning goal choices is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.125	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Table 50. **Comparison of ‘Learning goal choice’ by Mathematics Teacher**

		Mathematics Teacher							
		A/B	A/C	CI	D	E	F	G	I
		Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %
Learning goal choices	5 performance goal score very strong	.0%	3.6%	.0%	.0%	.0%	.0%	.0%	.0%
	6	30.0%	17.9%	15.4%	29.2%	22.7%	17.6%	11.1%	12.5%
	7	16.7%	25.0%	25.6%	37.5%	45.5%	17.6%	55.6%	29.2%
		46.7%	46.5%	41.0%	66.7%	68.2%	35.2%	66.7%	41.7%
	8	30.0%	28.6%	28.2%	16.7%	18.2%	17.6%	11.1%	33.3%
	9	10.0%	17.9%	15.4%	12.5%	9.1%	17.6%	22.2%	16.7%
	10 learning goal score very strong	13.3%	7.1%	15.4%	4.2%	4.5%	29.4%	.0%	8.3%

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Learning goal choices is the same across categories of Mathematics Teacher.	Independent-Samples Kruskal-Wallis Test	.223	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Table 51. Comparison of 'Learning goal choice' by KS2 National Curriculum level

		KS2 Level				
		Not known	Level 2	Level 3	Level 4	Level 5
		Column N %	Column N %	Column N %	Column N %	Column N %
Learning goal choices	5 performance goal score very strong	.0%	.0%	.0%	.0%	1.8%
	6	.0%	16.7%	14.3%	25.5%	18.2%
	7	20.0%	33.3%	46.4%	27.7%	23.6%
		20.0%	50.0%	60.7%	53.2%	43.6%
	8	40.0%	16.7%	14.3%	26.6%	25.5%
	9	20.0%	33.3%	14.3%	12.8%	14.5%
	10 learning goal score very strong	20.0%	.0%	10.7%	7.4%	16.4%

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Learning goal choices is the same across categories of KS2 Level.	Independent-Samples Kruskal-Wallis Test	.191	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Analysis of Teaching groups at School D1 by gender

Table 52.

		Mathematics Group											
		Set 1		Set 2		Set 3		Set 4		Set 5		Set 6	
		Gender		Gender		Gender		Gender		Gender		Gender	
		Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
		Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %
Implicit theory of fixed intelligence	3 strongly agree	.0%	.0%	.0%	.0%	.0%	.0%	15.4%	.0%	.0%	.0%	.0%	.0%
	4	.0%	.0%	.0%	.0%	.0%	.0%	7.7%	.0%	.0%	.0%	.0%	.0%
	5	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	9.1%	.0%
	6 agree	.0%	.0%	.0%	.0%	8.3%	7.1%	.0%	14.3%	.0%	12.5%	.0%	22.2%
	7	.0%	.0%	.0%	.0%	.0%	.0%	7.7%	7.1%	.0%	.0%	.0%	11.1%
	8	9.1%	.0%	.0%	13.3%	8.3%	.0%	15.4%	7.1%	.0%	12.5%	9.1%	.0%
	9 mostly agree	18.2%	5.3%	13.3%	.0%	.0%	14.3%	7.7%	14.3%	20.0%	12.5%	.0%	22.2%
	10	9.1%	.0%	6.7%	.0%	8.3%	7.1%	7.7%	21.4%	.0%	12.5%	18.2%	.0%
		36.4%	5.3%	20.0%	13.3%	24.9%	28.5%	61.6%	64.2%	20.0%	50.0%	36.4%	55.5%
	11	.0%	10.5%	6.7%	20.0%	25.0%	14.3%	7.7%	14.3%	10.0%	.0%	9.1%	11.1%
	12 mostly disagree	.0%	15.8%	20.0%	13.3%	8.3%	21.4%	15.4%	7.1%	.0%	.0%	27.3%	22.2%
	13	9.1%	10.5%	13.3%	6.7%	33.3%	35.7%	15.4%	.0%	.0%	.0%	9.1%	.0%
	14	9.1%	10.5%	13.3%	6.7%	.0%	.0%	.0%	.0%	10.0%	.0%	.0%	.0%
	15 disagree	9.1%	26.3%	6.7%	26.7%	.0%	.0%	.0%	.0%	10.0%	37.5%	18.2%	11.1%
	16	9.1%	.0%	6.7%	6.7%	.0%	.0%	.0%	14.3%	20.0%	12.5%	.0%	.0%
	17	9.1%	5.3%	13.3%	.0%	8.3%	.0%	.0%	.0%	.0%	.0%	.0%	.0%
	18 strongly disagree	18.2%	15.8%	.0%	6.7%	.0%	.0%	.0%	.0%	30.0%	.0%	.0%	.0%

Table 53.		Mathematics Group											
		Set 1		Set 2		Set 3		Set 4		Set 5		Set 6	
		Gender		Gender		Gender		Gender		Gender		Gender	
		Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
		Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %
Confidence in one's own intelligence	very high	54.5%	36.8%	46.7%	40.0%	41.7%	7.1%	25.0%	7.1%	66.7%	.0%	.0%	12.5%
	high	27.3%	42.1%	13.3%	33.3%	25.0%	35.7%	16.7%	14.3%	11.1%	25.0%	66.7%	25.0%
		81.8%	78.9%	60.0%	73.3%	66.7%	42.8%	41.7%	21.4%	77.8%	25%	66.7%	37.5%
	low	.0%	15.8%	26.7%	20.0%	16.7%	21.4%	16.7%	64.3%	22.2%	37.5%	33.3%	25.0%
	very low	18.2%	5.3%	13.3%	6.7%	16.7%	35.7%	41.7%	14.3%	.0%	37.5%	.0%	37.5%

Table 54.		Mathematics Group											
		Set 1		Set 2		Set 3		Set 4		Set 5		Set 6	
		Gender		Gender		Gender		Gender		Gender		Gender	
		Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
		Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %
Implicit theory of fixed personality	3 strongly agree	9.1%	5.3%	.0%	.0%	8.3%	7.7%	15.4%	14.3%	11.1%	.0%	16.7%	14.3%
	4	.0%	.0%	.0%	.0%	.0%	7.7%	.0%	7.1%	.0%	.0%	.0%	.0%
	5	9.1%	.0%	.0%	.0%	8.3%	.0%	.0%	14.3%	11.1%	12.5%	.0%	.0%
	6 agree	9.1%	10.5%	6.7%	13.3%	8.3%	15.4%	15.4%	14.3%	11.1%	50.0%	.0%	14.3%
	7	.0%	10.5%	.0%	6.7%	8.3%	.0%	.0%	7.1%	11.1%	.0%	.0%	.0%
	8	9.1%	10.5%	6.7%	6.7%	.0%	15.4%	30.8%	14.3%	.0%	12.5%	16.7%	14.3%
	9 mostly agree	18.2%	10.5%	.0%	6.7%	41.7%	7.7%	15.4%	.0%	.0%	.0%	.0%	28.6%
	10	9.1%	10.5%	13.3%	.0%	8.3%	23.1%	15.4%	7.1%	.0%	12.5%	33.3%	14.3%
		63.7%	57.8%	26.7%	33.4%	83.2%	77.0%	92.4%	78.5%	44.4%	87.5%	66.7%	85.8%
	11	9.1%	5.3%	.0%	26.7%	.0%	15.4%	7.7%	7.1%	11.1%	.0%	16.7%	14.3%
	12 mostly disagree	.0%	10.5%	33.3%	20.0%	.0%	7.7%	.0%	7.1%	22.2%	12.5%	.0%	.0%
	13	.0%	5.3%	6.7%	6.7%	8.3%	.0%	.0%	.0%	22.2%	.0%	16.7%	.0%
	14	.0%	10.5%	.0%	6.7%	.0%	.0%	.0%	7.1%	.0%	.0%	.0%	.0%
	15 disagree	9.1%	10.5%	26.7%	.0%	8.3%	.0%	.0%	.0%	.0%	.0%	.0%	.0%
	18 strongly disagree	18.2%	.0%	6.7%	6.7%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%

Table 55.		Mathematics Group											
		Set 1		Set 2		Set 3		Set 4		Set 5		Set 6	
		Gender		Gender		Gender		Gender		Gender		Gender	
		Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
		Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %	Column N %
Learning goal choices	5 performance goal score very strong	.0%	.0%	7.1%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%
	6	27.3%	31.6%	14.3%	21.4%	16.7%	41.7%	27.3%	18.2%	11.1%	25.0%	.0%	20.0%
	7	18.2%	15.8%	14.3%	35.7%	33.3%	41.7%	36.4%	54.5%	.0%	37.5%	50.0%	60.0%
		45.5%	47.4%	35.7%	57.1%	50.0%	83.4%	63.7%	72.2%	11.1%	62.5%	50.0%	80.0%
	8	36.4%	26.3%	28.6%	28.6%	25.0%	8.3%	18.2%	18.2%	11.1%	25.0%	.0%	20.0%
	9	.0%	15.8%	28.6%	7.1%	16.7%	8.3%	9.1%	9.1%	22.2%	12.5%	50.0%	.0%
	10 learning goal score very strong	18.2%	10.5%	7.1%	7.1%	8.3%	.0%	9.1%	.0%	55.6%	.0%	.0%	.0%

Tests of significance: Boys by Set 1-6 at School D1

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Implicit theory of fixed intelligence is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.007	Reject the null hypothesis.
2	The distribution of Confidence in one's own intelligence is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.170	Retain the null hypothesis.
3	The distribution of Implicit theory of fixed personality is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.019	Reject the null hypothesis.
4	The distribution of Learning goal choices is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.108	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Tests of significance: Girls by Set 1-6 at School D1

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Implicit theory of fixed intelligence is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.002	Reject the null hypothesis.
2	The distribution of Confidence in one's own intelligence is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.002	Reject the null hypothesis.
3	The distribution of Implicit theory of fixed personality is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.029	Reject the null hypothesis.
4	The distribution of Learning goal choices is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.652	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Analysis of Teaching groups at School D1 by KS2 NC level

Table 56.		KS2 Level					
		Level 5					
		Mathematics Group					
		Set 1	Set 2	Set 3	Set 4	Set 5	Set 6
		Column N %	Column N %	Column N %	Column N %	Column N %	Column N %
Implicit theory of fixed intelligence	3 strongly agree	.0%	.0%	.0%	.0%	.0%	.0%
	4	.0%	.0%	.0%	.0%	.0%	.0%
	5	.0%	.0%	.0%	.0%	.0%	.0%
	6 agree	.0%	.0%	.0%	.0%	.0%	.0%
	7	.0%	.0%	.0%	.0%	.0%	.0%
	8	4.3%	.0%	.0%	.0%	.0%	.0%
	9 mostly agree	8.7%	.0%	.0%	.0%	.0%	.0%
	10	4.3%	.0%	100.0%	.0%	.0%	.0%
		17.3%	0.0%	100.0%			
	11	8.7%	30.0%	.0%	.0%	.0%	.0%
	12 mostly disagree	13.0%	10.0%	.0%	.0%	.0%	.0%
	13	8.7%	20.0%	.0%	.0%	.0%	.0%
	14	.0%	10.0%	.0%	.0%	.0%	.0%
	15 disagree	21.7%	20.0%	.0%	.0%	.0%	.0%
	16	4.3%	.0%	.0%	.0%	.0%	.0%
	17	8.7%	10.0%	.0%	.0%	.0%	.0%
	18 strongly disagree	17.4%	.0%	.0%	.0%	.0%	.0%

Table 57.		Set 1	Set 2	Set 3	Set 4	Set 5	Set 6
		KS2 Level					
		Level 5					
		Mathematics Group					
		Column N %	Column N %	Column N %	Column N %	Column N %	Column N %
Confidence in one's own intelligence	very high	43.5%	60.0%	.0%	.0%	.0%	.0%
	high	39.1%	20.0%	.0%	.0%	.0%	.0%
		82.6%	80.0%	0%			
	low	8.7%	20.0%	.0%	.0%	.0%	.0%
	very low	8.7%	.0%	100.0%	.0%	.0%	.0%

Table 58.		KS2 Level					
		Level 5					
		Mathematics Group					
		Set 1	Set 2	Set 3	Set 4	Set 5	Set 6
		Column N %	Column N %	Column N %	Column N %	Column N %	Column N %
Implicit theory of fixed personality	3 strongly agree	8.7%	.0%	.0%	.0%	.0%	.0%
	4	.0%	.0%	.0%	.0%	.0%	.0%
	5	.0%	.0%	.0%	.0%	.0%	.0%
	6 agree	13.0%	10.0%	.0%	.0%	.0%	.0%
	7	4.3%	.0%	.0%	.0%	.0%	.0%
	8	8.7%	10.0%	.0%	.0%	.0%	.0%
	9 mostly agree	8.7%	.0%	100.0%	.0%	.0%	.0%
	10	13.0%	10.0%	.0%	.0%	.0%	.0%
		56.4%	30.0%	100.0%			
	11	8.7%	10.0%	.0%	.0%	.0%	.0%
	12 mostly disagree	8.7%	10.0%	.0%	.0%	.0%	.0%
	13	4.3%	10.0%	.0%	.0%	.0%	.0%
	14	8.7%	.0%	.0%	.0%	.0%	.0%
	15 disagree	8.7%	30.0%	.0%	.0%	.0%	.0%
	18 strongly disagree	4.3%	10.0%	.0%	.0%	.0%	.0%

Table 59.		KS2 Level					
		Level 5					
		Mathematics Group					
		Set 1	Set 2	Set 3	Set 4	Set 5	Set 6
		Column N %	Column N %	Column N %	Column N %	Column N %	Column N %
Learning goal choices	5 performance goal score very strong	.0%	10.0%	.0%	.0%	.0%	.0%
	6	30.4%	.0%	.0%	.0%	.0%	.0%
	7	21.7%	30.0%	.0%	.0%	.0%	.0%
		52.1%	40.0%	0.0%			
	8	21.7%	40.0%	100.0%	.0%	.0%	.0%
	9	13.0%	20.0%	.0%	.0%	.0%	.0%
	10 learning goal score very strong	13.0%	.0%	.0%	.0%	.0%	.0%

Tests of significance: All level 5 students at School D1 by mathematics group

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Implicit theory of fixed intelligence is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.302	Retain the null hypothesis.
2	The distribution of Confidence in one's own intelligence is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.180	Retain the null hypothesis.
3	The distribution of Implicit theory of fixed personality is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.334	Retain the null hypothesis.
4	The distribution of Learning goal choices is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.931	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Table 60.		KS2 Level					
		Level 4					
		Mathematics Group					
		Set 1	Set 2	Set 3	Set 4	Set 5	Set 6
		Column N %	Column N %	Column N %	Column N %	Column N %	Column N %
Implicit theory of fixed intelligence	3 strongly agree	.0%	.0%	.0%	11.1%	.0%	.0%
	4	.0%	.0%	.0%	.0%	.0%	.0%
	5	.0%	.0%	.0%	.0%	.0%	.0%
	6 agree	.0%	.0%	8.7%	11.1%	.0%	.0%
	7	.0%	.0%	.0%	5.6%	.0%	20.0%
	8	.0%	5.6%	4.3%	11.1%	.0%	.0%
	9 mostly agree	16.7%	11.1%	8.7%	11.1%	20.0%	.0%
	10	.0%	5.6%	4.3%	11.1%	20.0%	.0%
		16.7%	22.3%	26.0%	61.1%	40.0%	20.0%
	11	.0%	5.6%	21.7%	5.6%	.0%	.0%
	12 mostly disagree	.0%	22.2%	13.0%	11.1%	.0%	20.0%
	13	16.7%	5.6%	34.8%	11.1%	.0%	20.0%
	14	50.0%	5.6%	.0%	.0%	20.0%	.0%
	15 disagree	.0%	16.7%	.0%	.0%	.0%	40.0%
	16	.0%	11.1%	.0%	11.1%	20.0%	.0%
	17	.0%	5.6%	4.3%	.0%	.0%	.0%
	18 strongly disagree	16.7%	5.6%	.0%	.0%	20.0%	.0%

Table 61.		KS2 Level					
		Level 4					
		Mathematics Group					
		Set 1	Set 2	Set 3	Set 4	Set 5	Set 6
		Column N %	Column N %	Column N %	Column N %	Column N %	Column N %
Confidence in one's own intelligence	very high	33.3%	38.9%	26.1%	17.6%	20.0%	20.0%
	high	33.3%	27.8%	30.4%	17.6%	60.0%	60.0%
		66.6%	66.7%	56.5%	35.2%	80.0%	80.0%
	low	16.7%	22.2%	21.7%	41.2%	.0%	20.0%
	very low	16.7%	11.1%	21.7%	23.5%	20.0%	.0%

Table 62.		Set 1	Set 2	Set 3	Set 4	Set 5	Set 6
		KS2 Level					
		Level 4					
		Mathematics Group					
		Column N %	Column N %	Column N %	Column N %	Column N %	Column N %
Implicit theory of fixed personality	3 strongly agree	.0%	.0%	9.1%	11.1%	20.0%	33.3%
	4	.0%	.0%	4.5%	.0%	.0%	.0%
	5	.0%	.0%	4.5%	11.1%	20.0%	.0%
	6 agree	.0%	11.1%	13.6%	11.1%	40.0%	.0%
	7	16.7%	5.6%	4.5%	.0%	.0%	.0%
	8	16.7%	.0%	4.5%	22.2%	.0%	.0%
	9 mostly agree	33.3%	5.6%	22.7%	11.1%	.0%	.0%
	10	.0%	5.6%	18.2%	11.1%	.0%	33.3%
		66.7%	27.9%	81.6%	77.7%	80.0%	66.6%
	11	.0%	11.1%	9.1%	11.1%	.0%	.0%
	12 mostly disagree	.0%	38.9%	.0%	5.6%	.0%	.0%
	13	.0%	5.6%	4.5%	.0%	20.0%	33.3%
	14	.0%	5.6%	.0%	5.6%	.0%	.0%
	15 disagree	16.7%	5.6%	4.5%	.0%	.0%	.0%
	18 strongly disagree	16.7%	5.6%	.0%	.0%	.0%	.0%

Table 63.		KS2 Level					
		Level 4					
		Mathematics Group					
		Set 1	Set 2	Set 3	Set 4	Set 5	Set 6
		Column N %	Column N %	Column N %	Column N %	Column N %	Column N %
Learning goal choices	5 performance goal score very strong	.0%	.0%	.0%	.0%	.0%	.0%
	6	33.3%	29.4%	28.6%	26.7%	40.0%	.0%
	7	.0%	23.5%	38.1%	40.0%	.0%	100.0%
		33.3%	52.9%	66.7%	66.7%	40.0%	100.0%
	8	50.0%	23.5%	14.3%	20.0%	20.0%	.0%
	9	.0%	17.6%	14.3%	6.7%	.0%	.0%
	10 learning goal score very strong	16.7%	5.9%	4.8%	6.7%	40.0%	.0%

Tests of significance: All level 4 students at D1 by mathematics group

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Implicit theory of fixed intelligence is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.024	Reject the null hypothesis.
2	The distribution of Confidence in one's own intelligence is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.529	Retain the null hypothesis.
3	The distribution of Implicit theory of fixed personality is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.017	Reject the null hypothesis.
4	The distribution of Learning goal choices is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.962	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Table 64.		Set 1	Set 2	Set 3	Set 4	Set 5	Set 6
		KS2 Level					
		Level 3					
		Mathematics Group					
		Column N %	Column N %	Column N %	Column N %	Column N %	Column N %
Implicit theory of fixed intelligence	3 strongly agree	.0%	.0%	.0%	.0%	.0%	.0%
	4	.0%	.0%	.0%	16.7%	.0%	.0%
	5	.0%	.0%	.0%	.0%	.0%	12.5%
	6 agree	.0%	.0%	.0%	.0%	8.3%	25.0%
	7	.0%	.0%	.0%	16.7%	.0%	.0%
	8	.0%	100.0%	.0%	.0%	8.3%	.0%
	9 mostly agree	.0%	.0%	.0%	.0%	16.7%	.0%
	10	.0%	.0%	.0%	16.7%	.0%	.0%
			100.0%		50.1%	33.3%	37.5%
	11	.0%	.0%	.0%	33.3%	8.3%	25.0%
	12 mostly disagree	.0%	.0%	50.0%	16.7%	.0%	37.5%
	13	.0%	.0%	50.0%	.0%	.0%	.0%
	14	.0%	.0%	.0%	.0%	.0%	.0%
	15 disagree	.0%	.0%	.0%	.0%	33.3%	.0%
	16	.0%	.0%	.0%	.0%	16.7%	.0%
	17	.0%	.0%	.0%	.0%	.0%	.0%
	18 strongly disagree	.0%	.0%	.0%	.0%	8.3%	.0%

Table 65.		KS2 Level					
		Level 3					
		Mathematics Group					
		Set 1	Set 2	Set 3	Set 4	Set 5	Set 6
		Column N %	Column N %	Column N %	Column N %	Column N %	Column N %
Confidence in one's own intelligence	very high	.0%	.0%	.0%	.0%	36.4%	.0%
	high	.0%	.0%	50.0%	16.7%	.0%	57.1%
				50.0%	16.7%	36.4%	57.1%
	low	.0%	100.0%	.0%	50.0%	45.5%	.0%
	very low	.0%	.0%	50.0%	33.3%	18.2%	42.9%

Table 66.		KS2 Level					
		Level 3					
		Mathematics Group					
		Set 1	Set 2	Set 3	Set 4	Set 5	Set 6
		Column N %	Column N %	Column N %	Column N %	Column N %	Column N %
Implicit theory of fixed personality	3 strongly agree	.0%	.0%	.0%	33.3%	.0%	16.7%
	4	.0%	.0%	.0%	16.7%	.0%	.0%
	5	.0%	.0%	.0%	.0%	9.1%	.0%
	6 agree	.0%	.0%	.0%	16.7%	27.3%	16.7%
	7	.0%	.0%	.0%	16.7%	9.1%	.0%
	8	.0%	.0%	50.0%	16.7%	9.1%	16.7%
	9 mostly agree	.0%	.0%	.0%	.0%	.0%	.0%
	10	.0%	.0%	.0%	.0%	9.1%	16.7%
				50.0%	100.0%	63.7%	66.8%
	11	.0%	100.0%	.0%	.0%	.0%	33.3%
	12 mostly disagree	.0%	.0%	50.0%	.0%	27.3%	.0%
	13	.0%	.0%	.0%	.0%	9.1%	.0%
	14	.0%	.0%	.0%	.0%	.0%	.0%
	15 disagree	.0%	.0%	.0%	.0%	.0%	.0%
	18 strongly disagree	.0%	.0%	.0%	.0%	.0%	.0%

Table 67.		KS2 Level					
		Level 3					
		Mathematics Group					
		Set 1	Set 2	Set 3	Set 4	Set 5	Set 6
		Column N %	Column N %	Column N %	Column N %	Column N %	Column N %
Learning goal choices	5 performance goal score very strong	.0%	.0%	.0%	.0%	.0%	.0%
	6	.0%	.0%	50.0%	20.0%	9.1%	.0%
	7	.0%	.0%	50.0%	60.0%	27.3%	50.0%
				50.0%	80.0%	36.4%	50.0%
	8	.0%	.0%	.0%	.0%	18.2%	25.0%
	9	.0%	.0%	.0%	20.0%	18.2%	25.0%
	10 learning goal score very strong	.0%	.0%	.0%	.0%	27.3%	.0%

Tests of significance: All level 3 students at School D1 by mathematics group

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Implicit theory of fixed intelligence is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.152	Retain the null hypothesis.
2	The distribution of Confidence in one's own intelligence is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.817	Retain the null hypothesis.
3	The distribution of Implicit theory of fixed personality is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.143	Retain the null hypothesis.
4	The distribution of Learning goal choices is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.193	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Analysis of Teaching groups at School D2 by gender

Table 68.		Mathematics Group					
		7MA		7MB		7MC	
		Gender		Gender		Gender	
		Male	Female	Male	Female	Male	Female
		Column N %	Column N %	Column N %	Column N %	Column N %	Column N %
Implicit theory of fixed intelligence	3 strongly agree	.0%	.0%	.0%	.0%	6.7%	.0%
	5	.0%	.0%	7.1%	14.3%	.0%	.0%
	6 agree	.0%	9.1%	.0%	14.3%	.0%	.0%
	7	7.7%	36.4%	.0%	.0%	.0%	11.1%
	8	7.7%	9.1%	.0%	.0%	6.7%	11.1%
	9 mostly agree	.0%	27.3%	7.1%	14.3%	.0%	11.1%
	10	15.4%	.0%	14.3%	14.3%	20.0%	11.1%
		30.8%	81.9%	28.5%	57.2%	33.4%	44.4%
	11	7.7%	.0%	7.1%	.0%	6.7%	.0%
	12 mostly disagree	15.4%	18.2%	7.1%	.0%	.0%	.0%
	13	15.4%	.0%	14.3%	.0%	.0%	11.1%
	14	7.7%	.0%	.0%	.0%	6.7%	.0%
	15 disagree	23.1%	.0%	14.3%	28.6%	.0%	33.3%
	16	.0%	.0%	14.3%	14.3%	13.3%	.0%
	18 strongly disagree	.0%	.0%	14.3%	.0%	40.0%	11.1%

Table 69.		Mathematics Group					
		7MA		7MB		7MC	
		Gender		Gender		Gender	
		Male	Female	Male	Female	Male	Female
		Column N %	Column N %	Column N %	Column N %	Column N %	Column N %
Confidence in one's own intelligence	very high	38.5%	20.0%	42.9%	.0%	56.3%	11.1%
	high	38.5%	40.0%	42.9%	42.9%	18.8%	22.2%
		77.0%	60.0%	85.8%	42.9%	75.1%	33.3%
	low	7.7%	40.0%	14.3%	42.9%	12.5%	33.3%
	very low	15.4%	.0%	.0%	14.3%	12.5%	33.3%

Table 70.		Mathematics Group					
		7MA		7MB		7MC	
		Gender		Gender		Gender	
		Male	Female	Male	Female	Male	Female
		Column N %	Column N %	Column N %	Column N %	Column N %	Column N %
Implicit theory of fixed personality	3 strongly agree	7.7%	9.1%	.0%	.0%	.0%	.0%
	4	.0%	.0%	.0%	14.3%	.0%	.0%
	5	.0%	9.1%	16.7%	.0%	.0%	11.1%
	6 agree	.0%	54.5%	8.3%	14.3%	6.7%	11.1%
	7	15.4%	9.1%	8.3%	14.3%	13.3%	.0%
	8	7.7%	9.1%	.0%	28.6%	6.7%	11.1%
	9 mostly agree	30.8%	.0%	.0%	.0%	13.3%	11.1%
	10	.0%	.0%	8.3%	.0%	.0%	.0%
		61.6%	90.9%	71.6%	71.5%	40.0%	44.4%
	11	.0%	.0%	.0%	.0%	.0%	11.1%
	12 mostly disagree	7.7%	.0%	8.3%	28.6%	6.7%	.0%
	13	.0%	.0%	8.3%	.0%	6.7%	11.1%
	14	7.7%	.0%	8.3%	.0%	.0%	.0%
	15 disagree	23.1%	9.1%	8.3%	.0%	.0%	22.2%
	16	.0%	.0%	.0%	.0%	6.7%	.0%
	17	.0%	.0%	.0%	.0%	6.7%	.0%
	18 strongly disagree	.0%	.0%	25.0%	.0%	33.3%	11.1%

Table 71.		Mathematics Group					
		7MA		7MB		7MC	
		Gender		Gender		Gender	
		Male	Female	Male	Female	Male	Female
		Column N %	Column N %	Column N %	Column N %	Column N %	Column N %
Learning goal choices	5 performance goal score very strong	.0%	.0%	.0%	.0%	.0%	.0%
	6	8.3%	18.2%	22.2%	14.3%	.0%	33.3%
	7	25.0%	9.1%	33.3%	42.9%	40.0%	11.1%
		33.3%	27.3%	55.5%	57.2%	40.0%	44.4%
	8	16.7%	36.4%	33.3%	28.6%	26.7%	44.4%
	9	25.0%	18.2%	11.1%	.0%	20.0%	11.1%
	10 learning goal score very strong	25.0%	18.2%	.0%	14.3%	13.3%	.0%

Tests of significance: Boys at School D2 by mathematics group

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Implicit theory of fixed intelligence is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.312	Retain the null hypothesis.
2	The distribution of Confidence in one's own intelligence is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.781	Retain the null hypothesis.
3	The distribution of Implicit theory of fixed personality is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.344	Retain the null hypothesis.
4	The distribution of Learning goal choices is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.192	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Tests of significance: Girls at School D2 by mathematics group

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Implicit theory of fixed intelligence is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.086	Retain the null hypothesis.
2	The distribution of Confidence in one's own intelligence is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.248	Retain the null hypothesis.
3	The distribution of Implicit theory of fixed personality is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.051	Retain the null hypothesis.
4	The distribution of Learning goal choices is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.406	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Analysis of Teaching groups at School D2 by KS2 NC level

Table 72.		KS2 Level		
		Level 5		
		Mathematics Group		
		7MA	7MB	7MC
		Column N %	Column N %	Column N %
Implicit theory of fixed intelligence	3 strongly agree	.0%	.0%	.0%
	5	.0%	11.1%	.0%
	6 agree	.0%	.0%	.0%
	7	22.2%	.0%	.0%
	8	.0%	.0%	.0%
	9 mostly agree	33.3%	11.1%	.0%
	10	11.1%	.0%	.0%
		66.6%	22.1%	0.0%
	11	.0%	11.1%	.0%
	12 mostly disagree	11.1%	.0%	.0%
	13	.0%	11.1%	.0%
	14	.0%	.0%	.0%
	15 disagree	22.2%	22.2%	.0%
	16	.0%	11.1%	40.0%
	18 strongly disagree	.0%	22.2%	60.0%

Table 73.		KS2 Level		
		Level 5		
		Mathematics Group		
		7MA	7MB	7MC
		Column N %	Column N %	Column N %
Confidence in one's own intelligence	very high	44.4%	55.6%	100.0%
	high	44.4%	44.4%	.0%
		88.8%	100.0%	100.0%
	low	11.1%	.0%	.0%
	very low	.0%	.0%	.0%

Table 74.		KS2 Level		
		Level 5		
		Mathematics Group		
		7MA	7MB	7MC
		Column N %	Column N %	Column N %
Implicit theory of fixed personality	3 strongly agree	11.1%	.0%	.0%
	4	.0%	.0%	.0%
	5	11.1%	.0%	.0%
	6 agree	.0%	12.5%	.0%
	7	11.1%	12.5%	.0%
	8	22.2%	.0%	.0%
	9 mostly agree	.0%	.0%	.0%
	10	.0%	.0%	.0%
		55.5%	25.0%	0%
	11	.0%	.0%	.0%
	12 mostly disagree	.0%	12.5%	.0%
	13	.0%	12.5%	20.0%
	14	11.1%	12.5%	.0%
	15 disagree	33.3%	12.5%	.0%
	16	.0%	.0%	20.0%
	17	.0%	.0%	.0%
	18 strongly disagree	.0%	25.0%	60.0%

Table 75.		KS2 Level		
		Level 5		
		Mathematics Group		
		7MA	7MB	7MC
		Column N %	Column N %	Column N %
Learning goal choices	5 performance goal score very strong	.0%	.0%	.0%
	6	11.1%	28.6%	.0%
	7	22.2%	28.6%	20.0%
		33.3%	57.2%	20.0%
	8	11.1%	28.6%	20.0%
	9	22.2%	.0%	20.0%
	10 learning goal score very strong	33.3%	14.3%	40.0%

Tests of significance: All level 5 students at School D2 by mathematics group

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Implicit theory of fixed intelligence is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.006	Reject the null hypothesis.
2	The distribution of Confidence in one's own intelligence is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.121	Retain the null hypothesis.
3	The distribution of Implicit theory of fixed personality is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.046	Reject the null hypothesis.
4	The distribution of Learning goal choices is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.235	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Table 76.		KS2 Level		
		Level 4		
		Mathematics Group		
		7MA	7MB	7MC
		Column N %	Column N %	Column N %
Implicit theory of fixed intelligence	3 strongly agree	.0%	.0%	7.1%
	5	.0%	14.3%	.0%
	6 agree	12.5%	.0%	.0%
	7	12.5%	.0%	7.1%
	8	12.5%	.0%	14.3%
	9 mostly agree	.0%	.0%	7.1%
	10	.0%	.0%	7.1%
		37.5%	14.3%	42.7%
	11	.0%	.0%	.0%
	12 mostly disagree	12.5%	14.3%	.0%
	13	25.0%	14.3%	7.1%
	14	12.5%	.0%	7.1%
	15 disagree	12.5%	28.6%	14.3%
	16	.0%	28.6%	.0%
	18 strongly disagree	.0%	.0%	28.6%

Table 77.		KS2 Level		
		Level 4		
		Mathematics Group		
		7MA	7MB	7MC
		Column N %	Column N %	Column N %
Confidence in one's own intelligence	very high	25.0%	14.3%	33.3%
	high	50.0%	42.9%	20.0%
		75.0%	57.2%	53.3%
	low	12.5%	42.9%	26.7%
	very low	12.5%	.0%	20.0%

Table 78.		KS2 Level		
		Level 4		
		Mathematics Group		
		7MA	7MB	7MC
		Column N %	Column N %	Column N %
Implicit theory of fixed personality	3 strongly agree	.0%	.0%	.0%
	4	.0%	14.3%	.0%
	5	.0%	14.3%	6.7%
	6 agree	25.0%	.0%	6.7%
	7	25.0%	.0%	13.3%
	8	.0%	14.3%	6.7%
	9 mostly agree	25.0%	.0%	20.0%
	10	.0%	14.3%	.0%
		75.0%	57.2%	53.4%
	11	.0%	.0%	.0%
	12 mostly disagree	12.5%	28.6%	6.7%
	13	.0%	.0%	6.7%
	14	.0%	.0%	.0%
	15 disagree	12.5%	.0%	6.7%
	16	.0%	.0%	.0%
	17	.0%	.0%	6.7%
	18 strongly disagree	.0%	14.3%	20.0%

Table 79.		KS2 Level		
		Level 4		
		Mathematics Group		
		7MA	7MB	7MC
		Column N %	Column N %	Column N %
Learning goal choices	5 performance goal score very strong	.0%	.0%	.0%
	6	12.5%	16.7%	20.0%
	7	12.5%	33.3%	26.7%
		25.0%	50.0%	46.7%
	8	50.0%	33.3%	33.3%
	9	12.5%	16.7%	20.0%
	10 learning goal score very strong	12.5%	.0%	.0%

Tests of significance: All level 4 students at School D2 by mathematics group

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Implicit theory of fixed intelligence is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.412	Retain the null hypothesis.
2	The distribution of Confidence in one's own intelligence is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.887	Retain the null hypothesis.
3	The distribution of Implicit theory of fixed personality is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.463	Retain the null hypothesis.
4	The distribution of Learning goal choices is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.625	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Table 80.		KS2 Level		
		Level 3		
		Mathematics Group		
		7MA	7MB	7MC
		Column N %	Column N %	Column N %
Implicit theory of fixed intelligence	3 strongly agree	.0%	.0%	.0%
	5	.0%	.0%	.0%
	6 agree	.0%	25.0%	.0%
	7	.0%	.0%	.0%
	8	50.0%	.0%	.0%
	9 mostly agree	.0%	.0%	.0%
	10	.0%	75.0%	66.7%
		50.0%	100.0%	66.7%
	11	50.0%	.0%	33.3%
	12 mostly disagree	.0%	.0%	.0%
	13	.0%	.0%	.0%
	14	.0%	.0%	.0%
	15 disagree	.0%	.0%	.0%
	16	.0%	.0%	.0%
	18 strongly disagree	.0%	.0%	.0%

Table 81.		KS2 Level		
		Level 3		
		Mathematics Group		
		7MA	7MB	7MC
		Column N %	Column N %	Column N %
Confidence in one's own intelligence	very high	50.0%	.0%	.0%
	high	.0%	50.0%	66.7%
		50.0%	50.0%	66.7%
	low	.0%	50.0%	33.3%
	very low	50.0%	.0%	.0%

Table 82.		KS2 Level		
		Level 3		
		Mathematics Group		
		7MA	7MB	7MC
		Column N %	Column N %	Column N %
Implicit theory of fixed personality	3 strongly agree	.0%	.0%	.0%
	4	.0%	.0%	.0%
	5	.0%	33.3%	.0%
	6 agree	.0%	33.3%	50.0%
	7	.0%	33.3%	.0%
	8	.0%	.0%	50.0%
	9 mostly agree	100.0%	.0%	.0%
	10	.0%	.0%	.0%
		100.0%	100.0%	100.0%
	11	.0%	.0%	.0%
	12 mostly disagree	.0%	.0%	.0%
	13	.0%	.0%	.0%
	14	.0%	.0%	.0%
	15 disagree	.0%	.0%	.0%
	16	.0%	.0%	.0%
	17	.0%	.0%	.0%
	18 strongly disagree	.0%	.0%	.0%

Table 83.		KS2 Level		
		Level 3		
		Mathematics Group		
		7MA	7MB	7MC
		Column N %	Column N %	Column N %
Learning goal choices	5 performance goal score very strong	.0%	.0%	.0%
	6	50.0%	.0%	.0%
	7	50.0%	50.0%	100.0%
		100.0%	50.0%	100.0%
	8	.0%	50.0%	.0%
	9	.0%	.0%	.0%
	10 learning goal score very strong	.0%	.0%	.0%

Tests of significance: All level 3 students at School D2 by mathematics group

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Implicit theory of fixed intelligence is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.515	Retain the null hypothesis.
2	The distribution of Confidence in one's own intelligence is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.957	Retain the null hypothesis.
3	The distribution of Implicit theory of fixed personality is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.116	Retain the null hypothesis.
4	The distribution of Learning goal choices is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.287	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Analysis of all students grouped by KS2 NC level against each variable of school, mathematics teacher, mathematics group and gender

All Level 3 students by school

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Implicit theory of fixed intelligence is the same across categories of School Name.	Independent-Samples Mann-Whitney U Test	.161	Retain the null hypothesis.
2	The distribution of Confidence in one's own intelligence is the same across categories of School Name.	Independent-Samples Mann-Whitney U Test	.342	Retain the null hypothesis.
3	The distribution of Implicit theory of fixed personality is the same across categories of School Name.	Independent-Samples Mann-Whitney U Test	.520	Retain the null hypothesis.
4	The distribution of Learning goal choices is the same across categories of School Name.	Independent-Samples Mann-Whitney U Test	.213	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

All level 3 students by mathematics teacher

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Implicit theory of fixed intelligence is the same across categories of Mathematics Teacher.	Independent-Samples Kruskal-Wallis Test	.200	Retain the null hypothesis.
2	The distribution of Confidence in one's own intelligence is the same across categories of Mathematics Teacher.	Independent-Samples Kruskal-Wallis Test	.840	Retain the null hypothesis.
3	The distribution of Implicit theory of fixed personality is the same across categories of Mathematics Teacher.	Independent-Samples Kruskal-Wallis Test	.214	Retain the null hypothesis.
4	The distribution of Learning goal choices is the same across categories of Mathematics Teacher.	Independent-Samples Kruskal-Wallis Test	.235	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

All level 3 students by mathematics group

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Implicit theory of fixed intelligence is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.280	Retain the null hypothesis.
2	The distribution of Confidence in one's own intelligence is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.905	Retain the null hypothesis.
3	The distribution of Implicit theory of fixed personality is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.171	Retain the null hypothesis.
4	The distribution of Learning goal choices is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.238	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

All level 3 students by gender

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Implicit theory of fixed intelligence is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	.746	Retain the null hypothesis.
2	The distribution of Confidence in one's own intelligence is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	.016	Reject the null hypothesis.
3	The distribution of Implicit theory of fixed personality is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	.715	Retain the null hypothesis.
4	The distribution of Learning goal choices is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	.608	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

All level 4 students by School

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Implicit theory of fixed intelligence is the same across categories of School Name.	Independent-Samples Mann-Whitney U Test	.357	Retain the null hypothesis.
2	The distribution of Confidence in one's own intelligence is the same across categories of School Name.	Independent-Samples Mann-Whitney U Test	.829	Retain the null hypothesis.
3	The distribution of Implicit theory of fixed personality is the same across categories of School Name.	Independent-Samples Mann-Whitney U Test	.360	Retain the null hypothesis.
4	The distribution of Learning goal choices is the same across categories of School Name.	Independent-Samples Mann-Whitney U Test	.241	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

All level 4 students by mathematics teacher

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Implicit theory of fixed intelligence is the same across categories of Mathematics Teacher.	Independent-Samples Kruskal-Wallis Test	.085	Retain the null hypothesis.
2	The distribution of Confidence in one's own intelligence is the same across categories of Mathematics Teacher.	Independent-Samples Kruskal-Wallis Test	.733	Retain the null hypothesis.
3	The distribution of Implicit theory of fixed personality is the same across categories of Mathematics Teacher.	Independent-Samples Kruskal-Wallis Test	.036	Reject the null hypothesis.
4	The distribution of Learning goal choices is the same across categories of Mathematics Teacher.	Independent-Samples Kruskal-Wallis Test	.887	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

All level 4 students by mathematics group

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Implicit theory of fixed intelligence is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.075	Retain the null hypothesis.
2	The distribution of Confidence in one's own intelligence is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.804	Retain the null hypothesis.
3	The distribution of Implicit theory of fixed personality is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.056	Retain the null hypothesis.
4	The distribution of Learning goal choices is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.901	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

All level 4 students by gender

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Implicit theory of fixed intelligence is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	.497	Retain the null hypothesis.
2	The distribution of Confidence in one's own intelligence is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	.079	Retain the null hypothesis.
3	The distribution of Implicit theory of fixed personality is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	.029	Reject the null hypothesis.
4	The distribution of Learning goal choices is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	.001	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

All Level 5 students by school

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Implicit theory of fixed intelligence is the same across categories of School Name.	Independent-Samples Mann-Whitney U Test	.819	Retain the null hypothesis.
2	The distribution of Confidence in one's own intelligence is the same across categories of School Name.	Independent-Samples Mann-Whitney U Test	.160	Retain the null hypothesis.
3	The distribution of Implicit theory of fixed personality is the same across categories of School Name.	Independent-Samples Mann-Whitney U Test	.094	Retain the null hypothesis.
4	The distribution of Learning goal choices is the same across categories of School Name.	Independent-Samples Mann-Whitney U Test	.151	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

All level 5 students by mathematics teacher

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Implicit theory of fixed intelligence is the same across categories of Mathematics Teacher.	Independent-Samples Kruskal-Wallis Test	.019	Reject the null hypothesis.
2	The distribution of Confidence in one's own intelligence is the same across categories of Mathematics Teacher.	Independent-Samples Kruskal-Wallis Test	.085	Retain the null hypothesis.
3	The distribution of Implicit theory of fixed personality is the same across categories of Mathematics Teacher.	Independent-Samples Kruskal-Wallis Test	.030	Reject the null hypothesis.
4	The distribution of Learning goal choices is the same across categories of Mathematics Teacher.	Independent-Samples Kruskal-Wallis Test	.468	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

All level 5 Students by mathematics group

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Implicit theory of fixed intelligence is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.008	Reject the null hypothesis.
2	The distribution of Confidence in one's own intelligence is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.130	Retain the null hypothesis.
3	The distribution of Implicit theory of fixed personality is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.032	Reject the null hypothesis.
4	The distribution of Learning goal choices is the same across categories of Mathematics Group.	Independent-Samples Kruskal-Wallis Test	.342	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

All level 5 students by gender

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Implicit theory of fixed intelligence is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	.461	Retain the null hypothesis.
2	The distribution of Confidence in one's own intelligence is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	.058	Retain the null hypothesis.
3	The distribution of Implicit theory of fixed personality is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	.032	Reject the null hypothesis.
4	The distribution of Learning goal choices is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	.743	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Comparative analysis between schools - gender

Table 84.		School Name			
		D1		D2	
		Gender		Gender	
		Male	Female	Male	Female
		Column N %	Column N %	Column N %	Column N %
Implicit theory of fixed intelligence	3 strongly agree	2.8%	.0%	2.4%	.0%
	4	1.4%	.0%	.0%	.0%
	5	1.4%	.0%	2.4%	3.7%
	6 agree	1.4%	7.6%	.0%	7.4%
	7	1.4%	2.5%	2.4%	18.5%
	8	6.9%	5.1%	4.8%	7.4%
	9 mostly agree	9.7%	10.1%	2.4%	18.5%
	10	8.3%	6.3%	16.7%	7.4%
		33.3%	31.6%	31,1%	62.9%
	11	9.7%	12.7%	7.1%	.0%
	12 mostly disagree	12.5%	13.9%	7.1%	7.4%
	13	13.9%	10.1%	9.5%	3.7%
	14	5.6%	3.8%	4.8%	.0%
	15 disagree	6.9%	16.5%	11.9%	18.5%
	16	5.6%	5.1%	9.5%	3.7%
	17	5.6%	1.3%	.0%	.0%
	18 strongly disagree	6.9%	5.1%	19.0%	3.7%

Table 85.		School Name			
		D1		D2	
		Gender		Gender	
		Male	Female	Male	Female
		Column N %	Column N %	Column N %	Column N %
Confidence in one's own intelligence	very high	39.7%	20.5%	46.5%	11.5%
	high	25.0%	30.8%	32.6%	34.6%
		64.7%	51.3%	79.1%	46.1%
	low	19.1%	29.5%	11.6%	38.5%
	very low	16.2%	19.2%	9.3%	15.4%

Table 86.		School Name			
		D1		D2	
		Gender		Gender	
		Male	Female	Male	Female
		Column N %	Column N %	Column N %	Column N %
Implicit theory of fixed personality	3 strongly agree	9.1%	6.6%	2.5%	3.7%
	4	.0%	2.6%	.0%	3.7%
	5	4.5%	3.9%	5.0%	7.4%
	6 agree	9.1%	17.1%	5.0%	29.6%
	7	3.0%	5.3%	12.5%	7.4%
	8	10.6%	11.8%	5.0%	14.8%
	9 mostly agree	13.6%	7.9%	15.0%	3.7%
	10	12.1%	10.5%	2.5%	.0%
		62.0%	65.7%	47.5%	70.3%
	11	6.1%	11.8%	.0%	3.7%
	12 mostly disagree	10.6%	10.5%	7.5%	7.4%
	13	7.6%	2.6%	5.0%	3.7%
	14	.0%	5.3%	5.0%	.0%
	15 disagree	9.1%	2.6%	10.0%	11.1%
	16	.0%	.0%	2.5%	.0%
	17	.0%	.0%	2.5%	.0%
	18 strongly disagree	4.5%	1.3%	20.0%	3.7%

Table 87.		School Name			
		D1		D2	
		Gender		Gender	
		Male	Female	Male	Female
		Column N %	Column N %	Column N %	Column N %
Learning goal choices	5 performance goal score very strong	1.6%	.0%	.0%	.0%
	6	18.0%	27.5%	8.3%	22.2%
	7	23.0%	36.2%	33.3%	18.5%
		42.6%	63.7%	41.6%	40.7%
	8	23.0%	21.7%	25.0%	37.0%
	9	18.0%	10.1%	19.4%	11.1%
	10 learning goal score very strong	16.4%	4.3%	13.9%	11.1%

Comparative analysis between schools – gender – boys

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Implicit theory of fixed intelligence is the same across categories of School Name.	Independent-Samples Mann-Whitney U Test	.171	Retain the null hypothesis.
2	The distribution of Confidence in one's own intelligence is the same across categories of School Name.	Independent-Samples Mann-Whitney U Test	.218	Retain the null hypothesis.
3	The distribution of Implicit theory of fixed personality is the same across categories of School Name.	Independent-Samples Mann-Whitney U Test	.048	Reject the null hypothesis.
4	The distribution of Learning goal choices is the same across categories of School Name.	Independent-Samples Mann-Whitney U Test	.731	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Comparative analysis between schools – gender- girls

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Implicit theory of fixed intelligence is the same across categories of School Name.	Independent-Samples Mann-Whitney U Test	.039	Reject the null hypothesis.
2	The distribution of Confidence in one's own intelligence is the same across categories of School Name.	Independent-Samples Mann-Whitney U Test	.645	Retain the null hypothesis.
3	The distribution of Implicit theory of fixed personality is the same across categories of School Name.	Independent-Samples Mann-Whitney U Test	.417	Retain the null hypothesis.
4	The distribution of Learning goal choices is the same across categories of School Name.	Independent-Samples Mann-Whitney U Test	.113	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Appendix 5

Descriptive Statistics – Y7 Teacher Questionnaires

Respondents Name

Table 1.		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	A	1	20.0	20.0	20.0
	CI	1	20.0	20.0	40.0
	D	1	20.0	20.0	60.0
	G	1	20.0	20.0	80.0
	I	1	20.0	20.0	100.0
	Total	5	100.0	100.0	

Research School

Table 2.		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	D1	3	60.0	60.0	60.0
	D2	2	40.0	40.0	100.0
	Total	5	100.0	100.0	

gender

Table 3.		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	male	2	40.0	40.0	40.0
	female	3	60.0	60.0	100.0
	Total	5	100.0	100.0	

My Year 7 class is grouped by:

Table 4.		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	mixed ability	2	40.0	40.0	40.0
	setted	3	60.0	60.0	100.0
	Total	5	100.0	100.0	

Everyone has a certain amount of intelligence and you can't really do much to change it

Table 5.		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	disagree	2	40.0	40.0	40.0
	strongly disagree	3	60.0	60.0	100.0
	Total	5	100.0	100.0	

People's intelligence is something about them that they can't change very much

Table 6.		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	disagree	3	60.0	60.0	60.0
	strongly disagree	2	40.0	40.0	100.0
	Total	5	100.0	100.0	

To be honest, people can't really change how intelligent they are

Table 7.		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	disagree	4	80.0	80.0	80.0
	strongly disagree	1	20.0	20.0	100.0
	Total	5	100.0	100.0	

People can learn new things, but they can't really change their basic intelligence

Table 8.		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	mostly disagree	1	20.0	20.0	20.0
	disagree	3	60.0	60.0	80.0
	strongly disagree	1	20.0	20.0	100.0
	Total	5	100.0	100.0	

The kind of person someone is, is something very basic about them and it can't be changed very much

Table 9.		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	mostly disagree	1	20.0	20.0	20.0
	disagree	3	60.0	60.0	80.0
	strongly disagree	1	20.0	20.0	100.0
	Total	5	100.0	100.0	

People can do things differently, but the important parts of who they are can't really be changed

Table 10.		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	agree	1	20.0	20.0	20.0
	mostly disagree	2	40.0	40.0	60.0
	disagree	2	40.0	40.0	100.0
	Total	5	100.0	100.0	

As much as I hate to admit it, you can't teach old dogs new tricks. People can't really change their deepest attributes

Table 11.		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	mostly disagree	1	20.0	20.0	20.0
	disagree	3	60.0	60.0	80.0
	strongly disagree	1	20.0	20.0	100.0
	Total	5	100.0	100.0	

Everyone is a certain kind of person, and there is not much that can be done to really change that

Table 12.		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	mostly agree	1	20.0	20.0	20.0
	disagree	3	60.0	60.0	80.0
	strongly disagree	1	20.0	20.0	100.0
	Total	5	100.0	100.0	

In maths lessons I most often give students

Table 13.		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Problems that they learn a lot from, even if they won't look so clever	5	100.0	100.0	100.0

If I knew students weren't going to do well in a maths problem, I probably wouldn't give it to them even if they might learn a lot from it

Table 14.		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	agree	1	20.0	20.0	20.0
	mostly disagree	1	20.0	20.0	40.0
	disagree	3	60.0	60.0	100.0
	Total	5	100.0	100.0	

Although I hate to admit it, I sometimes would prefer students to do well in maths lessons than learn a lot

Table 15.		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	mostly disagree	3	60.0	60.0	60.0
	disagree	1	20.0	20.0	80.0
	strongly disagree	1	20.0	20.0	100.0
	Total	5	100.0	100.0	

It is much more important for students to learn new things in maths lessons than it is for them to get the best level

Table 16.		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	1	20.0	20.0	20.0
	agree	1	20.0	20.0	40.0
	mostly agree	1	20.0	20.0	60.0
	mostly disagree	1	20.0	20.0	80.0
	strongly disagree	1	20.0	20.0	100.0
	Total	5	100.0	100.0	

If I had to choose between students getting a good level and being challenged in maths lessons I would choose

Table 17.		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	good level	2	40.0	40.0	40.0
	being challenged	3	60.0	60.0	100.0
	Total	5	100.0	100.0	

Implicit theory of intelligence * Respondents Name Cross tabulation

% within Respondents Name

Table 18.		Respondents Name					Total
		A	CI	D	G	I	
Implicit theory of intelligence	Disagree			100.0%	100.0%	100.0%	60.0%
	22	100.0%					20.0%
	Strongly disagree		100.0%				20.0%
Total		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Implicit theory of personality * Respondents Name Cross tabulation

% within Respondents Name

Table 19.		Respondents Name					Total
		A	CI	D	G	I	
Implicit theory of personality	Mostly disagree	100.0%			100.0%		40.0%
	Disagree					100.0%	20.0%
	21		100.0%	100.0%			40.0%
Total		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Learning goal choice * Respondents Name Cross tabulation

% within Respondents Name

Table 20.		Respondents Name					Total
		A	CI	D	G	I	
Learning goal choice	8				100.0%	100.0%	40.0%
	9			100.0%			20.0%
	10 Challenge goal very strong	100.0%	100.0%				40.0%
Total		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Appendix 6

University of Sussex
Sussex Institute

Standards and Guidelines on Research Ethics Annex: Checklist for proposed research

Standards 1 & 3: Safeguard the interests and rights of those involved or affected by the research. Establish informed consent.

1.1	Have you considered the well-being of those involved or affected? Have measures been taken to protect their interests (e.g. by clarifying use to be made of outcomes)	**Yes** √☐	**No** ☐
1.2	Has written and signed consent been obtained without coercion? Have participants been informed of their right to refuse or to withdraw at any time?	**Yes** √☐	**No** ☐
1.3	Have the purposes and processes of the research been fully explained, using alternative forms of communication where necessary and making reference to any implications for participants of time, cost and the possible influence of the outcomes?	**Yes** √☐	**No** ☐
1.4	Where covert research is proposed, has a case been made and brought to the attention of the School committee and approval sought from the relevant external professional ethical committee? N/A	**Yes** ☐	**No** ☐
1.5	Does the proposal include procedures to verify data with respondents and offer feedback on findings?	**Yes** √☐	**No** ☐
1.6	Will the participants be involved in the design, data collection or reporting where feasible?	**Yes**	**No**

		☐	√☐
1.7	Has conditional anonymity and confidentiality been offered?	**Yes** √☐	**No** ☐
1.8	Has the appropriate person (e.g. headteacher, manager of residential home, head of service) been identified to whom disclosures that involve danger to the participant or others, must be reported?	**Yes** √☐	**No** ☐
Standard 2: Ensure legislative requirements on human rights and data protection have been met.			
2.1	Have the implications of at least, the four pieces of legislation listed in this document been considered?	**Yes** √☐	**No** ☐
2.2	Where any particular implications arise from legislation or uncertainties exist, has contact been made with the named university person? N/A	**Yes** ☐	**No** ☐
Standard 4: Develop the highest possible standards of research practices including in research design, data collection, storage, analysis, interpretation and reporting			
4.1	Has existing literature and ongoing research been identified and considered?	**Yes** √☐	**No** ☐
4.2	Have methods been selected to be fit for purpose?	**Yes** √☐	**No** ☐

4.3	Where appropriate to the research design, will all data collection proposed be used to address the question?	**Yes** √☐	**No** ☐
4.4	Have methods for verifying data (e.g. audit trails, triangulation, etc.) been built into the research design?	**Yes** √☐	**No** ☐
4.5	Where research is externally funded, has agreement with sponsors been reached on reporting and intellectual property rights? N/A	**Yes** ☐	**No** ☐
4.6	Have plans been made that will enable the archiving of data (e.g. through consulting the guidance available from the UK Data Archive)?	**Yes** ☐	**No** √☐
Standard 5: Consider the consequences of your work or its misuse for those you study and other interested parties			
5.1	Have the short and long term consequences of the research been considered from the different perspectives of participants, researchers, policy-makers and where relevant, funders?	**Yes** √☐	**No** ☐
5.2	Have the costs of the research to participants or their institutions/services and any possible compensation been considered? N/A	**Yes** ☐	**No** ☐
5.3	Has information about support services (e.g. mentoring, counselling) that might be needed as a consequence of any possible unsettling effects of the research itself been identified?	**Yes** √☐	**No** ☐
5.4	Are the plans flexible enough to ensure that time can be spent discussing any issues that arise from the	**Yes**	**No**

	effects of the research on the individuals or institutions/services?	√☐	☐
	Standard 6: Ensure appropriate external professional ethical committee approval is granted where relevant		
6.1	Have colleagues/supervisors been invited to comment on your research proposal?	**Yes** √☐	**No** ☐
6.2	Have any sensitive ethical issues been raised with the School Committee and comments sought?	**Yes** ☐	**No** √☐
6.3	If relevant, which includes all health and social care research, has the external professional ethical committee been identified? N/A	**Yes** ☐	**No** ☐
6.4	Have the guidelines from that professional committee been used to check the proposed research? N/A	**Yes** ☐	**No** ☐
6.5	Do plans include seeking clearance from this committee (e.g. time to obtain approval may need building into the proposal)? N/A	**Yes** ☐	**No** ☐