Improving Opportunities for Mathematical Learning Amongst Students Identified as Having Behavioural, Emotional and Social Difficulties within a Special School Environment.

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Declaration

I hereby declare that this thesis has not been and will not be, submitted in whole or in part to another University for the award of any other degree.

Signature: ……

Date: ……

Summary

This thesis reports on a small scale action research study conducted within the mathematics classroom of a special school in England, categorized as catering for students with Behavioural, Emotional and Social and Difficulties (BESD). In the UK, more students are identified as having BESD than any other category of Special Educational Need and yet students identified in this way experience some of the poorest educational outcomes. This study sought to explore how one class of six Year 10 students (aged 14 -15) viewed and experienced their learning of mathematics. It aimed to identify whether particular pedagogical approaches could provide improved opportunities for learning. Instead of focusing on strategies and sanctions to manage behaviour, this research concentrated on better understanding the specific learning needs of this small but diverse group of students.

The study was informed by theories of learning that emphasise the importance of social and cognitive processes in the learning of mathematics. In order to encourage peer communication and social interaction, the teacher adopted the role of facilitator, increasing opportunities for students to engage in dialogue and learn from each other. The curriculum area of measurement estimation was chosen as the focus of the intervention. As this is an area of mathematics that does not necessarily lead to a single correct answer, it reduced the risk to students of getting it 'wrong' which could further exacerbate issues of low self-esteem and confidence. Data were gathered at each phase of the action research cycle and included: audio recordings made during and after each of the seven learning activities that comprised the intervention; notes from the teacher-researcher's research journal and copies of students' work. As the study aimed to capture the students' perspective of their mathematical learning, they each took part in an individual, semi-structured interview during the reconnaissance phase and a focus group discussion following the intervention stage. Data collected from the reconnaissance stage were analysed using a process of thematic analysis and informed the development of the intervention.

The study poses a number of challenges for those interested in improving the opportunities for mathematical learning amongst students identified as having BESD. Although all six students within this study initially expressed a preference for working alone, pedagogical approaches based on active and participatory learning were found to be motivating and engaging for the majority of learners. Although most students demonstrated an increased capacity to work together cooperatively, some struggled to learn collaboratively. The study highlighted that, in developing social constructivist approaches to learning mathematics, students' social competence and trust in each other, needs to be nurtured. Finally, the teacher's role in stimulating 'talk' was identified as a key factor in increasing opportunities for students to learn mathematics.

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List of Abbreviations

ADHD	Attention Deficit Hyperactivity Disorder
BERA	British Education Research Association
BESD	Behavioural, Emotional and Social Difficulties[1]
DCSF	Department for Children, Families and Schools (2007 – 2010)
DfE	Department for Education (2010 – Present)
DfES	Department for Education and Science (2001 – 2007)
DSM-V	Diagnostic and Statistical Manual of Mental Disorders (Version 5)
EBD	Emotional and Behavioural Difficulties[1]
FSM	Free School Meal
GCSE	General Certificate of Secondary Education
LSA	Learning Support Assistant
OfSTED	Office for Standards in Education
SAT	Standard Assessment Test
SEBD	Social, Emotional and Behavioural Difficulties[1]
SEBDA	Social, Emotional and Behavioural Difficulties Association
SEN(D)	Special Educational Needs (and Disability)

[1] For consistency the term BESD has been adopted throughout this thesis, whilst acknowledging that some literature uses the terms SEBD or EBD to refer to the same type of Special Educational Need.

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1. Introduction

Behavioural, Emotional and Social Difficulties (BESD) is an umbrella term covering numerous conditions and behaviours (Crossley, 2011 p. 153) and was first defined as a category of Special Education Need in the 2001 Code of Practice (DfES, 2001) thus:

> Children and young people who demonstrate features of emotional and behavioural difficulties, are withdrawn or isolated, disruptive and disturbing, hyperactive and lack concentration; those with immature social skills; and those presenting challenging behaviours arising from other complex special needs.
>
> (DfES, 2001 Ch 7 Para 60 p. 87)

This definition clearly highlights that BESD is not a homogenous group of need, with individuals exhibiting many polarised behaviours -withdrawn or disruptive or hyperactive or introverted. As Cole (2004) comments, 'BESD delineates a rather large and amorphous SEN category' that Fovet (2011) suggests is best viewed as a continuum of need, spanning 'a spectrum ranging from unacceptable behaviour to mental illness' (Fovet, 2011 p. 250).

Although students identified as having BESD often struggle with both their learning and behaviour within the classroom, research and policy guidelines primarily focus on addressing observable and externalised behaviours (Tran Nguyen Templeton *et al.*, 2008 p. 226). Much educational research attempts to make these students 'fit' into a classroom environment by requiring them to change their behaviours, for example Stormont (2008) and Reid *et al.* (2005). These approaches assume that it is the student who needs to adapt to the school environment. In contrast to this approach, Thomas (2005) suggests that the origins of many difficulties that students experience lie less within them 'but more in the character of the organisation which we ask them to inhabit for a large part of their lives' (Thomas, 2005 p. 72). Similarly, Prosser (2007 p. 4) argues that, 'We are encouraged to ask why students fail in school and society, but not to ask how school and society may fail our students.'

There is much research offering generalised guidance on how to teach students identified as having BESD, such as Wheeler (2010) or DuPaul and Stoner (2003). For example, Hughes and Cooper (2007) state that a structured learning environment, with clear boundaries is essential in supporting students identified as having BESD effectively. They cite good discipline and adherence to routine, as well as letting the student work at their own pace with adult support, as essential prerequisites.

Barkley (2006) describes the characteristics of pedagogical practices that have been shown to improve performance for students with BESD as, frequent and immediate feedback, instant reinforcement and constant opportunities to respond to academic stimulation. However none of this research specifically relates or refers to the issues surrounding learning or mathematics.

BESD are essentially socially constructed, in the sense that pupils' behaviour is interpreted in terms of expected patterns (norms) of behaviour (Lindsay *et al.*, 2006 p. 8). It is a subjective category of SEN(D) and relies on the construction of 'normality' for comparison purposes. The category of BESD defines a range of behaviours that includes ADHD. However, it is important to bear in mind the purpose and usefulness of labelling students' behaviour in this way and as Visser and Jehan (2009 p. 127) comment, 'educational professionals would do well to look beyond the label to the child's needs.'

The focus of this study then, was to ascertain how mathematical learning for students identified as having BESD could be promoted. A further aim of this study was to gain a better understanding of the factors that students consider relevant to the process of learning mathematics, by actively seeking students' views on how they learn best. As a teacher of mathematics in a special school that caters for learners categorised as having BESD for the past 18 years, I wished to expand my professional practice by exploring these issues more formally through research. I carried out this small scale study, with six Year 10 students, whom I taught at a maintained community non-residential special school in England. The study was carried out during the Spring term of 2014, following Elliott's (1991) action research methodology. The initial reconnaissance stage consisted of initial individual interviews with students to elicit their views of learning mathematics and the audio recording of the group during a single investigative style lesson. Using the data collected from this process, an intervention was developed and then implemented during the group's usual timetabled mathematics lessons, in order to capture typical classroom interaction and practice. At the end of the research cycle, students took part in both post-intervention semi-structured interviews as well as a focus group discussion. Other empirical qualitative data sources that were drawn upon during this research include the students' written work, my reflective journal, a written account of the views of the mathematics Learning Support Assistant and lesson planning documents. The three research questions were formulated thus:

RQ1: How do students categorised as having BESD view their learning of mathematics?

RQ2: What specific challenges do students identified with BESD face when it comes to learning mathematics?

RQ3: How can approaches to teaching and learning be developed to take account of these barriers to learning mathematics?

The students who attend the school come with significant histories of difficulties with school attendance, behaviour and engagement in learning as a result of complex emotional and social challenges. Research that focuses on improving the mathematical experiences of students labelled as having BESD is scarce (Vaughn and Bos, 2012) and even fewer studies seek to document the child and young person's perspective (Shattell *et al.*, 2008). As Davie *et al.* (1996 p. 7) suggest, listening to students may 'hold the key to our understanding of the problem and its resolution'. The lack of research involving the students' perspective of their learning is documented by Davis and Florian (2004):

> There is a need for research that focuses on involving children and young people with BESD as active members of the decision making process in designing and implementing teaching strategies and approaches. (Davis and Florian, 2004 p. 25)

The remainder of this chapter details the rationale and context of the study, concluding with an explanation of the conceptual approach that informed this study.

1.1 Rationale of Study

The primary motivation for this research was to improve opportunities to engage in learning mathematics by focusing on understanding the challenges that students face, from their perspective. The factors that underpin the rationale of this study are discussed below.

1.1.1 Poor Educational Outcomes

The issue of academic underachievement amongst this group of learners has been well documented (Loe and Feldman, 2007, Ek *et al.*, 2010). In 2013, only 18.4% of students with a Statement for BESD achieved at least five GCSEs at grades A* to C, including English and mathematics as opposed to a national figure of 58.8% (DfE, 2014a). The consequences of this underperformance for these students means that they are less likely to gain employment when they leave education (Hallahan *et al.*, 2014), are less likely to continue in education post-16 (Groom and Rose, 2005 p. 319) and more likely to be involved in criminality (Farrell and Polat, 2003). Students identified as having BESD often display characteristics that do not support success in or out of school (Jolivette *et al.*, 2000) and this combined with them having low aspirations (Casey *et al.*, 2006) makes the situation more problematic. As Bradley *et al.* (2008) summarise, students identified as having BESD have the poorest educational, behavioural and social outcomes of any SEN(D) group.

1.1.2 A Focus on Learning

Students categorised as having BESD are more likely to present problems for teaching and learning, given the increased risk for antisocial behaviours such as defiance, hyperactivity, aggression and bullying (Jull, 2008 p. 14). These challenges present difficulties for schools in creating or maintaining orderly environments, in ensuring effective learning and teaching and in promoting and sustaining good behaviour (DENI, 2012 p. 258). There is currently much more research with a focus on addressing behavioural issues, as opposed to tackling learning for this group of students, as Regan *et al.* (2009) comment:

> The literature in the field of EBD has primarily focused on how to manage behaviours and improve social/emotional functioning of these individuals, and provided less guidance in the area of academic achievement.
>
> (Regan *et al.*, 2009 p. 318)

This focus on behaviour was mirrored within the school in which this research was conducted. Staff discussions regarding an individual student's progress tended to focus on their behaviour and less on their academic achievement. A student was said to have had a good day if there had been no incidents of poor behaviour. Grasping a key concept of algebra often seemed of lesser concern within this BESD environment.

BESD is a category of SEN(D) that exposes a child to increased risk of exclusion, as a function of the very SEN(D) identified as requiring special provision in the first instance (Jull, 2008). In 2014, the Department for Education (2014b) reported that the most common reason cited for exclusion was persistent disruptive behaviour, accounting for 30.8% of permanent exclusions and 24.2% of fixed period exclusions. They further state that students with a statement of SEN(D) are around six times more likely to be permanently excluded than those students with no SEN(D).

Although specialist behavioural provision is made available to support this category of SEN(D), the Department for Education (2011) acknowledge that accessing it can feel like a battle, 'where [parents] are passed from pillar to post, and where bureaucracy and frustration face them at every step.' (DfE, 2011 p. 2). The rationale then for this research was to focus upon the students' learning needs, rather than focussing on controlling the 'problem behaviours'.

1.1.3 Student Voice

The DfES (2001) emphasizes the importance of listening to students' views of their learning and giving them the opportunity to express their needs. However, as Cefai and Cooper (2010) report, little attention is given to this process and students with BESD have been recognised as one of the least listened to groups of learners (Lewis and Burman, 2008). Students are uniquely placed to provide an understanding of the causes and nature of their difficulties in learning that might not be obvious to the teacher (Hamill and Boyd, 2002). It is important however to note Porter's (2009) comment:

> Arguably children are the best source of information about the ways in which schools support their learning and what barriers they encounter. Accessing this requires a deeper level of reflection than simply asking what children find difficult.
> (Porter, 2009 p. 349)

Cooper *et al.* (2006) consider students to be a valuable source of knowledge of what it is like to be a student in a particular school. They can also provide an insightful account of their own learning and how this could be enhanced by classroom teaching practices (Leitch and Mitchell, 2007). Valuing the views of students ultimately empowers them to take more control and responsibility for their own learning (Norwich *et al.*, 2006). This study therefore aimed to inform those working with students identified as having BESD, of the potential barriers to the learning of mathematics, whilst at the same time, giving and listening to the voice of these students.

1.2 Teacher-Researcher's Background

I began my teaching career in September 1995 working in a co-educational mainstream secondary school teaching mathematics. Within a few years I found that my interest was drawn towards the more disaffected and disruptive students, often labelled 'under-achieving' within this school. The school's system of rewards and sanctions seemed effective for the vast majority of the school population. However there was still a small group of students who seemed unwilling, but at the same time able, making very little academic progress. After completing three years in this mainstream environment, I became increasingly disillusioned by an education system, the success of which was judged by the number of students attaining 'grade C or above' at GCSE. There was little focus on those students who were predicted to achieve less than a grade C and I began to find myself being drawn towards, what was then for me, the secretive umbrella of special education. In September 1998, I accepted the role of Senior Teacher at a special school categorised as catering for students with Social, Emotional and Behavioural difficulties (SEBD).

The special school where this research was conducted, emulates the practices and procedures that are commonly found within many English secondary mainstream schools, that is, following the same curriculum with subject specialist based teaching, subject to the same OFSTED inspection framework and where students are expected to sit the same external GCSE examinations. Where it differs from a mainstream model however, is in the intensity of the individual support that is required for students to make progress. There is certainly a greater need for patience and nurture as well as for an elevated understanding and tolerance of student behaviours. However, with regard to

teaching practices, the same approaches are used as those found in any mainstream school. It is this aspect of special school education that surprised me the most – the students are 'labelled' as BESD, placed in an alternative environment, but then taught using the same methods.

The way in which I approach my teaching, to a certain extent, has been influenced by my own experiences of being a learner of mathematics myself. My earliest memory of being in a mathematics lesson was at Primary school, simply because it was very different to all my previous experiences of learning. The teacher asked everyone to put their work away, ten minutes before the end of the lesson and she then wrote two fractions on the board ½ +¼. The teacher asked 'Does anyone know the answer?' What made this lesson so memorable was the fact that we had not been studying fractions at all that lesson and that the teacher chose not to tell anyone, if the answer they offered, was correct or not. As a learner, I could see that most of my peers were adding the two top numbers and the bottom two together, making $^{2}/_{6}$, which seemed too straightforward to me. When everyone had exhausted all the possible combinations of answers, the teacher just said, 'That's what we will be doing tomorrow!' Was it the mystery of not being told the answer or how to work it out, the novelty and surprise of the approach or perhaps the intrigue of having to wait until the next lesson to 'know' which made this experience so unforgettable? These are all characteristics that I endeavour to include in my own teaching. Although I am a mathematics teacher and not a children's entertainer, if students identified as having BESD are not interested or inspired to learn, they will just walk out of the lesson or refuse to take part in no uncertain terms.

The values that I bring to this research are mixed, as before starting the Educational Doctorate, all of my educational experience had a mathematical or scientific bias. Being entrenched in a positivist worldview, where proving or disproving hypotheses, statistical analysis with pre and post groups or a control and treatment group seemed to be the only plausible way to be certain of finding objective truths. Epistemologically, positivism assumes that truth can only be attained because knowledge is objective and rests on a set of indisputable truths (Morgan and Smircich, 1980). During my journey through this doctorate programme however, the value and purpose of alternative paradigms has become apparent - positivistic inquiry is not an appropriate way to evaluate interaction between human beings within a classroom environment.

1.3 Context of the study

To situate this study contextually, this section gives consideration to the three levels of policy and practices that operate and affect the educational experience of the students who are the subjects of this research. These are the national approaches to the education of BESD students as well as the national policies which inform the teaching and learning of mathematics; the school's aims and philosophy and finally the ethos and environment of my classroom. Firstly then, in order to understand why some students identified as having BESD, are educated within a special school environment and others are not, it is useful to consider the historical changes in educational policy.

1.3.1 National Approach on BESD Provision

Currently the Special Educational Needs and Disability Act (2014k) places a duty on local education authorities to provide children with SEN(D) an education within a mainstream school unless, in the case of a statemented student, this is against the wishes of the student's parents or contrary to the provision of efficient education of other children. However, government policy on how best to educate students with SEN(D) has varied greatly over the last 70 years.

The 1944 Education Act stated that students with SEN should be categorised by their disabilities, defined in medical terms. These students were considered to be 'uneducable' and terms such as 'maladjusted' or 'educationally sub-normal' were used to describe them (Education and Skills Committee, 2006). The act demanded that SEN students should be educated separately in special schools. The publication of the Warnock Report (1978) heralded a radical shift in government policy which was reflected in the Education Act (1981). This saw the formulation of statements of SEN and promoted the concept of inclusion of students with SEN into mainstream schools. As a consequence, during the 1980s and 1990s there was a decline in the number of students attending special schools (Education and Skills Committee, 2006). A worldwide shift toward inclusive education was spearheaded by the Salamanca Statement which called on governments to 'adopt as a matter of law or policy the principle of inclusive education, enrolling all children in regular schools unless there are compelling reasons for doing otherwise' (UNESCO, 1994 p. ix). Government guidance entitled 'Removing Barriers to Achievement' (DfES, 2004) called for mainstream schools to provide support for the majority of SEN students, with special schools catering for more complex and severe need (DfES, 2004 p. 13).

In 2014, the Department for Education (2014i) reported that there were 232,190 students with Statements of Special Education Need which represented 2.8% of the total school population. Representing the largest group of SEN(D), 26.7% of Statements are issued to Secondary school aged students with BESD. 44.4% of all students with SEN(D) are educated within state funded special schools (DfE, 2014i p. 11). This is consistent with the government's agenda of inclusion and recommendations from the Warnock Report (1978) which recognises that not all students with SEN(D) require an education in a special school. It is interesting to note however that of all special school placements in England, 24.8% have statements for Severe Learning Difficulties, 22.5% for Autistic Spectrum Disorder and 17.2% have Moderate Learning Difficulties and only 11.8% of students with BESD are placed within specialist provision. These figures show that students identified as having BESD are more likely than any other SEN(D) category, to be educated within a mainstream environment.

The SEN(D) green paper entitled, 'Support and Aspiration: A New Approach to Special Educational Needs and Disability' (2011) proposed to reverse the previous trend towards the inclusion of students identified with BESD within mainstream schools. Much research concurs with this change in policy, recognising that students identified having BESD often pose the greatest challenge towards inclusive education (DfES, 2004, Heath *et al.*, 2004). In July 2014, the Department for Education published a new Special Educational Needs and Disabilities (SEND) Code of Practice which came into force from 1st September 2014. This Code reflected changes introduced by the Children and Families Act (2014) and saw school action, school action plus and statements of special educational need being replaced by Education, Health and Care Plans (EHCP). The BESD category of need was also reclassified as Social, Emotional and Mental Health Difficulties which would suggest the government's intention was to change the categorisation of those students who would otherwise be considered as having behavioural difficulties. It is not clear however, if this represents a repositioning away from behaviour to the root causes of it, namely social and emotional difficulties, or that behaviour is no longer considered a special educational need.

> Behavioural difficulties do not necessarily mean that a child or young person has a SEN and should not automatically lead to a pupil being registered as having SEN. However consistent disruptive or withdrawn behaviours can be an indication of unmet SEN, and where there are concerns about behaviour, there should be an assessment to determine whether there are any causal factors such as undiagnosed learning difficulties, difficulties with communication or mental health issues.
>
> (DfE, 2014k p. 61)

OFSTED (2006) reported that although BESD special schools are less effective than other types of special school, students identified as having BESD are as likely to make good progress with their academic, personal and social development regardless of whether they are placed within a mainstream or a special school environment (OFSTED, 2006 para. 12, Kalambouka *et al.*, 2007). When students identified as having BESD are excluded from mainstream environments, it is usually the role of special schools (for statemented students) or Pupil Referral Units to ensure that they are maintained within some form of educational provision (Daniels and Cole, 2010 p. 6). With current educational policy, in which mainstream schools compete with one another for students and where examination results are published in league tables, this has led schools to be increasingly reluctant to cater for pupils who may be disruptive (Farrell and Polat, 2003 p. 278). In essence, students are accommodated within a BESD special school following a 'managed move' or permanent exclusion from a mainstream environment, due to a variety of different reasons. The placement of a student within a BESD school is often viewed as a last resort, when mainstream education fails to manage a student's behaviour. There is a sense that a BESD school will eventually 'cure' and then return a student to a mainstream setting. This however is not the purpose of BESD schools and for many students attending a BESD school, it is the first time that they have felt secure in a school environment and more importantly, experienced success.

> Providing an education outside mainstream schools can be a better means of giving them a less troubled childhood and a chance of greater social inclusion as adults.
>
> (Cole and Knowles, 2011 p. 29)

The policy of concentrating students identified as having BESD within the same physicality, where their peer group will have similar behavioural difficulties, but often with very different underlying causes, could be considered unwise. It is often argued that placement within a mainstream environment would increase opportunities for these students to moderate their behaviour against more stable influences. Another argument that is often made of special school segregation is that it can lead to the stigmatisation of the students (Jull, 2008) as well as limiting opportunities for social inclusion. However, as OFSTED (1999) surmise:

> For many of these pupils such is the emotional turmoil in their lives both at home and at school that they need the respite and expertise offered by BESD schools to readjust and develop acceptable patterns of behaviour.
>
> (OFSTED, 1999 para. 12)

UNESCO (2009) define inclusion as 'a process of addressing and responding to the diversity of needs of all children, youth and adults through increasing participation in learning, cultures and communities, and reducing and eliminating exclusion' (UNESCO, 2009 p. 8). This view is supported by the DfES (2004 p. 12) who state that the issue of inclusion is much more than about attending a certain type of school. It is about the quality of experience offered to students, how they are helped to learn as well as providing the opportunity to contribute and participate in school activities. Unfortunately the emphasis on inclusion is predominantly viewed as an individual's human right and is not necessarily based on their learning difficulties. Inclusion should not be about treating everyone as the same, what is important, is that everyone should be treated equally (Wedell, 2008) and its meaning goes beyond putting children in the same place (Cooper, 2005).

The majority of studies that have been carried out reinforce the general view that the inclusion of students identified as having BESD into mainstream environments, poses a major challenge for schools, local authorities and government (Farrell and Humphrey, 2009). Cooper (2004) notes that students labelled BESD are just as likely to be placed in special school provisions as they were 30 years ago and have been described as the hardest group to 'include' (Fletcher-Campbell and Wilkin, 2003).

Reforms to the Special Educational Needs Code of Conduct (DfE, 2014k) stipulates that 'every teacher is a special needs teacher' and that teachers should be trained to meet the needs of all students. However there is currently no mandatory specialist training for preparing teachers to cater effectively for students identified as having BESD (Goodman and Burton, 2010). The role and future of special schools was clearly defined by government (DfE, 2014k), in the following statement:

> We will remove the bias towards inclusion and propose to strengthen parental choice by improving the range and diversity of schools. (DfE, 2014k p. 17)

It is difficult to imagine an education system that is truly socially inclusive of all students, whilst the Department for Education does not subscribe to the philosophy of the 'one size fits all' approach.

1.3.2 National Policy on Mathematics Education

This section discusses the governmental policy initiatives which have impacted on the teaching and learning of mathematics since the turn of the century. Consideration of how the introduction of both the national curriculum and national strategies have moulded the learning of students identified as having BESD is discussed.

Since the introduction of the national curriculum (DES, 1988) in 1998, the UK government has implemented much legislation and policy at a national level which has attempted to improve standards in mathematics teaching and learning. The enactment of the National Curriculum (DES, 1988) created for the first time, a legal entitlement for all students, including those attending special schools, to access a broad and balanced curriculum, with a further requirement that all learners should be assessed according to nationally defined standards. The national curriculum details the subject content that must be delivered rather than on process, that is, its focus is on what should be taught rather than how it is taught.

Government policy emphasising mathematical pedagogical approach was first introduced through the inception of the National Numeracy Strategy (DfEE, 1999) into all English primary schools and was then quickly followed by the secondary Key Stage 3 National Strategy (DfEE, 2001). The Key Stage 3 strategy was subsequently developed and renamed the Secondary National Strategy in 2008. These strategies were characterised by a focus on whole-class teaching and a central prescription of acceptable mathematical methods (Brown *et al.*, 2003). The strategies aimed to 'foster teaching methods that promote engagement, progression and high expectations' (Brooks *et al.*, 2004 p. 191). A key aspect of both the Primary and Secondary strategies was the formulation of a structured three part lesson, comprising a mental/oral starter, main activity and plenary. However, the formulaic structure of the three part lesson has been criticised by both Boaler (2002a) and Brown *et al.* (2003). Boaler (2002a) contends it reduces the opportunities for problem solving activities and can stifle creativity, whereas Brown *et al.* (2003 p. 16) report that the three part structure disadvantages lower attaining students. Unlike the national curriculum, the national strategies were non-statutory and came to an end in 2011.

Since the inception of the national curriculum, subsequent revisions in 1995, 1999 and 2007 have seen its prescribed content 'slimmed down' on each occasion. However reforms to the mathematics curriculum, introduced in 2014 (DfE, 2014f) has seen this trend reversed. Impacting upon only the English and Mathematics curriculum, students will be expected to learn more content knowledge and at an earlier age and this heightening level of challenge may further widen the gap in attainment between students identified as having BESD and national expectations. In 2009, controlled assessment replaced the coursework element of GCSE assessment in 26 GCSE subjects, this component of assessment however, was completely abolished in mathematics by the Education Secretary back in 2006 (Helm and Lightfoot, 2006). The decision to remove this element of assessment from GCSE ultimately de-incentivises teachers to provide opportunities for students to engage in collaborative problem solving tasks within the mathematics classroom. June 2017 saw government reforms to the assessment of GCSE mathematics increase from 3.5 hours of written examinations to 4.5 hours. With a reported high concurrence of BESD and literacy difficulties (Brownlie *et al.*, 2004, Nelson *et al.*, 2005) this change may further exacerbate difficulties for students identified as having BESD in attaining this qualification (Peacey, 2015 p.13).

1.3.3 The School Setting

In 2013, there were 548 state-funded BESD schools in England (DfE, 2013). According to government statistics, a typical BESD school caters for, on average, around 55 statemented students, where 43.4% of these students are entitled to free school meals (FSM) and 64.8% describing their ethnicity as White – British (DfE, 2014e). In comparison with other students, national figures indicate that students considered to have BESD are more likely to come from lower socioeconomic backgrounds (Lindsay *et al.*, 2006 p. 6), are more likely to have experience of being placed within the care system.

The special school where this research was conducted was under local authority control and is situated in the South-East of England. The school is co-educational, with a ratio of 3:1 male to female, students on role are aged between eleven to sixteen. The school offers access to the National Curriculum by following a mainstream secondary school model; curriculum subjects are timetabled and taught by specialist subject teachers. However, with such a complex range of needs, learners are offered individualised opportunities to achieve both vocational and academic qualifications, as each student has a differing range of ability and need. All of the students attending the school have an educational statement for BESD and a significant proportion also have a further diagnosis of ADHD. Demographically, just under half of students are entitled to free school meals, an indicator of deprivation (Gorard, 2012) and 38% of students have a youth offending order. The majority of students' ethnicity is described as White – British (83%). Although 20% of students are officially categorised as being 'looked after' by the local authority, a further 15% of students are cared for and live with an extended family member, leaving a remainder of 65% of students living with a least one of their biological parents. The significance of these statistics in relation to learning is explored later.

Each teaching group is timetabled to have one lesson of English, Maths, Science and Personal, Social Development each day, interspersed with other academic and practical subjects. Although the school is a special school, teaching and learning is still driven by the same expectations as any mainstream school - demonstrating student progress and implementing National Strategies; success of the school is still measured in terms of student examination performance. As a consequence, the mathematics curriculum that is taught, mirrors that of any other English Secondary School. By the end of Key Stage 3, students are entered for Entry Level Certification in mathematics and by the end of Key Stage 4 students are then entered for GCSE and/or functional skills qualifications in mathematics.

During the period of this research, the school was placed in special measures by OFSTED inspectors. The term 'Special Measures' is used to describe a school that is considered to be failing to supply an acceptable level of education, and the persons responsible for leading, managing or governing the school are not demonstrating the capacity to secure the necessary improvement in the school' Education Act (2005 Section 44(1)). In reporting on the quality of teaching at the school, OFSTED commented that students are not given sufficient opportunities to use their own initiative. Although staff give a high level of individual tuition to students, this is often ineffective as the work provided is not

appropriate and results in students becoming distracted. Opportunities for collaborative learning are minimal and students are not given opportunities to work together[2].

For the majority of the 8.3 million students in the English education system, life at school reinforces the secure and structured environment that they experience at home. The messages they receive within their society reinforce each other and meanings behind actions are consistent. However, from my own professional experience, I believe this is not always the case for students who attend schools categorised as catering for students with BESD. Frequently students encounter contradictions in the expectations of their behaviour between the staff at school and parents at home. The home lives of students identified as having BESD are often fraught with mixed messages, which negatively impact upon their social well-being. It is the responsibility of the school to introduce actions with positive connotations regarding acceptable behaviour.

The school in which this research was carried out, operates a predominantly behaviouristic approach to student management. Behavioural approaches have the advantage in that they offer more immediate impact than other interventions, being visible and readily accepted and understood (Perkins and McLaughlin, 2015 p. 25). As with all behavioural approaches, it is characterised by an emphasis on behaviours which are measureable rather than upon the causes which prompt the behaviour in the first place. Each student has a point sheet that is used to record a numerical value 0-4 for both their behaviour and attitude towards completing work for each lesson. At the end of week, these points are totalled and students receive a tangible reward. Staff are encouraged to catch students exhibiting positive behaviour and reward them with immediate positive attention.

Teaching groups in the school are arranged so that there are no more than eight students in each class. Membership of each group at the time of this study was based on prior attainment. Previously students were grouped in an attempt to reduce problematic behaviours between particular students. This change was implemented as it was believed that behavioural issues were being exacerbated as a result of a lack of challenge and differentiation of learning tasks.

[2] This quote is not referenced and has been paraphrased to avoid identifying the school.

1.3.4 The Classroom Environment

Previous research regarding the effects that the classroom environment has upon students, demonstrates a strong and positive link to both behaviour and academic attainment of students with BESD (Visser, 2001, Conroy *et al.*, 2002). As Visser (2001) remarks:

> Stimulating and cared-for classrooms can send pupils a very powerful message regarding the importance the teacher places upon the achievement of learning and the nature of the relationship they wish to build. (Visser, 2001 p. 65)

The desks in the mathematics classroom, where this research took place, are arranged so that students always face each other and in common with all teaching bases within the school, there is no teacher's desk. Although there is no formal seating plan in operation, students always choose to sit in the same seats each lesson. All lessons are one hour long and are supported by the same subject specific Learning Support Assistant. The classroom is only used to teach mathematics and there are no commercially produced posters on the wall, only examples of students' work. The room is laid out as shown:

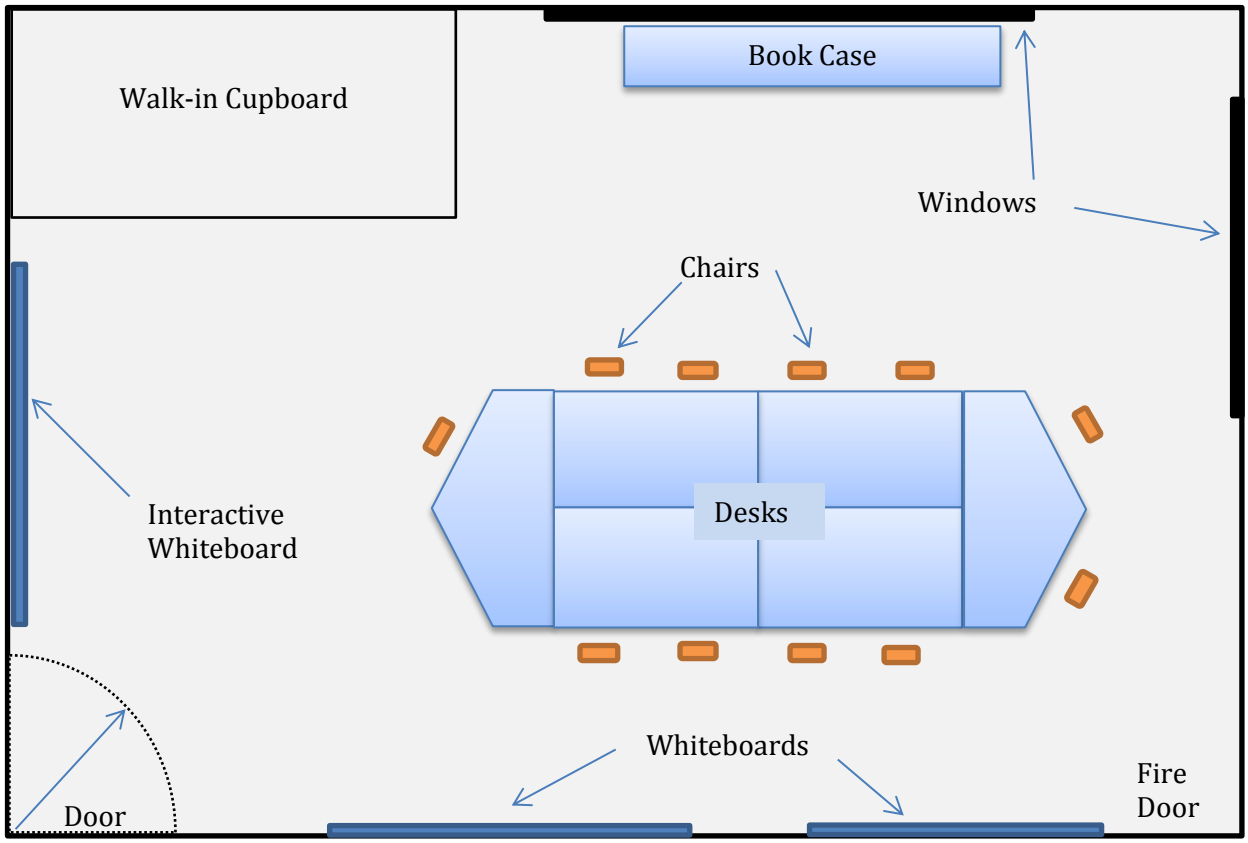


Figure 1 - The Physical Layout of the Mathematics Classroom

The layout of the seating and desks are arranged to encourage social interaction, cooperation and discussion amongst students. Another important consideration when working with students identified as having BESD, is that of personal space. Students can often feel threatened by having their work area 'invaded' and to reduce this issue, there is sufficient room to facilitate free movement around the classroom.

1.4 Design, Methodological Approach and Research Questions

A social constructivist paradigm has been adopted for this research as both BESD and mathematics can be viewed as being socially constructed. The epistemological positioning of action research as a methodological approach to enquiry is consistent with a social constructivist stance where the participants and researcher co-create understanding together. Knowledge is 'created' through social interaction with others. As McTaggart (1996) warns, to think that following the action research spiral constitutes 'doing action research' is a mistake.

> Action research is not a 'method' or a 'procedure' for research but a series of commitments to observe and problematise through practice a series of principles for conducting social enquiry. (McTaggart, 1996 p. 248)

This statement delineates action research as a methodology rather than a method or research tool. The ontological assumptions of action research, that is 'what do we intend to know', makes it a suitable approach to understand and explore the potential barriers of learning mathematics for students identified as having BESD.

1.4.1 The Research Questions

The research questions in this thesis were formulated to capture the students' views of learning mathematics and secondly, to improve opportunities for mathematical learning. Emerging from these general aims, each of the research questions are discussed below. The first question was:

RQ1: How do students categorised as having BESD, view their learning of mathematics?

Data collected to answer this question included semi-structured individual interviews with students, along with an audio recording of their interactions with each other during the reconnaissance phase lesson in particular. The interview questions explored students' preferred learning styles and what they felt made mathematics easier or harder for them to learn.

The second question was designed to elicit whether there are particular aspects of learning mathematics that present a specific challenge for students identified as having BESD.

RQ2: What specific challenges do students identified with BESD face when it comes to learning mathematics?

This question was posed to provide the opportunity to consider the possible effect that behaviour, emotions and social development may have on learning and access to learning for these students. Data sources used to inform this question included students' written work and the audio transcription of the seven intervention activities. The final research question was:

RQ3: How can approaches for teaching students identified as having BESD, be developed to increase opportunities for learning mathematics?

The purpose of this question was to provide space to reflect upon the wider implications of the findings from this research and how these could inform future curriculum design as well as developing appropriate classroom practice.

1.4.2 Structure of Thesis

This thesis has been structured in the following way. Chapter 2, a review of the literature, focuses on specific issues regarding the learning of mathematics and concludes by unpicking the implications of the BESD label. This section also considers whether there are particular characteristics of BESD that make mathematics difficult for students to learn. Chapter 3 details the research design and methodological approach adopted by this study, along with a description of the data collection methods and the analytical tools used to analyse the data. Ethical considerations such as obtaining informed consent and the positioning of an insider researcher are also included within the chapter. Chapter 4 details the process of the initial fact finding reconnaissance stage and details how the findings informed the planning of the intervention stage. The rationale behind the seven activities that constituted the intervention are detailed in chapter 5 and a discussion and analysis of the issues that arose during this stage follows. Chapter 6 then reflects on the intervention stage, drawing on data from a focus group and individual interviews with students. In concluding, chapter 7 addresses each of the research questions in turn and considers the pedagogical implications and recommendations of this research to the learning of mathematics.

2. Review of literature

In order to situate this study, the literature reviewed in this section falls into two distinct areas. Firstly, the literature review focuses upon what it means to learn mathematics, paying particular attention to the value of talk as a learning tool and the issue of student trust relationships within the classroom. The second section provides a more detailed discussion of the difficulties in defining BESD and asks whether there are particular characteristics of BESD that make learning mathematics difficult for students.

2.1 Literature Review Process

This review of literature was initially informed by my previous work on a Critical Analytical Study that focused on the 'Mathematical Attainment of Pupils Identified as Having ADHD'. When developing this review, a search of relevant literature, written specifically about BESD and the learning of mathematics was performed by examining three separate databases, chosen to reflect the educational and sociological nature of this study. These databases were ERIC, Scopus and PsycInfo. All journal articles, book chapters, government documents, reports and conference papers were restricted to those written in the English language and published between January 1998 and June 2014. These dates were chosen as 'behaviour' was only categorised as a special educational need in the 2001 Code of Practice and the National Curriculum for mathematics was introduced into England in 1998. The searching of these databases was carried out using combinations of terms 'Behavioural / Behavioral (American spelling)', 'Emotional', 'Social' and 'Difficulties' and the acronyms 'EBD', 'SEBD' and 'BESD' to describe the type of learner SEN(D) alongside the specific key words shown in table 1.

Key issues that arose in both formulating the research questions and from an analysis of data collected during the reconnaissance phase, identified the following themes (see Table 1) to be particularly relevant to this study. The following words were therefore also used to search for specific literature regarding each of these areas:

Identified Issue	Search items
What does it mean to learn Mathematics?	Philosophy, Education, Numeracy , Learning theory, pedagogy
Talk as a Tool for Mathematical Learning	Learning, Talk, Discourse, Conservation, Dialogue
The Issue of Trust in the Mathematics Classroom	Student-teacher relationships, trust, competence benevolence
Unpacking the BESD label	Attention Deficit Hyperactivity Disorder, ADHD, ADD, Learning, Cognition difficulties

Table 1 - Literature Review search items

The sections that now follow examines research literature that was identified in two parts, namely the issues surrounding the learning of mathematics and the definition and implications of the BESD label.

2.2 Mathematical Learning

There is no single accepted theory that can explain how mathematics is learnt (Leitch and Mitchell, 2007 p. 175). As Campbell (2006) said of mathematics educational theories:

> Theories are like toothbrushes… everyone has their own and nobody wants to use anyone else's. (Campbell, 2006)

There are however, at least three main paradigms of learning – behaviourism, cognitivism and constructivism, each with differing epistemological viewpoints, which in turn, shape practice in the classroom. Whilst behaviourism focuses on the external behaviour of learners, cognitivism emphasises the internal mental structures of the student. In contrast, those holding a constructivist perspective, view learning as an active process in which learners are engaged in constructing new concepts based on past knowledge. The relevance that these three paradigms have to understanding the learning of mathematics are now considered.

Behaviourism implies that learning takes place through stimuli and the subsequent responses made by an individual (Ertmer and Newby, 2013 p.48). In relation to mathematics, Thorndike (1922) proposed a 'law of exercise' for the mastery of arithmetical skills. He believed that by repeatedly practising a skill, a learner will reinforce and strengthen their ability. Drill and practice of mathematical facts and procedures are based on a belief that repetition establishes competence. An argument levelled at behaviourism, as a theory of learning however, is that it is too simplistic, if learning occurs only as a response to a stimulus, how can people be creative or inventive enough to think of new solutions to mathematical problems? Furthermore, behaviourism does not explain why people attempt to organise and make sense of the information that they learn. Behavioural learning theories offer useful ways to explain human behaviour, but behaviourism is limited as it focuses exclusively on observable behaviour and cannot therefore explain invisible mathematical learning processes. The theorisation of mathematics learning, over the last century, has moved away from behaviourists approaches of students working passively on drill and practice exercises towards a more active paradigm where meaning is constructed through social interaction.

Cognitivist learning theories are concerned with understanding the mental processes or cognition of the human mind to explain how people learn. Viewing learners as information processors, a cognitivist sees learning as the transformation of information in the classroom into knowledge that is stored in the brain. Learning happens when new knowledge is acquired or existing knowledge is modified by experience. Two main cognitivist theories of learning are Piaget's (1964) cognitive developmental theory and Vygotsky's (1978) sociocultural cognitive theory. Critical cognitive abilities for the learning of mathematics include skills such as symbolic thinking, spatial awareness and the ability to make mental representations of number and space. Piaget (1964) believed that students progress cognitively through four developmental stages, from birth to young adulthood. He claimed that students pass through these developmental age-related stages in a defined order and that each must be mastered before moving to the next.

Constructivism is regarded as the dominant approach of the learning mathematics (Orton, 2004, Boaler, 2013). Piaget is credited as one of the major contributors to the development of constructivism. Orton (2004) reports that 'the work of Piaget has probably been more influential than has the work of any other theorist in terms of mathematics curriculum development in Britain' (Orton, 2004 p. 60). A central tenet of Piaget's developmental theory is that knowledge is not just transmitted verbally but must

be constructed and reconstructed by the learner. Piaget asserted that for a child to know and construct knowledge of the world, the child must act on objects and it is this action which provides knowledge of those objects (Sigel and Cocking, 1977).

Vygotsky's (1978) sociocultural theory of learning represents one of the foundations of social constructivism. His theory is concerned with three major themes regarding social interaction, a more knowledgeable other and the zone of proximal development. Vygotsky (1978) postulated that students learn first, through interaction with others on a social level (inter-psychological) and then later, this knowledge becomes internalized within the learner (intra-psychological). A second aspect of Vygotsky's theory is the concept of the Zone of Proximal Development, which is the distance between where a learner is at developmentally on their own and where a learner could be with the help of a more knowledgeable other (Vygotsky, 1978 p. 86). The more knowledgeable other is often assumed to be a teacher; however Vygotsky defines the term to be anyone who has a better understanding than the learner.

An example of a constructivist approach to learning is the Cognitive Acceleration in Mathematics Education (CAME) intervention developed by Adhami and Shayer (1998). Their approach, which is theoretically underpinned by the work of Vygotsky and Piaget, is characterised by group interaction in solving challenging problems collaboratively. An important feature of CAME is concerned with developing a culture of thinking within the classroom and of the sharing of ideas rather than on specific knowledge or skills. In essence, CAME is an approach to teaching problem solving that focuses on the shared construction of learning rather than solely on the mathematical subject matter.

In summary, there are three main approaches, behaviourism, cognitivism, and constructivism, each providing a different rationale of learning in the mathematics classroom. Although behaviourist methods do not focus on the understanding of concepts, but more on giving the desired response, this approach can be useful as mathematics does demand the recall of facts such as in times-tables or number bonds. Cognitivism involves the development of thinking, reasoning and the understanding of mathematical concepts. Constructivism is a process in which the learner actively constructs or builds new concepts and ideas based on prior knowledge and experience. Although these approaches differ in their perspective, all are found in mathematics classrooms and form the foundations of mathematical learning.

2.2.1 What does it mean to learn Mathematics?

In terms of learning mathematics in schools, the Department of Education's 2014 National Curriculum Framework for Mathematics (DfE, 2014f) defines mathematics to be:

> A creative subject and highly inter-connected discipline that has been developed over centuries, providing the solution to some of history's most intriguing problems. It is essential to everyday life, critical to science, technology and engineering, and necessary in most forms of employment. A high-quality mathematics education therefore provides a foundation for understanding the world, the ability to reason mathematically, and a sense of enjoyment and curiosity about the subject. (DfE, 2014f p. 3)

This definition highlights the important position that society places on mathematics, making it a crucially important subject that is essential for a successful life. It is the only subject that is taught in practically every school in the world (Howson *et al.*, 1986 p. 11). As Freudenthal (1968 p. 5) comments, 'mathematics is needed not by a few people, but virtually by everybody'. This view is corroborated within OFSTED's report - Mathematics: Made to Measure (2012), which makes the following statement:

> The responsibility of mathematics education is to enable all pupils to develop conceptual understanding of the mathematics they learn, its structures and relationships, and fluent recall of mathematical knowledge and skills to equip them to solve familiar problems as well as tackling creatively the more complex and unfamiliar ones that lie ahead. (Hoyles, 2012 p. 6)

It is implicit from these statements that mathematics is not intended to be only concerned with the acquisition of abstract skills, but to also embrace solving problems in the real-world and the development of essential reasoning skills At its simplest level, it provides essential life skills such as checking the change given in a shop, reading information from a bus or train timetable or simply having an understanding of the quantities needed in a recipe.

Mathematics is a discipline that presents many challenges for students - having its own specialist vocabulary as well as symbols that have their own grammatical meaning (Morgan, 1998a). It is these factors that make it distinctively different to numeracy, which comprises the skills that everyone needs to possess in order to function in everyday life.

Approaches to Teaching Mathematics

Research by Pampaka *et al.* (2012b) on the teaching and learning practices in mathematics in English Secondary schools, reports that lessons are often characterised by 'transmissional' methods where students 'listening to the teacher talking about a topic' or 'copying notes from a board'. Not surprisingly, in their survey of 13,516 students, mathematics was rated as their least favourite school subject, due to the prominence of transmission-style teaching. The researchers cite the pressure of preparing students for examinations and time constraints as major factors influencing teachers' choice of pedagogy. Boaler (2013) describes this transmissional or 'talk and chalk' teaching approach as:

> … the teacher explains the method from the chalkboard at the front of the class for the first 15 to 20 minutes; they then give the students questions to work through from their textbooks. Most students sit in pairs in class, but they work alone.
>
> (Boaler, 2013 p. 16)

This directive 'talk and chalk' approach however, has had limited success with students categorised as having BESD (Brand *et al.*, 2002), as they are expected to be passive recipients of knowledge, watching and listening quietly whilst copying what the teacher does. Interestingly, Lerman and Cowley (2012) argue that:

> Traditional formal teaching actually inhibits learning; pupils will mimic the teacher but because they have not constructed the ideas for themselves they will not have understood and will not retain what the teacher has shown them.
>
> (Lerman and Cowley, 2012 p. 38)

In a report produced for the Department for Education and Skills investigating the underlying principles of teaching mathematics effectively, Swan (2005) advocates the use of active rather than passive teaching of mathematics. He states that the most dominant pedagogical practice observed in the teaching of mathematics is 'chalk and talk', where learners are forced to adopt a passive learning strategy. In commenting about learners, he says:

> Mathematics is something that is 'done to them', rather than being a creative, stimulating subject to explore. It has become a collection of isolated procedures and techniques to learn by rote. (Swan, 2005 p. 4)

In their best evidence meta-analysis of 189 studies, Slavin *et al.* (2009) concluded that mathematics learning is significantly enhanced by the use of cooperative learning methods that encourage student interaction. Cooperative learning is an approach to organising classroom activities into both academic and social learning experiences. As a pedagogical approach it involves students working together in small groups on a structured activity, with the aim of creating meaningful knowledge. Cooperative learning encourages active student learning which is an important element of mathematics learning and research suggests that academic achievement is improved (Cheng, 2011). This approach can enhance learning, by the sharing of ideas and discussing misunderstandings with peers, however this is more problematic with students with BESD (Nelson *et al.*, 1996 p. 57). Students identified as having BESD are not naturally sociable, preferring to work independently (Wagner *et al.*, 2006). Although collaborative teaching practices are inherently superior to transmissional methods (Swan, 2006) these practices can often conflict with behavioural management strategies.

The Nature of Mathematics

An important issue in learning mathematics is that of understanding. Students often claim that they understand a mathematical concept, but in fact this can often mean that they know how to follow a particular procedure that leads to a solution – an essentially behaviouristic approach to learning. Skemp (1976) defines two types of mathematical learning. Instrumental learning involves learning processes by rote and relational learning which requires the understanding of concepts and the reasoning underlying the knowledge; it is knowing why, rather than just applying rules. Research shows that pedagogy that does not allow for the development of understanding, leads many students to view mathematics as a series of unrelated procedures and techniques that have to be committed to memory (Swan, 2006 p. 162). Mathematics education research continues to demonstrate that good mathematical pedagogy incorporates both conceptual and procedural understanding in order for students to have a complete understanding of topics (Grouws and Cebulla, 2000). It is easy to suggest that learning mathematics with understanding is an important goal; however it is much more difficult to translate this objective into practice in the classroom. Not only are learners expected to master mathematical procedures, but they are also supposed to grasp what is going on and why. However, with the pressure facing teachers to ensure that as many students as possible pass examinations, it is inevitable that the emphasis of 'teaching' procedures to get the right answer increases (Pampaka *et al.*, 2012a p. 474).

A priori learning plays a vital role in the acquisition of new mathematical learning. The nature of learning mathematics is that concepts are built in a hierarchical structure (Bruner, 1960, Ausubel *et al.*, 1968). Until earlier building blocks of mathematics are grasped, new concepts are less likely to be understood. Cockcroft (1982) states in paragraph 228 that this is one of the reasons that mathematics can be so difficult to learn.

> The ability to proceed to new work is very often dependent on a sufficient understanding of one or more pieces of work, which have gone before.
>
> (Cockcroft, 1982 p. 67)

According to Skemp (1976), students construct schemata to link what they already know with any new learning. As an example, in teaching a student to round a number to the nearest 10, the student needs to use their understanding of place value and their concept of number magnitude to the learning. He suggests that students cannot understand a higher concept until the earlier building blocks which it is dependent on, are understood first.

Students identified as having BESD, with sporadic and persistent non-attendance patterns (DCSF, 2009 p. 9) and at an increased risk of exclusion, are more likely than most to have missed significant parts of their mathematical education. These gaps in their education could therefore contribute to their ability to understand more conceptually difficult mathematical learning, if the earlier building blocks have not be learnt.

Mathematics, more than any other school subject, can be characterised as being only concerned with right or wrong answers (Boley, 1999). Right answers represent evidence of understanding and incorrect responses signifies confusion or carelessness (Crespo, 2000 p. 162). This notion is partly a reaction to the lingering image of school mathematics as consisting of rows of sums with ticks and crosses (Barnard, 1996). In Schoenfeld's (1992 p. 359) survey of students' beliefs regarding the nature of mathematics, he reported that students believe 'mathematics problems have one and only one right answer.' This view of mathematics is acknowledged by Boaler (2002b) who reports that students often view mathematics as being about speed, procedure, right and wrong answers and unique methods leading to a single solution. Invariably, it is the teacher or textbook that hold the authority on the correctness of a response and this can be a motivating factor for students who thrive on this precision and exactness (Boaler, 2002a p. 44). This fundamentalist approach to mathematics, of only being concerned with right or wrong answers, is not supported by a socially constructed view of mathematics. Fallibilism assumes that

mathematics is created through human activity and is not just there waiting to be discovered. As Hudson *et al.* (2015) comment:

> Aspects that are associated with high epistemic quality involve an approach which presents mathematics as fallible, refutable and uncertain and which promotes critical thinking, creative reasoning, the generation of multiple solutions and of learning from errors and mistakes. (Hudson *et al.*, 2015 p. 377)

Skemp (1976) would argue that fundamentalism does not encourage true relational understanding of mathematics. Although questions such as 'what does 3 x4 equal' can only have one answer, this predominant image of mathematics can belittle the beauty and depth of the subject.

2.2.2 Talk as a Tool for Mathematical Learning

The importance of talk within the mathematics classroom is a central tenet of many social constructivist theories of learning. For example, Vygotsky (1964) believed that social interactions between the learner and physical world play an essential role in the process of cognitive development. He suggested that students learn through their interactions with their peers, teachers or a more knowledgeable other. He postulated that spoken language was an essential tool for the construction of knowledge. This claim is reinforced by Staarman and Mercer (2010) who state:

> [Spoken] language is the one of the most important meaning-making tools available for learners, and at the same time, it is one of the most important pedagogical tools available for teachers to help learners. (Staarman and Mercer, 2010 p. 75)

Education policy over the last thirty years has encouraged the development of talk as a teaching tool - the Cockcroft report (1982 para 243) states, 'Mathematics teaching at all levels should include opportunities for discussion between teacher and pupils and between pupils themselves. OFSTED (2008 p. 5) reports that in mathematics 'most lessons do not emphasise talk enough; and as a result pupils struggle to express and develop their thinking.' Similarly, the Department of Education's 2014 National Curriculum Framework for Mathematics (DfE, 2014f), says 'teachers should ensurae that pupils build secure foundations by using discussion to probe and remedy their [students] misconceptions.' (DfE, 2014f p. 3).

The use of talk as a learning tool affords many opportunities to promote mathematical learning, such as providing an immediate way for students to share their thinking and understanding; for teachers to assess their learners' knowledge as well as 'enabling the collective negotiation of meaning' (Cobb and Bauersfeld, 1995). In analysing classroom conversations, Mercer (1995) defines three distinct types of talk that can be found within classrooms – disputational, cumulative and exploratory talk. Disputational talk is 'characterised by disagreement and individualised decision making. There are few attempts to pool resources, or to offer constructive criticism of suggestions'. Cumulative discourse however, involves a more collaborative process of constructing a `common knowledge' with each student building positively through confirmation or repetition of what the other student has said. The last type of conversational interaction is termed exploratory, where students engage in constructive criticism of each other's ideas. Compared to the first two types of talk, knowledge is made more publicly accountable and reasoning is more visible through exploratory talk. Progress then emerges from the eventual joint agreement reached. (Mercer, 1995 p. 104).

Although classroom talk is frequently dominated by the teacher (Myhill, 2006 p. 24), research suggests that learning through the use of talk can positively impact on student learning (Chapin and O'Connor, 2007, Obrycki *et al.*, 2009) and increases motivation for learning (Jansen and Middleton, 2011). It is important to bear in mind however, as Stein *et al.* (2008) point out, that classroom 'talk' must be purposeful and carefully engineered. Chapin and O'Connor (2007) concur in their comments that mathematical discourse must be academically productive 'in that it supports the development of students' reasoning and students' abilities to express their thoughts clearly' (Chapin and O'Connor, 2007 p. 115).

Keeping classroom conversations focussed on a particular topic of learning can be more problematic when working with students who, by definition (Hallahan *et al.*, 2014), are characterised as having difficulties in forming positive peer relationships (SEBDA, 2006) and can lack the necessary social interactional skills required to take a constructive role in discussion (Staikova *et al.*, 2013). Common BESD traits such as calling out and verbal aggression need to be carefully managed if 'talk' is to be used effectively within the classroom.

2.2.3 The Issue of Trust in the Mathematics Classroom

The importance of a relationship based on trust between teacher and student is fundamental to both the student's ability to learn (Raider-Roth, 2005) and for effective teaching (Durnford, 2010). The impact that trust has, it is argued by Gregory and Ripski (2008), is that it can encourage students to participate in learning without a fear of failure. The importance of this is summarised by Taplin (2002 p. 28) who suggests 'Mathematics, with its emphasis on 'right' or 'wrong' answers can potentially reinforce these fears.' Notwithstanding this, trust has also been reported to be a significant factor in increasing student motivation and achievement (Ennis and McCauley, 2002).

However, trust is a complex concept and is difficult to define. Although the word is used frequently in conversation, it is defined by researchers in many different ways (Romero, 2010). Although there is no singly accepted definition, there is common agreement that a 'willingness to be vulnerable is an essential component of trust building' (Hoy and Tarter, 2004). In their review of literature, Tschannen-Moran and Hoy (2000) identified five common components used to define the concept. In terms of the relationships between students and teachers, they are:

- Benevolence, which is the belief that a teacher will meet students' needs with care and concern, whilst providing a level of protection that reduces a student's vulnerabilities.
- Reliability, pertains to the belief that members of staff are predictable and behave in a way that is both fair and consistent (Hoy and Tschannen-Moran, 1999)
- Openness, relates to the concepts of transparency, sharing information and sharing influence and control (Tschannen-Moran, 2014 p. 25)
- Honesty, is concerned with truthfulness and a person's character, integrity and authenticity.
- Competence, refers to the student's belief that a teacher has the necessary skills, ability and knowledge to educate them effectively (Adams and Forsyth, 2009).

There are two aspects of trust that are particularly relevant to this study. The first is that of competence-based trust which describes the relationship in which an individual believes that another person is knowledgeable about a given subject area (Tomei, 2007 p. 140). Often in mathematics lessons, students will seek validation and confirmation that their answers are correct before committing them to paper. The second facet of trust that is particularly relevant to working with students categorised as having BESD is that of benevolence. Forming trusting relationships with either peers or adults is something that

students with BESD find extremely difficult (SEBDA, 2006). Visser (2013) advises that, 'to meet the needs of pupils with EBD in schools the most important 'tool' is the building of positive relationships between teacher and learner.' Benevolence-based trust is one in which an individual will not intentionally harm another when given the opportunity to do so (Tomei, 2007 p. 140). Levin *et al.* (2002) assert that both of these types of trust are intertwined and critical for any knowledge sharing processes to be effective.

2.2.4 Summary

In summary then, learning mathematics is not just concerned with the transference of mathematical facts from teacher to learner, but of developing both a conceptual and procedural understanding. Research suggests that this is more readily achieved by adopting an active and constructive approach to teaching compared to more frequently used, passive and transmissional styles of teaching. The important role that talk plays as a constructivist tool in promoting both social and cognitive growth was identified as a key factor in learning, as well as the discussion of the value of different categories of talk. Finally the importance of building trust relationships with students identified as having BESD was discussed.

2.3 Unpacking the BESD label

The term BESD covers a multitude of needs, many of which have their roots in mental health. BESD is not a diagnosis but an umbrella term used to label a spectrum of behaviours, symptoms and conditions which the Code of Practice (DfE, 2014k) defines as:

> a wide range of social and emotional difficulties which manifest themselves in many ways. These may include becoming withdrawn or isolated, as well as displaying challenging, disruptive or disturbing behaviour. These behaviours may reflect underlying mental health difficulties such as anxiety or depression, self-harming, substance misuse, eating disorders or physical symptoms that are medically unexplained. Other children and young people may have disorders such as attention deficit disorder, attention deficit hyperactive disorder or attachment disorder.
>
> (DfE, 2014k p. 98)

This definition highlights the broad and diverse range of need that is included within this SEN group. Hallahan *et al.* (2014) helpfully categorise the behaviours associated with BESD into two distinct categories - internalised behaviours (social withdrawal, guilt, depression, anxiety and poor peer relations) and externalised behaviours (hyperactivity, uncooperativeness, defiance and aggression). Externalising behaviours are more overt and more common in males (Meltzer *et al.*, 2003), whereas internalising behaviours, which often go unnoticed, are more predominant in female students. Consequently, boys are four times more likely to be identified as having BESD than girls (Green, 2005, DfES, 2007).

The broadness of the BESD category of need is reflected in the changing emphasis and ordering of the letters B, E, S and D over the past few decades. SEBDA - the Social, Emotional and Behavioural Difficulties Association, contend that the 'Social' and 'Emotional' create the 'Behaviour' and should come first (SEBDA, 2006). Similarly Cole and Knowles (2011 p. 18) suggest that placing the 'Behaviour' first, draws unnecessary attention to it, whilst detracting from the emotions behind it. The ordering and inclusion of each letter, to a certain extent, defines its importance and consequently the direction in which any support or intervention is approached. Although the Department for Education has until recently advocated a preference for BESD, from September 2014 the word 'behaviour' has been removed from this categorisation of SEN(D), renaming it Social, Emotional and Mental Health. A behaviour problem or difficulty itself is no longer seen as a SEN(D) (Norwich and Eaton, 2014 p. 10). The Department for Education redefined the BESD category as they believed that the term was 'over-used' and would instead prefer to view BESD as a vulnerable group due largely to their family problems and home circumstances (DfE, 2011 p. 70).

Although BESD is a recognised category of SEN(D), it differs from other categories of need, in the fact that it can be interpreted as not being one at all. A notion persists that students who behave badly in school are somehow in control of their behaviour (Broomhead, 2013) and are 'doing it deliberately', whereas physical or learning difficulties cannot be helped and are not their fault (McNamara and Moreton, 2001 p. 2). BESD has also been attributed to poor parenting of students or due to difficult home circumstances (DfES, 1989 p. 133, Rogers, 2003).

> Children who experience family difficulties, including parent conflict, separation, neglect, indifference and erratic discipline are more likely to develop BESD.
> (DCSF, 2008 para. 61)

Although there are strong links between BESD and social deprivation, low income and family dysfunction (Cooper and Jacobs, 2011), no causal relationship has ever been established (Hunter-Carsch, 2006 p. 3). As Fovet (2011) aptly writes, 'it is nevertheless assumed in most literature that emotional instability and behaviour manifestations are usually loosely and intrinsically linked to social status' (Fovet, 2011 p. 249). However, as the Training and Development Agency (TDA, n.d.) note:

> Students are sometimes described as being 'disaffected' rather than having SEN or mental health needs. This terminology reflects an assumption that the causes of their behaviour lie in social and cultural factors (such as peer group influence, or being asked to follow a curriculum that is not relevant to their lives or needs) rather than factors within the pupils themselves. (TDA, n.d. p. 6)

However, these factors are considered by Cole and Knowles (2011) to be a possible cause of BESD. The risk-resilience theory postulates that children who are subject to risk factors, such as poverty, family breakdowns or domestic violence, need a certain level of resilience to counter this adversity. Children who lack this resilience will ultimately display emotional and behavioural difficulties (Cole and Knowles, 2011 p. 65).

Many psychological perspectives have been proposed to explain the aetiology of BESD; these include behaviouristic, medical and bio-psychosocial models as well as an eco-systemic perspective. The medicalisation of BESD has generally been disregarded and is currently out of favour. This approach views abnormal behaviour as the outward sign of biological imbalances or possibly due to genetic factors. Pathologizing behaviour as being 'within child' as oppose to being based 'in and with social systems', takes the responsibility of treatment away from the field of education as it is considered a medical condition.

The eco-systemic model however asserts that behaviour is a product of the interaction between the individual and their environment (Evans *et al.*, 2004). This approach proposes that behaviour is in response to the context of social and cultural interactions with peers, families and school. The student is viewed as being an intrinsic part of a wider social system both in and outside of school and the nature of these overarching systems influence the behaviour of the student. An extension to this model is the bio- psychosocial approach which places an increased emphasis on psychological, social and educational factors, with medical intervention being viewed as an addition to these. This eclectic 'mind – body connection' paradigm addresses the emotional, behavioural and biological factors that interact to produce BESD behaviours. Acceptance of the bio-psychosocial approach in explaining the causation of BESD is a key concept in the rationalisation of this thesis. It is only through understanding the relationship and inter-play between the psychological, social and educational factors, that the possible barriers to the learning in mathematics can be researched.

Although students categorised as having BESD may fail to meet national academic expectations, it is not due to any intellectual or cognitive difficulties. However it is important to bear in mind that the behaviours associated with BESD can also present in classroom environments as a 'mask' resulting from a struggle with an undiagnosed learning difficulty. As the Code of Practice (DfE, 2014k) comments:

> Some learning difficulties and disabilities occur across the range of cognitive ability and, left unaddressed may lead to frustration, which may manifest itself as disaffection, emotional or behavioural difficulties. (DfE, 2014k Ch 6 Para 23)

In summary, BESD is a contested social construct which spans a continuum of need. It can present as both internalised (depression, withdrawal or anxiety) and externalised (hyperactivity or disruptive) behaviours. Although various models have been put forward to explain its aetiology, current approaches suggest that focus should be on the emotional and social aspects of this condition, rather than the behaviour that is displayed (Cole and Knowles, 2011). When a student is described as having behavioural difficulties, there is an assumption that the student is disruptive. BESD and disruptive behaviour are not the same. Disruptive behaviour is commonly exhibited by students with no BESD and conversely students with BESD do not always exhibit disruptive behaviour. BESD are a special educational need that are possibly best summarised by Cefai (2010) who states:

> BESD is a loose umbrella term encompassing behaviours and expressions of emotion among students which are experienced by adults and students as disruptive and/or disturbing and which interfere with the student's learning, social functioning and development and/or their peers. (Cefai, 2010 p. 117)

Cefai (2010) surmises concisely the complex nature of BESD whilst at the same time acknowledging the effects that such difficulties have on the learning of both the individual and others. Although the education of students identified as having BESD could be viewed as daunting, it is more beneficial, educationally, to define BESD in terms of the interaction between biological, environmental, social and attitudinal factors.

2.3.2 Do the behaviours associated with BESD make Learning Mathematics Difficult?

There is a variety of research that suggests that the characteristic behaviours associated with BESD can make the learning of mathematics problematic. Research acknowledges that challenging behaviour has a negative impact on academic achievement (Hinshaw, 1992, Nelson *et al.*, 2004) and that under-achievement encourages the development of disruptive behaviours. Circular 9/94 (DfE, 1994) comments that students categorised as having BESD have 'significantly greater difficulties in learning than most of their peers'. Notwithstanding this, Lerner and Johns (2008) note that students identified as having BESD often demonstrate high levels of off-task engagement and show little motivation for learning; further Nelson *et al.* (2004) comment that these students lack academic skills and content knowledge.

In their survey of 40 BESD special schools, OFSTED (1999) stated that 'by definition, pupils who are placed in schools for those with emotional and behavioural difficulties have failed to benefit from ordinary schools. They are among the most difficult pupils to teach'. (OFSTED, 1999 para. 1). They further suggest that 'pupils' prior learning in literacy and numeracy was often a history of repeated failure and a constant source of frustration.' (OFSTED, 1999 para. 42). Literacy difficulties amongst students identified as having BESD are clearly evident from the UK government's end of Key Stage 2 SAT results.

	Reading	Writing	Mathematics
Nationally (all Students)	89%[3]	76%[4]	86%[4]
Nationally (BESD students)	64%[4]	50%[5]	61%[5]
Students in this Study	29%	29%	29%

Table 2 - The Percentage of Students Attaining Level 4 or Above in Reading, Writing and Mathematics by the End of Key Stage 2 in 2014

These figures show that by the age of 10/11, students identified as having BESD are already significantly under-attaining in comparison with other students. The students that took part in this study are also significantly below the national average for students categorised as having BESD.

A significant barrier to learning for students identified as having BESD, is that approximately 20% – 30% have an identified specific learning difficulty in reading, mathematics or writing (DuPaul and Stoner, 2003, Mayes and Calhoun, 2006). It is further recognised within literature, that between 40%-90% of students categorised as having BESD have language and communication difficulties (Benner *et al.*, 2002). Higher rates of mathematical learning difficulties for students diagnosed with ADHD of 31% are reported by Shalev *et al.* (2001) compared to between 6%-7% for the general school aged population.

Many theorists have put forward hypotheses of the relationship between mathematical skill acquisition and ADHD in particular. For example, Ackerman *et al.* (1986) proposed that children diagnosed with ADHD struggle with mathematics due to a failure to automate arithmetical processes because of a major cognitive memory deficit. They believe that this poor automaticity, impairs acquisition of numerical information, which in turn restricts the learning of more advanced mathematical procedures. A further theory, proposed by Marshall *et al.* (1997) suggest that mathematical skills are best learnt by repetitive practice, this learning mechanism however is one often shunned by students identified as having BESD who may have limited attention spans.

[3] DfE, (2014d) First statistical Release: National Curriculum Assessments at Key Stage 2 in England, 2014 (Provisional). London: Department for Education.

[4] DfE, (2014c) First statistical Release: Children with Special Educational Needs: An Analysis - 2014 (Attainment Progression Tables) Table 2.10. London: Department for Education.

2.3.3 Factors Influencing the Learning of Students Identified as having BESD

Although not part of the criteria used to define BESD, there are many characteristics that are closely associated with this SEN(D) group that are known to create significant barriers to learning. The relationship between BESD and parental socioeconomic status, gender and poor attendance, have all been demonstrated to have a negative effect on learning (Connolly, 2006). Although each of these factors interact differently for each individual student, the impact that these interconnected influences exert are now considered.

Socio-Economic Status

Students identified as having BESD form the largest group of students entitled to free school meals (FSM) (DfE, 2014i), which is an indicator of social depravation and is linked to low parental socioeconomic status. The link between FSM entitlement and low academic attainment is well established (Goodman *et al.*, 2010, Gorard, 2012). This link is borne out in government statistics that show of FSM eligible students, only 37.9% achieved 5 or more A*-C grades at GCSE (including English and Mathematics) in 2013, compared with 64.6% of non-FSM eligible students achieving this benchmark (DfE, 2014a). This FSM gap in attainment has been consistent since data collection began in 2006. The mechanisms behind the influential relationship that socioeconomic status has on attainment has been explained, by researchers, to be associated with issues such as a lack of parental engagement with schools (Szumski and Karwowski, 2012), lower academic parental aspirations (McCarron and Inkelas, 2006) and the characteristics of the student's home environment (Leventhal and Brooks-Gunn, 2000). All of the attributes associated with lower socioeconomic standing are prevalent in the lives of those students considered to have BESD and have a negative impact on their chances of attaining educational goals. However, it is possible that with such a negative combination of success characteristics, professionals working with students identified as having BESD may have lower aspirational expectations.

> In England, there continues to be a strong association between differences in educational outcomes and socio-economic background but the extent to which these differences should be attributed to factors outside schools is an area for debate. (Gazeley, 2011 p. 297)

Teachers must therefore be careful not to give students the impression that they have low expectations of them, in case this becomes a self-fulfilling prophesy for the learner.

Gender

Since male students are four times more likely to be identified as having BESD than girls, the effect of any gender related trends in attainment would consequently be magnified within this group of learners. For some time in England there has been a trend of girls outperforming boys from the Early Years Foundation Stage (DfE, 2014h) right through to GCSE (DfE, 2014a). This gender gap is present across all curriculum areas, although it tends to be greater in English than it is in mathematics (Mensah and Kiernan, 2010). In their report on the relationship between gender and academic attainment, Mensah & Kiernan (2010 p. 252) found that the effects of low maternal qualifications, unemployment and living in relatively deprived neighbourhoods had a more detrimental effect on boys' attainment than girls'.

Attendance

School attendance has an obvious positive impact on academic attainment as good attendance generally increases students' exposure to more learning opportunities (Gottfried, 2010, DfE, 2014g). Attendance has been demonstrated to have a stronger link with student achievement than the effects of either gender or socioeconomic status (Smith, 2003). National absence figures for students identified as having BESD standing at 10. 3% are more than double than that for non-BESD students 4.8% (DfE, 2014j). National statistics also show that students identified as having BESD are nearly three times more likely to be persistently absent from school compared to non-BESD students (DfE, 2014j). Underlying these attendance figures however is the issue of exclusion. As mentioned previously, students with SEN(D) are six times more likely to receive both fixed term and permanent exclusions from school. Students identified as having BESD, with their identified connection to FSM entitlement and low attainment, heightens the group's susceptibility to exclusion. Entitlement to FSM increases the chances of exclusion threefold, and as Gazeley (2010) notes:

> Pupils from groups known to be at increased risk of low attainment are also known to be at increased risk of involvement in the disciplinary processes of schools.
>
> (Gazeley, 2010 p. 294)

In summary then, research would suggest that the inter-relationship between factors associated with students categorised as having BESD paint a negative outlook on their potential to achieve in comparison with other student populations.

2.3.4 Is there a BESD Pedagogy?

This section is primarily concerned with reviewing literature regarding whether there are specific pedagogical strategies that are considered more effective in engaging students identified as having BESD, with learning. It is important to note however, that the term pedagogy has many different interpretations and is not a very clearly defined term (Sajadi and Khan, 2014). Etymologically the term 'pedagogy' is formed from two Greek words *paidos* meaning 'child' and *ágō* meaning 'lead', so translated literally, pedagogy means 'to lead the child'. Invariably, within the UK education system, the word pedagogy is often used interchangeably with teaching style (Gore *et al.*, 2004). Leach and Moon (1999 p. 267) like many other researchers, define pedagogy to be much more than just teaching style; 'pedagogy is the practice that a teacher, together with a particular group of learners creates, enacts and experiences.' Pedagogy represents the study of the relationship between knowledge, teacher and learner, which encompasses attributes such as attitudes to learning, social interaction, relationships and the motivation to learn.

Research on pedagogical considerations with students identified as having BESD is limited, as Lewis and Norwich (2004) comment:

> Identifying a pedagogical approach for individuals with SEBD that is supported by empirical research is problematic because of the limited availability of empirically generated and validated writing about pedagogy and SEBD – especially by practitioners. (Lewis and Norwich, 2004 p. 168)

Research carried out by both Norwich and Lewis (2009) and Rix *et al.* (2009) attempted to answer the question of whether there is a particular pedagogy that is specifically effective in educating SEN(D) students. They summarised their findings thus:

> The lack of evidence in our review to support SEN-specific pedagogies might be surprising as there is a persistent sense that special education means special pedagogy to many teachers and researchers. (Norwich and Lewis, 2009 p. 325)

In reporting specifically about students identified as having BESD, Davis and Florian (2004) were also disappointed to find that there were no long-term studies available that examined the effects of different pedagogical approaches. They concluded that BESD teaching strategies merely focus on changing 'deficiencies' within students.

Hanko (2003) suggests that this lack of research is largely due to practitioners focussing their attention on behavioural issues at the expense of concentrating on analysing learning processes. However, pedagogical understanding has moved on considerably since Laslett's (1983) four stage model for teaching 'maladjusted' students, which was simply 'get them in, get on with it, get on with them and get them out'. In summary then, there is no evidence to suggest that there is a unique pedagogical approach that is particularly effective for students identified as having BESD.

2.4 Emerging Issues and Conceptual Approach

The review of literature has identified four key issues. These include the classification of BESD and matters surrounding pedagogical approach, the value of talk in learning and the issue of trust within the mathematics classroom.

Firstly then, literature suggests that there are many competing discourses attempting to explain the aetiology of BESD; it represents a broad and diverse category of need, which ranges from unacceptable behaviour to mental health disorders (DfE, 2011 p. 98, Fovet, 2011 p. 250). BESD are essentially a social construction that groups individual students together as having a particular special educational need. However, BESD is a heterogeneous category of need and it is generally the externalised behaviours such as hyperactivity, defiance and aggression that visibly disrupt learning. It is import though to recognise that internalised behaviours such as inattention and depression also have a significant negative effect within the classroom (Breen *et al.*, 2014 p. 14). Both of these categories of behaviour will undoubtedly have a negative impact on students' ability to learn and to interact socially with peers which could represent a potential barrier to implementing collaborative classroom practices.

Secondly, available evidence suggests that there is no preferred mathematical pedagogical approach considered more suitable for teaching students identified as having BESD (Lewis and Norwich, 2004, Rix *et al.*, 2009). Nevertheless, both Cefai (2010) and Groom and Rose (2005) suggest that active and 'practical' teaching approaches are more likely to engage students identified as having BESD. It is also suggested that when students labelled as having BESD feel supported and enjoy the learning process, they are less likely to engage in challenging behaviour (Vannest *et al.*, 2009 p. 81).

The term 'practical' as used throughout this thesis, is an umbrella term encompassing any active learning approach to solving a mathematical problem. In terms of mathematical learning, 'practical' either involves the use of concrete objects or manipulatives to enhance learning experiences or physical movement or performance, rather than passively listening or watching. Within the mathematics curriculum, practical learning is frequently enacted through the process of applying mathematical skills and knowledge to solve real-life problems, such as through investigative tasks. In defining Complex Instruction[5], a method of engaging students in active group work, Boaler (2006) defines tasks to be group-worthy if they are:

> … open-ended problems which illustrate important mathematical concepts, have multiple entry points and solution paths, can be solved using multiple representations, and allow students to use many different skills to complete them.
> (Boaler, 2006 p. 40)

Reviewed literature has also highlighted the importance of the use of dialogue within the classroom in promoting conceptual understanding and learning. Whilst Sutherland (2006) and Chapin and O'Connor (2007) report that talk positively impacts on student learning, Jansen and Middleton (2011) further suggest that its use within the classroom increases students' motivation for learning. Mercer (1995) defines three distinct types of talk - disputational, cumulative and exploratory. It is exploratory talk, where students engage critically but constructively with each other's ideas, that promotes student learning and cognition (Gillies, 2006 p. 273). Although other researchers, such as Barnes and Sheeran (1992) categorise 'talk' in other ways, Mercer's categories of talk are used later in this thesis, to inform the discussion of data collected. The decision to use Mercer's categories of talk was based on the fact that the majority of research conducted within the mathematics classrooms on talk has used his definitions.

When faced with learning any new topic in mathematics, students may encounter failure, a fear of making mistakes and of being 'wrong' (Taplin, 2002 p. 28). Coupled with this is that many students categorised as having BESD also have low self-esteem and self-confidence issues (Cole and Knowles, 2011 p. 59). It is therefore essential to create relationships based on mutual respect and trust, between all members of the classroom community, so that all can become more confident in taking risks with their learning (Gregory and Ripski, 2008).

[5] Complex Instruction 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. Altendorff (2012)

The identification of these areas discussed suggest value in adopting a social constructivist approach as both social and cognitive processes play a central role in the learning of mathematics (Ernest, 1994 p. 304). As Idris (2005 p. 18) state 'educational research provides compelling evidence that students learn mathematics well only when they construct their own mathematical understanding.' This understanding of mathematical learning as an active and practical activity is consistent with a focus on supporting the learning needs of students identified as having BESD. The advantages of such an approach are described by Yackel *et al.* (1990) thus:

> Mathematical ideas and truths are cooperatively established by the members of a culture. As such, the constructivist classroom is a culture in which children discover and invent their knowledge socially, by sharing, explaining, negotiating and evaluating ideas (Yackel *et al.*, 1990 p. 34)

The study was also informed by an understanding of the importance of two key social constructivist principles. The first is that mathematical learning will occur more readily when students communicate and interact with each other. The second is that students' social skills can be developed by taking an active and participatory role in learning experiences. As Moschkovich (2007 p. 25) suggests, the benefits of developing communication and discussion skills with students identified as having BESD are two-fold in that it enables both social and cognitive development.

Learning occurs through active participation by the student as opposed to passive acceptance of information presented by the teacher. As Hertz-Lazarowitz (1992 p. 77) comments, the teacher's role is 'the guide on the side, not the sage on the stage'. Cognitive change therefore comes about through interaction, experience and dialogue between students and a key role for the teacher is to encourage this social interaction between students.

DuPaul and Stoner (2003 p. 229) suggest that students identified as having BESD do not necessarily lack social skills, it is that they have a deficit in applying the rules for social intercourse, even though they know them. Fostering the development of students' social skills through, active learning approaches could help to enhance these skills and does not assume that the students have already developed such skills or indeed that they cannot.

3. Research Design

The focus of this research was to increase opportunities for learning mathematics for students identified as having BESD, using interview and classroom interaction techniques to gather data through an action research process, as outlined by Elliott (1991). This chapter details my implementation of Elliott's action research cycle as well as documenting the timeline of data collection and methods used. The ethical implications of carrying out research with vulnerable students is carefully considered along with the issues and challenges faced by an insider researcher. An explanation of my approach to the issue and processes of data analysis are also presented and discussed.

3.1 Methodological Approach

Cohen *et al.* (2013) assert that the choice of research methodology must be guided by how the research questions would be best answered. Epistemological choice does not necessarily govern whether a qualitative, quantitative or a mixed methodology approach is taken (Schmuttermaier and Schmitt, 2001). Qualitative research methods, although designed to help researchers understand people and the society which they live in, are not necessarily the exclusive tools of constructivism. However, quantitative methods have been largely associated with positivist principles (Reichardt and Rallis, 1994). Qualitative methodologies generally generate in-depth and detailed data of a small number of subjects by gathering information that is rich and descriptive in nature, and which illustrates the phenomenon being studied (Labuschagne, 2003). Recognising that there are many qualitative research methods, the framework offered by Elliot's (1991) approach to action research, provided the flexibility and structure of design to accommodate the aims of this study. This choice of research method is explained more fully, in section 3.3.

Qualitative research is often conducted in natural settings where the researcher wishes to gain an understanding of the social world from the viewpoint of the insiders (Miles and Huberman, 1994). Any classroom environment is a complex arena in which to carry out research as there is a rich array of interaction and nuances at play. This fact, combined with students who can often display emotional and behavioural challenges, which are not necessarily due to the issues being researched, makes a qualitative methodology seem more appropriate for this study.

An action researcher's own personal values and assumptions will always be reflected, to some extent, in their interpretation of data collected and the subsequent conclusions drawn from it. Creswell (2013 p. 8) suggests that qualitative researchers interpret data through a 'personal lens', situated in a particular cultural and social viewpoint, which is why it is necessary for researchers to analyse their own positionality in any research process. With this criticism in mind, the next section of this chapter clearly sets out my own positionality as an insider researcher.

3.2 Insider Researcher Positionality

Positionality

There are different ways of knowing things, referred to as paradigms, which are broad orientations about the world and the nature of research. There are two main competing philosophies, positivism and constructivism, which vary in how they view reality, the creation of knowledge and ways of carrying out research (Matthews, 2003). According to Grix (2010), good research is conducted by:

> setting out clearly the relationship between what a researcher thinks can be researched (ontological position) linking it to what we can know about it (epistemological approach) and how to go about acquiring it (methodology), you can begin to comprehend the impact your ontological position can have on what and how you decide to study. (Grix, 2010 p. 68)

As noted earlier in section 1.4, the nature of both BESD and education, it could be argued, are both socially constructed. The social constructivist approach asserts that people construct their own meaning in a complex world. It argues that there are no absolute truths to be found in people's actions and reactions, advocating instead the creation of subjective and multiple realities. In contrast to positivism, the constructive paradigm seeks to understand rather than explain social phenomenon.

As a teacher, I have never previously questioned my philosophical or epistemological position. However, my ontological stance to such questions as whether mathematics is discovered (fundamentalism) or created (fallibilism), ultimately impacts on my approach to daily classroom practice. As a researcher however, the impact that my dual role of practitioner and researcher has, is now discussed.

Insider Researching

Robson (2002) defines the term 'insider researcher' to be where the researcher has a direct involvement or relationship with the research setting as opposed to an 'objective outsider' who studies externally to themselves (Denzin and Lincoln, 2000). In a sense, all teachers are researchers – reflecting, analysing and acting upon everything that happens within their classroom. However, the dual roles of teaching and researching can cause a conflict of interests due to the differing agendas and commitments that each of these positions hold. Hammersley (1993) talks of dilemmas such as objectivity, over familiarity and the ethical issues regarding the change in relationships and status between students and teacher/researcher. Mercer (2007) highlights three dilemmas of insider researching which are:

1) Informant Bias – the student's responses to the questions posed are based on what they think the researcher wants to hear and is not a reflection of their true opinion.

2) Interview Reciprocity –the researcher and interviewee build rapport through the sharing of experiences and thoughts which would then influence their responses.

3) Research Ethics – the researcher and research questions will be known within their workplace and how much information is shared with others needs to be considered.

However, an insider researcher holds a unique position to research issues within their own classroom and there are many advantages of such a position. For example, insiders have a wealth of knowledge regarding the environment, students and the politics surrounding the research setting, which an outsider would not have access to (Smyth and Holian, 2008). Interviewees may feel more relaxed and open to talk if they are known to the researcher. As Rooney (2005 p. 7) states, 'Insider research has the potential to increase validity due to the added richness, honesty, fidelity and authenticity of the information acquired.'

Vulliamy and Webb (1993) comment positively with regard to insider teacher research within special education environments:

> We believe that teacher research is particularly suited to the area of special needs, where teachers are often concerned to understand pupils with unique learning difficulties. (Vulliamy and Webb, 1993 p. 188).

When carrying out research with students who can exhibit challenging behaviours, the advantages of being an insider researcher are reported in research by Gillies and Robinson (2010). As outsider researchers, working with students at risk of exclusion, Gillies and Robinson encountered students refusing to participate in their research, hostility from other staff members and difficulties in establishing any rapport with the students.

Student-teacher relationships inevitably involve power differentials between the student participants and teacher researcher (Nolen and Putten, 2007). It is this power difference that gives students confidence and trust in the teacher's ability to manage their learning. However, as a researcher I want to reduce this inequality, in order to empower student voice and create a greater sense of autonomy. As the students' regular mathematics teacher however, there was a tension between letting 'difficult to manage' students discover mathematics for themselves and the urge to guide their learning whilst managing their behaviour. The social dynamics of classroom protocol places the teacher as the poser of questions, whilst students try to guess the answer that the teacher is seeking. As a researcher, this readiness to please could lead to informant bias - students will try to guess what the researcher wants to here. Consideration of the difficulty that students may face in responding honestly to questions regarding my practice as a teacher will need to be addressed.

3.3 Action Research

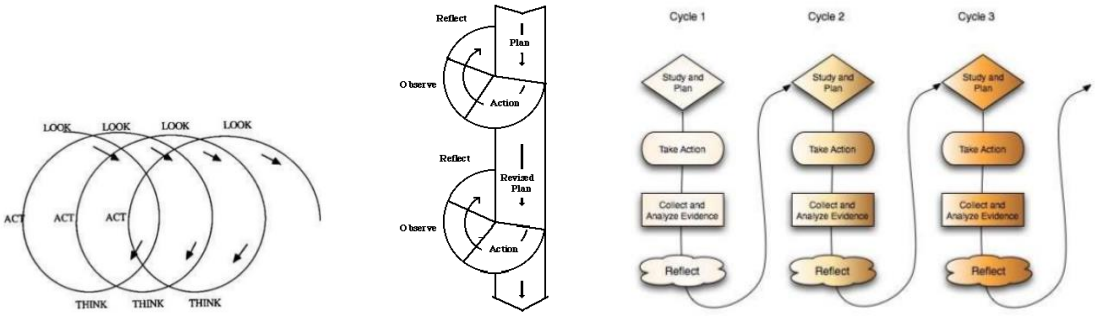
Action research has as its broad premise the belief that research with human beings should be participatory and democratic (Ladkin, 2004). The ontological and epistemological assumptions of action research, provide the flexibility that is required to implement effective change within the classroom, while at the same time enabling the views and opinions of the participants to be voiced. Action research is essentially a practical approach to professional inquiry within a social situation (Water-Adams, 2006). An important characteristic of any action research model is that both the action (change) and the research (understanding) are intended outcomes. Carr and Kemmis (1986) define action research to be:

> A form of self-reflective enquiry undertaken by participants in social situations in order to improve the rationality and justice of their own practices, their understanding of these practices, and the situations in which these are carried out.
> (Carr and Kemmis, 1986 p. 220)

Both the nature and the features that an action research methodology offers, make it an ideal approach to answering the research questions posed within this study. These features are summarised by Koshy (2009) as:

- Action research is a method used for improving educational practice. It involves action, evaluation and reflection and based on gathered evidence, changes in practice.
- It is participative, collaborative and situation-based.
- It develops reflection based on the interpretations made by participants.
- Knowledge is created through action, and at the point of application.
- In action research, findings emerge as action develops, but they are not conclusive or absolute. (Koshy, 2009 p. 2)

Many different models have been developed from this initial framework that detail how action research can be carried out (Mertler, 2013 p. 13). In fact, Chandler and Torbert (2003) have identified at least 27 different design models of action research. Although they look very different on paper, they share similar characteristics - an initial focus of investigation; a cyclical approach to action and reflection and the collection and analysis of data and the formulation of a plan of action (Mills, 2011).



Interacting Spirals Stringer (2007) | Kemmis' Spiral Model | Progressive Problem Solving Riel (2010)

Figure 2 - Action research Models

Elliott (1991) argues that these models are restrictive in the fact that the research question is fixed in advance and that the initial step of identifying the problem is simply a fact finding activity. Elliot offers an alternative cycle where the initial reconnaissance step is repeated and can be both a fact finding and an analytical process. Although the reconnaissance phase of action research is not a unique feature of Elliott's model, he describes it as a stage of action research with two aspirations: namely to describe and explain the facts of the situation (Townsend, 2013 p. 74). For this reason I chose to implement Elliott's (1991 p. 71) model.

Action research is used widely within educational settings, especially by teachers who use it to improve either their teaching or to affect change within their organization (Hien, 2009). Unlike other research methods, it offers practical solutions toward positive change in practice. As Wenmoth (2007) comments:

> Taking the time to reflect critically on the things we are doing in our classrooms is perhaps the most effective thing we can do to ensure that what we are doing is having the desired outcomes, and is changing our practice in the ways we want it to. (Wenmoth, 2007 p. 1)

An important methodological issue of any action research study is that of data validation. Triangulation refers to the use of multiple methods or data sources to develop a comprehensive understanding of the issues that are being studied. This process enhances the trustworthiness of data collected and ultimately increases confidence in the findings of the research. The process of triangulation was approached by this study in two ways. Firstly by collecting data using a variety of qualitative research methods such as semi-structured interviews, questionnaires and a focus group and secondly by seeking other stakeholder's perspectives. The views of both the Head teacher of the school and the mathematics Learning Support Assistant were sought to provide differing viewpoints, thereby facilitating a level of data validity. As Thomas (2013 p. 146) comments 'viewing from several points is better than viewing from one.' The trustworthiness of the findings of this research were further strengthened by the use of a research journal to record reflexively the decisions made during the research process.

The diagram below details how Elliott's (1991) model was implemented by this study.

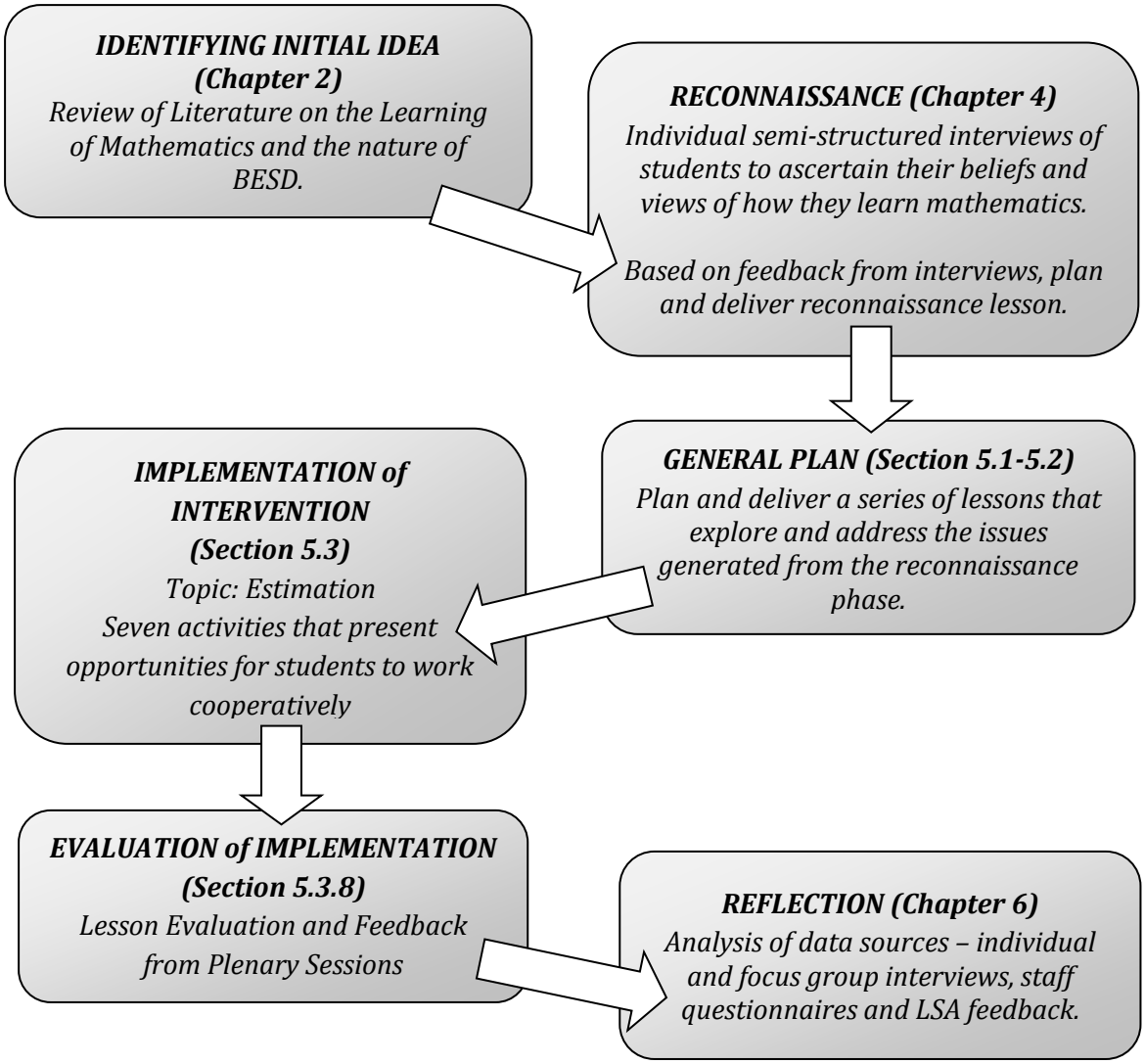


Figure 3 - Implementation of Elliott's Action Research Model

The cyclical nature of action research requires a continual revisiting of both understanding and action and the original research questions may therefore, as a consequence, become redefined as part of this process. The research findings of action research cannot be applied universally or claim any generalisation to wider applications. However, empirically-based practitioner action research is possibly more relevant to others working with similar students, as Gewirtz *et al.* (2009) state:

> Where teachers are able to explore and research their own practice, they are better able to own their findings. They become, in Stenhouse's terms, producers of knowledge. (Gewirtz *et al.*, 2009 p. 581)

3.4 Ethical Considerations

This section focuses on the ethical issues inherent in carrying out a research project which involves both work colleagues and students identified as having special educational needs. Consideration is paid to the process of gaining ethical approval as well as discussing the issues of anonymity and confidentiality of participants and that of informed consent.

Ethical Approval

As this empirical research involved working with both students (aged 14 – 15) and adults, ethical approval was sought from both the University of Sussex and the school where the research took place. Approval was initially sought from the Chair of the school's Interim Executive Board as well as that of the Head Teacher (see Appendix1). Ethical approval was also sought through the University of Sussex's Social Sciences Cluster-based Research Ethics Committee for this study. The university's risk assessment guidelines placed the application for approval in the high risk category, due of the vulnerable nature and age of the students who were to take part in this research. The original ethics submission was returned for revision, when two issues required further clarification. The first was to ascertain the procedure that would be adopted if a student and parent did not both agree to consent to participate in the study. It was decided that under these circumstances, the student would not be included. The second issue, regarded the use of the school's CCTV equipment to record student interviews, this was resolved and the resubmission of ethics approval was granted by the University of Sussex in March 2013.

Student Participants

Sieber (1992 p. 14) sees ethics in research as, 'the application of a system of moral principles to prevent harming or wronging others, to promote the good, to be respectful, and to be fair'. With this in mind, both the BERA (2011) Ethical Guidelines for Educational Research and the National Children's Bureau (McLaughlin, 2015) advice on conducting best ethical practice with students was followed. Both emphasise that the welfare of the participants should be of primary consideration. They list four essential areas that should be addressed in all research studies involving vulnerable groups; they are informed consent, child protection and confidentiality, rewards for participation and the importance of monitoring the impact of research on the students.

The externalised behaviours exhibited by students identified as having BESD, such as verbal and physical aggression, can often mask the vulnerability of those with this type of SEN(D), when compared say, to children with physical or sensory impairment. Taking in to account that the students who took part in this study were aged between 14 and 15, the vulnerability of this group of learners cannot be under-estimated and ethical considerations of this are now discussed.

Anonymity and Confidentiality

The students who agreed to take part in this study were asked to choose a name that would be used to anonymise their responses during the research process. However as Malin (2003 p.22) recognises, there are difficulties in ensuring anonymity in a small scale study. The specialised nature of the school where this research took place makes the establishment relatively easy to identify even though it is not specifically named. The number of both staff and students involved in this study make it relatively straightforward for individuals to recognise themselves or for other people to identify them. Although student names have been concealed through the use of pseudonyms to avoid identification, other characteristics, such as free school meal entitlement, whether they are subject to a care order or the diagnosis of additional behavioural difficulties, have been withheld.

The Right to Withdraw

A consequence of being an insider researcher is that students may not feel comfortable in refusing to participate in this research, due to the teacher-student relationship. Since the study formed part of the participants' normal lessons, it was not be possible for them to withdraw from their learning. However, action research is based on the premise that change in practice will only come about by cooperation of those concerned. The decision to conduct this research during the students' normal timetabled lesson was deliberate, so as to reduce disruption to the school day and to emulate and capture typical classroom practice. However, students were informed of their right to not have their class-work, or personal information, such as interview transcripts or lesson conversations used within this project, if they so wish and without prejudice. An information sheet (see Appendix 2) explaining the purpose of the project was given to participants so that it was explicit how the research would affect them and what their involvement would be. Since this research project was primarily concerned with enhancing the students' learning experience, it was felt that their involvement and participation was something they would benefit from.

Informed Consent

Consent for this study was sought at four different levels (university, school, parent and student) but perhaps the most important and tenuous was that obtained from students. Although they were given an information sheet that explained the research process, it was difficult to substantiate their level of comprehension on which they based their informed decision. The BERA (2011 p. 5) guidelines describes informed consent 'to be the condition in which participants understand and agree to their participation without any duress, prior to the research getting underway.' The regulatory, ethical and legal context of informed consent amongst vulnerable groups is considered by Wiles *et al.* (2005). They state that children under 16 are not automatically legally competent to give consent, unless the child can be judged to understand the implications of taking part in the research (Wiles *et al.*, 2005 p. 8). Conversely, Boddy (2014 p. 93) states 'there is no explicit requirement in law for adult consent to children's participation in research'. With this in mind, consent from both students and parents (and in the case of children who are in local authority care, of those with parental responsibility) was sought (see Appendix 3).

Adult Participants

As part of the data collection process, a questionnaire (see Appendix 4) regarding the teaching and learning of my research group was distributed to six teaching colleagues. I had not considered the ethical implications of this at the time, but I was also their line manager for performance management. There was a 100% return rate of questionnaires, within 20 minutes of being handed out. Although I had explained that completion of the questionnaire was voluntary and did not relate in any way to the appraisal process, the dual role of manager–researcher was difficult to untangle in this situation.

3.5 Data Collection

Table 4 provides an overview of the research methods utilised and the data collected at each stage of the action research cycle. The dates in the right hand column show when the data were collected with a brief description of the process involved in the middle column.

Stage	Method of Data Collection	Date undertaken
Reconnaissance	Reading through Students' Statement of SEN(D), Attendance and Exclusion data to identify / select research group against the criteria.	April 2013
	Initial Semi-Structured 10 minute individual interviews with seven students to elicit their views of learning mathematics	May 2013
	Individual discussion of transcript of interviews with students to clarify my interpretation/understanding of what they had said.	June 2013
	Reconnaissance Lesson to consider possible difficulties and challenges regarding recording and collation of data.	Nov 2013
Plan	Year 10 Scheme of Work for Mathematics Lesson Planning and Worksheets	Dec 2013
Intervention	First Two Activities – How Long is a Minute? and Measuring Estimating Every Day Objects (audio transcription)	Jan 2014
	Head teacher Lesson Observation of first lesson.	
	Third, Fourth and Fifth Activities – Who is the Tallest? and Create a Floor Plan and Metric and Imperial Units (audio transcription)	
	Sixth and Seventh Activities –, Numerosity and Impossible Questions (audio transcription)	
	Learning Support Assistant's Feedback on the intervention stage	Feb 2014
Evaluation	My initial thoughts and lesson evaluation following each intervention. Transcript of plenary at the end of each lesson.	As above
Reflection	Post Intervention Individual Interviews with students to confirm or oppose issues that arose during research process. (audio transcription)	Feb 2014
	Post Intervention Group Interview to gather a summary of the group's views and opinions. (audio transcription)	Mar 2014
	Staff Questionnaire of the teaching strategies used when working with the researched group.	Feb 2014

Table 3 - Timeline of Data Collection and Methods

3.6 Data Sources

This section discusses the rationale, advantages and limitations of each of the qualitative data collection methods used during this study. As Drew *et al.* (2010 p. 1677) note, a researcher must ensure that their chosen methodological approach is interesting and appealing in order to facilitate student engagement and promote participation. Consequently a variety of research methods were adopted within the study including semi-structured interviews, questionnaires, a focus group, adult observation and reflective journaling. The implementation of each of these data collection methods is now described and discussed.

3.6.1 Audio Transcription

Digital audio files were recorded as a primary source of data of the students' initial and final interviews, the reconnaissance and intervention lessons as well as the focus group discussion. This data were then transcribed to enable analysis. All conversations were transcribed verbatim wherever possible, square brackets [ ] were used to record movements or actions of the students during the lesson or interview. However, it was not possible to record non-verbal communication or the use of intonation or pauses in speech. Grammatical errors and slang terminology used by the students were recorded as said and uncorrected. The lessons were recorded under normal classroom conditions, which meant that sometimes noise levels were louder than conservations.

Advantages and Limitations of Interviewing

The main advantage of using audio recordings as a data source is that is captures not only what was being said, but also how it was said (Macintyre, 2012 p. 84). It also enables the researcher to focus on lesson delivery as the recordings can be played back and transcribed at a later date.

It is important to be mindful that the act of recording however, could alter the behaviours of the students as they may become more self-conscious. To counteract this possible limitation, the recording device was not made visible during the interviews and lessons, to avoid the students being constantly reminded that they were being recorded.

3.6.2 Semi-Structured Interviews

As a qualitative data source, interviews offer a simple way to obtain information and insight in research, as Gollop (2000) states, 'although there are many ways to gain information about children, the most ideal way is to obtain it from children directly'. Semi-structured interviewing is one of the most common data collection methods used in small-scale educational research (Hannan, 2007) as they provide both flexibility and structure in questioning. Dunne *et al.* (2005) suggest that semi-structured interviews should be conducted like conversations. Conversational style interviews are possibly more successful as they can put the interviewee at ease (Dunne *et al.*, 2005 p. 34) and are less restrictive than a structured interview which could present difficulties for a student to respond to as the researcher has more power (Garbarino and Stott, 1992). It is important that interviewing techniques give students as much power in the process as possible so that they can express their thoughts and feelings clearly about their learning.

> Children know more than they know they know. They surely know more about what they know than the researcher does. The purpose of interviews is to get them to talk about what they know. (Graue and Walsh, 1998 p. 112)

Semi-structured interviews were used as part of the initial reconnaissance phase to elicit the students' views of their experiences of learning mathematics and again at the end of the study to reflect and record any changes in their views following the interventional stage. The interviews were conducted in the mathematics classroom, as the students were familiar with this environment and were carried out during a 15 minute tutorial period that followed lunchtime. Students were asked whether they would prefer to be interviewed by themselves or with another student of their choice. However, all students opted to be interviewed separately. Before beginning each interview session I reaffirmed their consent before proceeding and asked if the student was still happy to be recorded. To reduce the risk of students becoming disinterested or apathetic during the interview process, the meetings were restricted to a maximum duration of 10 minutes. Students identified as having BESD can present with short attention spans and periods requiring concentration can result in 'verbal abuse, students engaging in something else or simply walking out of the classroom.' (Gillies and Robinson, 2010 p. 101). The stimuli and style of questioning was varied, so as to reduce the issue of inattention. Questions were styled in the third person where possible, asoften students find it easier to describe how they feel about a learning situation indirectly (Graue and Walsh, 1998). Although it is difficult to encapsulate a particular style of learning in an image, the use of pictures (see Question 1 overleaf) provided a useful way to assist with communication and the use of visual aids can also increase student interest and focus (Gollop, 2000).

To set the scene and for consistently in approach, each interview session began using the script below:

> *I want to talk to you to get your help. I am trying to find out about how young people learn mathematics best. There are no right or wrong answers. Everybody thinks differently, I just need to know what you think. I will record our conservation so that I can remember what we've said. Is that OK with you? When I type up our conversation I will not use your real name so then nobody will know who you are. Do you want to choose your new name that I will use?*

The questions used during this first interview were:

Question 1

I am going to show you some pictures of students in a classroom.

a) I want you to tell me whether you think they are learning or not.
b) How do you think they are learning?
c) Do you think that you would like to learn this way?

Question 2

Do you prefer to:

	Yes	No	Not sure	Some times
Work on your own				
Work as part of a pair				
Do different work to everyone else				
Work in a small group				
Work on a laptop				
Complete worksheets				
Work from a book				
Find things out for yourself				
Investigate				
Listen to music				
Practical work				

Table 4 - Reconnaissance Stage Interview Questions

Question 3

What makes learning difficult for you?

Question 4

What makes learning easier for you?

The closed design of question 2, using Likert scales, was used to quantify students' feelings on a broad range of issues relating to learning mathematics. The purpose of this scoping exercise was to explore initial thoughts and gauge student opinions. In contrast, questions 3 and 4 were designed as open ended opportunities for students to raise any further issues not already covered by the previous questions. The ordering of these last two questions was deliberate to ensure that the interview finished on a positive note.

Advantages and Limitations of Interviewing

There are two main advantages of using interview as a data gathering tool, the first is that it is far more flexible than many other methods and secondly it allows for greater depth of data analysis (Cohen *et al.*, 2013). Although semi-structured interviews are conducted by asking predetermined questions, there is flexibility in terms of the ordering and wording of the questions. Additional questions can be included as well as omitted, as judged appropriate by the interviewer (Robson, 2002). Furthermore, interviews give interviewees the opportunity to clarify questions and give interviewers the opportunity to probe their responses more deeply.

Although I had originally intended the interviews to be no longer than 10 minutes, I found the process rather artificial, with students being more monosyllabic in their answer than they are usually. I found that they were certainly more talkative nearer the end of the interviews and perhaps these interviews, in hindsight, should have been longer. In the case of the student named 'Clayton', I had managed to lose the original audio recording of his first interview, but when I re-interviewed him, he was a lot more animated and talkative on the second occasion.

3.6.3 Post Intervention Focus Group

Focus groups are a very popular method of data collection in social research (Robson, 2002) and are defined as 'a qualitative data collection method in which one or two researchers and several participants meet as a group to discuss a given research topic' (Mack *et al.*, 2005 p. 51). Further, Morgan (1998b) states:

> The hallmark of a focus group is the explicit use of the group interaction to produce data and insights that would be less accessible without the interaction found in a group. (Morgan, 1998b p. 12)

A focus group is based on a series of discussion topics decided beforehand by the researcher who acts as moderator during the discussion (Litosseliti, 2003). This qualitative methodology provides the opportunity to gather a rich data set efficiently that captures the group's social dynamic and interaction.

The focus group was set up at the end of this study, in which the students took part collectively, to gather a summary of their views and opinions on the issues that had arisen through this research. All six students took part in the focus group which lasted for approximately 20 minutes and was held in mathematics classroom. Questioning focussed discussion around themes that had emerged from the intervention lessons, they were:

1) What do you think a new maths teacher would need to know about how you learn maths?
2) Do you prefer to learn through practical activity?
3) Do you think that you learn by talking to each other during lessons?
4) What does it mean to you to work together?
5) Who do you trust to give you the right answer to a question in a maths lesson?

The fact that a focus group centres around discussion and social interaction was quite appropriate as these were two of the issues that arose during the research. The focus group discussion was audio-recorded, which meant time could be devoted to guiding the group interview and ensuring every student had the opportunity to be involved, rather than having to take detailed notes.

Advantages and Limitations of Focus Groups

Krueger and Casey (2014) suggest that adopting a focus group methodology offers a more natural environment than that of an individual interview because participants are influencing and influenced by each other. That is, focus groups provide the opportunities for participants to probe each other about why they may hold a certain view (Gray, 2009). Researchers who have consulted with students on research methodology have found that they prefer to discuss within a group environment as they feel less self-conscious and consider this method to be fun, quick and convenient (Hill, 2006 p. 81).

However, an important point to bear in mind when conducting a focus group interview, is that of equality and the inclusion of all student voices. As Rudduck and Fielding (2006) point out:

> the more self-assured and articulate students may dominate consultative conversations and be more readily 'heard' by teachers, but it is the silent – or silenced – students who find learning in school uncongenial whom we also want to hear from so that we can understand why some disengage and what would help them get back on track. (Rudduck and Fielding, 2006 p. 228)

Due care was taken to ensure that all students contributed to discussion. As far as possible I was mindful of the group dynamics and ensured each group member had an opportunity to express their views and that no group member dominated discussion.

3.6.4 Reflective Journal

Throughout this research, a reflective journal was kept to identify and understand any critical decisions that were taken during the research process. Nadin and Cassell (2006) suggest that a reflective stance, where the researcher reflects on the way in which the research is carried out is important, so that the journal can be used as a tool of analysis. This process of diarising decisions and thought processes adds a visible clarity to the decision making processes (Ortlipp, 2008 p. 695). A reflective journal can also provide an opportunity to record any informal conservation with students that would otherwise not be recorded. Some of these conversations, although not directly linked with the objectives of this research, added richness in describing the context of the students within the study.

During the research process, the reflective journal was used to:

1) record my thoughts, conversations and comments that occurred during the study
2) record any critical decisions or events that shaped the design or outcomes of my research and
3) reflect on any changes in my perception and understanding of both the students and the data collected.

Advantages and Limitations of Journaling

Ortlipp (2008) describes how a reflective approach through the use of journaling is now a widely accepted method in qualitative research. It enables researchers to keep a record of any decisions and choices made, whilst recording any personal assumptions and individual belief systems. The keeping of a reflective journal makes clear:

> the researcher's own experiences, values, and positions of privilege that have influenced their research interests, the way they choose to do their research, and the ways they choose to represent their research findings.
>
> (Harrison *et al.*, 2001 p. 325)

As this research was conducted within my normal working environment, the familiar everyday conversations with staff were not recorded, however these might otherwise have seemed worthy of comment to an outsider. This has limited my research, as conversations which often mirrored my own views or possibly presented alternative views were lost. The purpose of a reflective journal is to record what is observed and experienced and is therefore subject to individual interpretation. Consequently, there is always a risk that a researcher may only note incidents and conversations that support their viewpoint and neglect to record observations that negate these conceptualisations of the situation.

3.6.5 Teaching Staff Questionnaires

The defining characteristic of a questionnaire is that it is a written form of questioning (Thomas, 2013 p. 207). Questionnaires are often used to gather people's opinion on how strongly they agree or disagree with a statement (closed questioning) or more powerfully by posing open-ended questions and giving respondents a space in which to formulate their answer (Munn and Drever, 1990 p. 23). Cohen *et al.* (2013) advise that questionnaire design needs to pay due regard to many issues such as ethical considerations, linguistic style and question structure. They warn that:

> questionnaires will always be an intrusion into the life of the respondent, be it in terms of time taken to complete the instrument, the level of threat or sensitivity of the questions, or the possible invasion of privacy. Questionnaire respondents are not passive data providers for researchers. (Cohen *et al.*, 2013 p. 377)

The views of six subject specialist teachers regarding the research group were captured through the use of a questionnaire (see Appendix 4). Questions focussed on eliciting staff responses on how they felt the students learnt best in their subject area, with particular reference to pair and group work, practical activity and peer learning. Staff members were given the same set of open-ended questions to respond to without any intervention from the researcher. The questions were based around four issues that had come to the fore through this research, which were:

1) How do you group students to maximise learning opportunities in your subject?
2) Do you think our students learn more readily through the use of practical activities?
3) Do students learn better from each other or from the teacher?
4) Is there a particular teaching approach that you feel is more effective in helping our students to learn?

Advantages and Limitations of Questionnaires

This method was chosen as it has several advantages and are one of the most widely used means of collecting data (Rowley, 2014 p. 308). Firstly, they can be completed relatively quickly, which is a consideration when working within a busy school environment and secondly they could possibly elicit more honest responses than those obtained through interviewing. Although the format of questionnaires does not allow for in-depth discussion of complex issues (Beiske, 2003), as an insider researcher I was fortunate in having the opportunity to follow up on and clarify any issues that arose from the questionnaire data with staff as required.

3.6.6 Additional Sources of Data

Although individual stakeholders may hold differing interests and agendas of the educational experience of the students in this research, this diversity offers an additional layer of analysis to my research. The views of both the mathematics LSA who had worked with the group throughout this study and the Head Teacher of the school were sought.

Learning Support Assistant's Account of the Intervention

Using an 'account' as a data source is described by Thomas (2013) as being similar to an unstructured interview, an account is usually provided in the form of a long written piece of prose (Thomas, 2013 p. 200). Being the only other adult who was directly involved with this research, I sought the views of the LSA who had supported the students' learning of mathematics throughout this study. I had considered though, that through almost daily conversations regarding both lesson planning and my research aims, I may have compromised the objectiveness of her observations. However, with both her role and responsibilities within the learning environment being different to my own and with her working relationship with the students being different, her reflections afforded a different viewpoint of the learning process and that of student behaviour. Her feedback reflected upon different issues, from a different perspective to my own.

Head Techer's Lesson Observation

The purpose of a lesson observation is to focus upon the quality of the teaching and learning experience as a whole. However, I had invited the Head teacher to observe the first intervention lesson to consider specifically the issue of developing strategies to create opportunities for social interactions and cooperative learning situations. It is difficult for a practitioner-researcher to critically analyse or evaluate data which forms part of their own practice as they are fully immersed in its delivery and in the meeting of students' needs. The value of this data became much clearer through the process of reflection after the event.

3.7 Methods of Data Analysis

Data analysis for this qualitative research study was approached through the method of constant comparison as described by Thomas (2013 p. 235). This method was originally developed for the use in a grounded theory methodology and is now applied more widely as a method of analysis in qualitative research (Leong *et al.*, 2010). It provides an inductive and systematic way of analysing raw data, whilst providing transparency. The process is summarised succinctly by Taylor and Bogdan (1984) thus:

> In the constant comparative method the researcher simultaneously codes and analyses data in order to develop concepts; by continually comparing specific incidents in the data, the researcher refines these concepts, identifies their properties, explores their relationships to one another, and integrates them into a coherent explanatory model. (Taylor and Bogdan, 1984 p. 126)

The connections between different themes can then be related to one another through a process of thematic network analysis. Thematic analysis is 'a method for identifying, analysing and reporting patterns (themes) within data (Braun and Clarke, 2006 p. 79) and provides a hierarchical organisation of the ideas contained within the data (Thomas, 2013 p. 236). But as Attride-Stirling (2001) points out, this web-like structure is a tool for analysis and not the analysis itself.

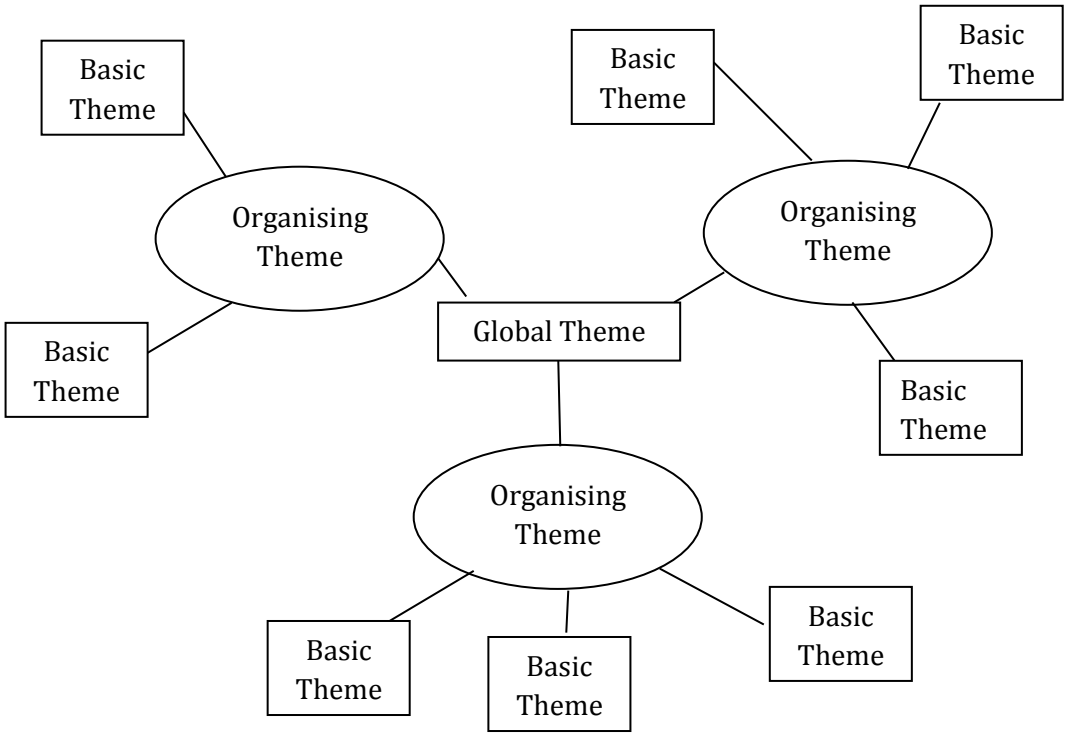


Figure 4 - Structure of a Thematic Network (Attride-Stirling, 2001 p. 388).

A basic theme is the simplest characteristic derived directly from the text; it says very little about the whole text and must be read within the context of other basic themes in order to make sense beyond its immediate meaning. Organising themes are more abstract and more revealing of what is going on in the text; it captures something important about the data in relation to the research questions (Braun and Clarke, 2006). A group of organising themes link together to form a global theme. A global theme is a super-ordinate theme and presents an assertion about an issue. Global themes provide a summary of the main ideas in the data and a revealing interpretation of the text (Attride-Stirling, 2001). This approach of creating basic themes and then clustering together to form organising themes was followed to produce the thematic network for this study.

Although thematic analysis provides a useful way to analyse large quantities of data, it is important to acknowledge its limitations. Two criticisms of thematic analysis are that firstly, there is no clear guidance on how it should be conducted (Attride-Stirling, 2001) and secondly as Braun and Clarke (2006) claim, there is no concise measure of how much data are required to verify the existence of a theme. It is therefore imperative that researchers describe explicitly the process that they will use to analyse their data when adopting this approach.

3.8 Identifying a Teaching Group to be Researched

Although students with BESD are not a homogenous group of learners, the teaching group that was selected to be included within this study were chosen so as to represent a broad cross-section of behavioural, social and emotional characteristics. The 31 male and 10 female students on roll at the school are placed into one of six teaching groups. Group 1 is a Key Stage 3 (Years 7-9, aged 11 - 13) group comprising six students whereas Groups 2, 3 and 4 are Key Stage 4 (Years 10 -11, aged 14-15) where membership is based broadly on attainment – Group 2 meets the needs of six of the lowest attaining students; Group 3 for seven middle attaining learners and Group 4 is composed of the two highest attaining students. Members of teaching Group 5 are characterised by having a reduced timetable which concentrates on delivering a core curriculum of English, mathematics and science only. These five groups all follow a mainstream secondary school approach of being taught by subject specialist teachers which is in contrast to the sixth group which takes a nurture base approach. Group 6 are based in one classroom and are taught every lesson by the same member of staff.

My criteria for inclusion in this research, as detailed in my Ethical Review Submission, were that students should:

1) Not be in their final year of school, as they may be preparing for external examinations.
2) Have attendance of at least 60%, to increase the chance that they will be available to take part and complete the study.
3) To be not currently subject to any Child Protection issues to avoid any ethical or disclosure issues and
4) To not have had a high exclusion rate over of the previous academic term.

These criteria were implemented so as to ensure maximum student participation within the study. However, it is acknowledged that this could mean that the group is not true representation of those identified as having BESD. As can be seen from table 5, teaching group 3 comprising 7 students[6], all having attendance above 60% and are not subject to child protection, met my selection criteria for inclusion in this study. This group was selected, subject to consent being obtained, as the research group.

Group	Number of Students	Gender	Average Attendance of Group	Average Number of Days Excluded (Sept – April 2013)	Number of Non Year 11 Students	Number of Students in Local Authority Care	Number of Students with ADHD	Number of Students Entitled to FSM
1	6	4♂ 2♀	84.6%	1.58	6	1	2	4
2	6	6♂	79.2%	1.50	6	1	3	3
3	7	4♂ 3♀	87.7%	0.35	7	1	5	3
4	2	2♂	86.0%	1.75	0	0	0	2
5	14	12♂ 2♀	53.9%	3.54	6	3	6	6
6	6	3♂ 3♀	48.8%	1.75	2	2	3	1

Table 5 - Characteristics of Teaching Groups

Epidemiologically, there is a gender imbalance within the BESD population (DfES, 2007), where boys outnumber girls in a ratio of 4:1. Ideally a student sample representative of this figure would mirror more closely the national picture. This would necessitate changing student groupings as no teaching group met this criteria, however this was deemed to be too disruptive to student learning.

[6] Although there were 7 students in teaching group 3, one of the students (Kat) was absent from school during the intervention stage of this study.

The Participants

Mooney *et al.* (2003 p. 280) discuss the critical need for researchers to include participant characteristics such as gender, SES status, ethnicity to a high level of detail. In order to protect the anonymity of the students in this study, these identifiable traits have not been included. During the initial interview process, the members of the researched group were asked to choose a name that would be used to anonymise their responses during this study. The synonyms Clayton, Damien, Kat, Keeley, Poppy, Robbie and Rhys are used throughout this thesis. What follows is a brief description of both the commonalities that the research group shared and their individual differences. This information was taken from their Statements of SEN(D) and pupil profiles[7] - a document created by teaching staff collectively, which contains details of each student's observed behaviours, family background and educational history.

Commonalities

Even though the students at the school present as individuals with differing attributes, they share many common characteristics that make them a distinctive group of learners. For example, all of the students have been assessed and statemented under Section 324 of the Education Act 1996 as having Behavioural, Emotional and Social Difficulties. Each student has also been additionally identified as having further behavioural and developmental disorders. Notwithstanding any of these behavioural labels, all students have found integrating into a mainstream school problematic and have consequently experienced at least one permanent exclusion for exhibiting particular behaviours. Their level of need is such that they require more concentrated behavioural support than would otherwise be available in a mainstream environment. Interestingly, none of the students in this study, lived with both of their biological parents, the father being absent in all cases.

Both the literacy and numeracy skills of all of the students in this research, have been identified as being below national and age related expectations, mainly due to the fact that behavioural and emotional difficulties sometimes prevent learning from taking place. This under-achievement is further exacerbated, for a significant majority of these students, by having experienced a prolonged period of absence from school in the transfer from a mainstream placement to a special educational provision.

[7] Permission was obtained from students, parents and the head teacher to refer to and access this information.

Individualities

Each of the seven students present with differing strengths and attitudes which make them a diverse group of learners. For example, whilst Robbie has a high regard for his mathematical ability which can annoy other students at times, Poppy can lack social confidence and is the only student who perceives herself as not being 'good' at mathematics. Attitudes towards learning and each other also vary considerably. For instance, Keeley enjoys group work and discussion activities, but can be both verbally and physically aggressive towards other students, whereas Damien is a cheerful and popular member of the group, but prefers to work alone. Socially some find forming positive peer relationships difficult and will often isolate themselves, whilst other learners have no difficulty in wandering around the classroom engaging in conversations whenever they are required to complete a written task.

Although Damien is the only student within the group who has not been formally diagnosed as having ADHD, this difference is not generally observable within the classroom. Of the other students however, four are diagnosed as having hyperactive ADHD which manifests itself very differently to the behaviours displayed by the two students identified as having inattentive ADHD. Students identified as having BESD often display their frustration with learning in differing ways. For example, Clayton can be stubborn and argumentative, refusing to engage with learning whereas Rhys becomes angry with himself when he 'makes mistakes'.

Notwithstanding any of these similarities or differences, these learners have been grouped together by an education system that has identified them as having BESD and by a school based on attainment, both of which will ultimately define their success, or otherwise, within the education system.

4. Data Analysis: Reconnaissance Stage

This section outlines my implementation of the reconnaissance stage of the action research cycle. It presents and analyses the data gathered to provide a clear rationale for the actions and decisions taken in designing the intervention stage. How the findings from this reconnaissance were used to inform the intervention stage are also discussed.

The initial fact finding reconnaissance stage comprised three distinct opportunities for data collection. The first part involved reviewing students' statements of SEN(D) along with attendance and exclusion data to identify a research teaching group that matched the inclusion criteria for this study. Once identified, each of the seven participants of the group engaged in a 10 minute individual semi-structured interview in order to elicit their views and experience of learning mathematics. Following on from this, the third element of this stage was a reconnaissance lesson which focussed on exploring further the issues that the students had raised during their initial interviews.

4.1 Initial Student Interviews

Students were given the choice of being interviewed separately or as a pair, all chose to be interviewed alone. Contrary to my expectations, they were all keen to take part and generally seemed to enjoy the process, evidenced through my journal entry below.

> *Thursday 30th May 2013*
>
> I was surprised (and relieved) that the students seemed to like being interviewed. They were really keen to get started with the process. Was it because I was actively listening to them? The students seemed proud and honoured somehow, when I told them that I was going to type up our conversation. Most said that they would like to read it (or at least see it) afterwards.

Figure 5 - Reflective Journal Entry 30th May 2013

Being semi-structured in nature, each interview covered similar ground, although there was flexibility to discuss any individual issues that arose. From the outset of the interview process, I had subconsciously assumed that the students would present as a unique group of learners, being clearly defined by having very specific requirements and criteria that would optimise their learning. After completing the first couple of interviews however, it

became apparent that this premise was flawed; each student appeared to have less in common with each other than I had assumed. However, although the students presented as a heterogeneous group of learners, they collectively agreed on many points during their interviews which are discussed later.

Once transcribed, all audio recordings of these interviews were analysed using Braun and Clarke's (2006 p. 87) six stage process of thematic analysis as described in section 3.7. The thematic analysis generated by this process is detailed in figure 6.

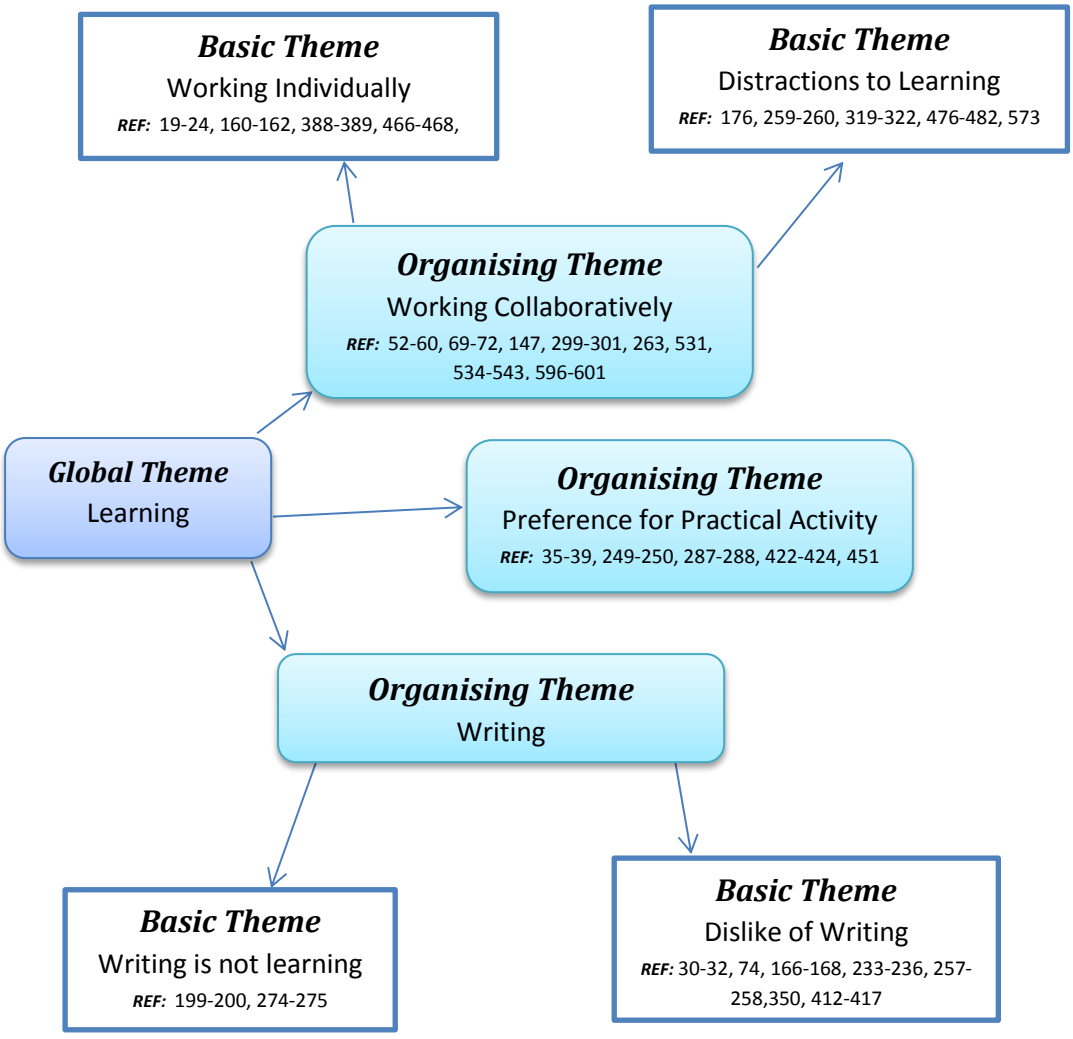


Figure 6 - Thematic Analysis Generated from Reconnaissance Interviews.

The diagram shows that the analysis of the interview data yielded a global theme of learning, which was comprised of three organising themes–'Working collaboratively', 'Writing' and a 'Preference for practical activity'. Data for two of these organising themes was further divided into two basic themes. The numbers in each box represent the lines in the raw data where the codes representing each theme are located.

According to Braun and Clarke the final phase of the process of thematic analysis is for the researcher to:

> tell the complicated story of your data in a way which convinces the reader of the merit and validity of your analysis. It is important that the analysis provides a concise, coherent, logical, non-repetitive and interesting account of the story the data tell. (Braun and Clarke, 2006 p. 93)

The three sections that now follow 'tell the story' of the data, offering analysis and discussion that supports each of the identified themes from the above process. Spoken words taken from original transcripts are highlighted by the use of italics.

4.1.1 Practical Activity

During their 10-15 minute reconnaissance interview, each student was shown the five images, depicting different learning styles and were asked to rank them in order of preference.

Image 1 - Working on a laptop

Image 1 - Students working from a textbook

Image 3 - Practical activity

Image 4- Teacher exposition

Image 5 – Discussion

An almost universal preference for learning through practical activity (Image 3) was indicated by the students during these interviews, this opinion was expressed through comments such as:

> *I much prefer practical to paper work. I think I learn from doing* (Clayton First Interiew)
> *I just prefer to get on with learning the practical way.* *(*Rhys First Interview)

As can be seen from table 6, practical learning was ranked as first or second choice by six of the seven students as a way that they would like to learn.

Name	Clayton	Damien	Kat	Keeley	Poppy	Rhys	Robbie
Favourite	Practical	Textbook	Discussion	Practical	ICT	Practical	Practical
	Discussion	Teacher Led	Practical	ICT	Practical	ICT	Discussion
	ICT	ICT	ICT	Discussion	Teacher Led	Teacher Led	ICT
	Teacher Led	Practical	Teacher Led	Textbook	Discussion	Textbook	Teacher Led
Least Favourite	Textbook	Discussion	Textbook	Teacher Led	Textbook	Discussion	Textbook

Table 6 - Students' Rankings of Their Own Preferred Learning Style

This preference, for practical learning, is consistent with previous research findings that students identified as having BESD prefer to learn this way:

> Pupils with BESD tend to favour the concrete experience and active learning styles. These learning styles are most useful in circumstances where tasks are experimental in nature: where learning emerges from doing.
>
> (Cooper *et al.*, 2005 p. 119)

Discussion (Image 5) received a mixed response from students (highlighted in yellow and underlined in table 6). In analysing their interview responses to this issue it would seem that some students saw discussion as a way of avoiding having to write, whilst others disliked the idea of having to interact socially, as expressed below:

> Me*:* *Thinking about how you learn, if you had to pick one of these pictures as your favourite way to learn maths, which one would you choose?*
> Kat: *This one* [Image 5], *less writing more talking.*

and:

> Damien: *I know which one I don't like, this one* [holding up Image 5].
> *I just prefer working on my own.* (First Interviews)

It is interesting to note that Damien's ranking of learning styles was broadly opposed to those of his peers. He would appear to prefer more transmissional and passive approaches to learning, such as the use of a textbook or teacher-led lessons which were scored much lower by the other students. In fact, the use of textbooks was ranked as the least favourable way to learn, being placed in the bottom two by all the other students. Yet the TIMSS -Trends in International Mathematics and Science Study (2012) reported that in schools across the UK, the textbook is still the most popular method of teacher instruction (27%) with worksheets or workbooks accounting for 21% of teaching time as the main resource (Mullis *et al.*, 2012 p. 394). This mismatch between these learners preferred learning style and the predominance of passive teaching styles could be a contributing factor towards their difficulties in learning in previous schools.

A preference for practical learning was further affirmed when students were asked the following question - In which of these five pictures do believe mathematical learning is taking place? Students indicated that they felt the picture representing practical activity (Image 5) portrayed 'learning' mathematics, more than any of the other given scenarios, as shown in table 7.

	Robbie	Clayton	Damien	Kat	Keeley	Poppy	Rhys	Total
Practical activity	✓	✓	✓	✓	✓		✓	6
Teacher exposition	✓		✓	✓	✓	✓		5
Discussion	✓	✓	✓		✓	✓		5
Students working from a textbook	✓		✓			✓		3
Students working on laptops						✓		1

✓indicates that the student believed that mathematical learning was taking place in the image.

Table 7 - Summary of Student Responses to the Question:
In which of these five pictures do believe mathematical learning is taking place?

In summary then, the majority of students indicated a preference to learn through practical activity and more importantly that they saw this as learning. It is interesting to note however that Poppy was the only student who considered ICT as a possible way of learning mathematics (See Table 7). It would seem that students like to use technology, but do not consider it to be learning or have possibly not experienced learning using this approach before.

Researchers such as Ollerton (2009) and Triadafillidis (1996) point out that practical approaches to learning mathematics are only used sporadically in secondary schools. This view was articulated by Robbie during his interview:

Me: *How about this picture here, practical learning?*
Robbie: *Yeah, they're learning but it's more for young ones.*
Me: *You think that it is only younger children that learn this way?*
Robbie: *Yes, you know like all that stuff with the robot that draws the squares on the floor. Drawing shapes and making things with cubes, you know the ones that click together. It's what I did at primary school, you don't ever see older kids playing with blocks.*

(First Interview)

Triadafillidis (1996) suggests that a lack of time due to curriculum demands, pressures on teachers to have calm and quiet classrooms and difficulties in obtaining practical equipment were the main reasons cited for not utilising 'hands-on' approaches in secondary school mathematics lessons.

> The decision not to use practical activity seems to be supported by arguments that draw not particularly on their effectiveness in promoting learning, but mostly on functional difficulties caused by their use as a teaching aid.
>
> (Triadafillidis, 1996 p. 162)

Ollerton (2009 p. 109) further cites government league tables and 'teaching to the test' as two major factors that have led to the decline in practical approaches to teaching mathematics.

There is an added tension or reluctance to use practical equipment when working with students who are prone to damage or mistreat equipment (Keddie, 2007 p. 55). An example of this was evidenced during the reconnaissance lesson, when Kat threw a pair of scissors across the classroom. The implementation of a practical interventional approach therefore needed to navigate a fine balance between providing physical resources whilst reducing the possibility of any destructive behaviours.

4.1.2 Writing

Cefai (2010) reports that students with BESD tend to dislike lessons that are restricted to written work and Lane (2004 p. 475) further suggests that 'writing is a subject area that students with BESD show much aversion to'. This view was reflected by the group of students who took part in this study. My prior experience of teaching this group is that they are reluctant to write. When asked to write even a few sentences, there is an almost audible sigh in the room, as though writing is some form of teacher administered punishment. Although there were no specific questions regarding writing in the reconnaissance interviews, the issue was brought up by five of the seven interviewees. For example, Rhys commented:

> Rhys: *Why do we have to do writing in maths? I mean we never get asked to work out sums in the middle of an English lesson do we?*
> Me: *Well I suppose not, but don't you use maths in other lessons, like Science?*
> Rhys: *Oh yeah, you mean like drawing graphs and things, sometimes we do. But we still have to do writing in Science, it's not fair we do English in all lessons apart from PE.* (Research Journal Entry, December 2013)

Although in this extract Rhys acknowledges the importance of writing as it is required across many subject areas, he does not necessarily conceptualize it as being synonymous with learning.

Me: *Do you think that the students in this picture are learning?*
Kat: *No they are writing stuff down. There just copying stuff out of a book.*

(Kat First Interview)

Kat's comment resonates with Douch's (2015) suggestion that sometimes teachers use 'copying from the board or book' as a way of keeping 'students seated, quiet and under control.' When asked during her interview what made learning difficult for her, Kat responded, *'Writing, cos I get bored and then I go off-task and then I talk.'* Although some students indicated that they did not see note taking as a useful learning tool, the value of informally jotting down relevant information was acknowledged by the some of the students.

If I want to work out a maths question then I prefer to write it out on a bit of paper.
(Damien First Interview)

and: *I learn a little bit better when I write things down.*
(Rhys First Interview)

As Rhys commented during his interview, if knowledge is not recorded in written form, then learning is not retained:

Rhys: *the teacher is showing them what it is yeah, but then for that minute they know what they are doing, and then if they haven't got a good memory and they don't write anything down, then they aren't learning.*
Me: *So do think learning is about remembering?*
Rhys*: Yes, if you don't remember anything you don't learn anything.*
(Rhys First Interview)

It would appear then that writing is only considered to be of value if it is to aid short term memory. Learning and memory are obviously very closely related to each other. Learning depends on memory for its permanence and memory would have no content without learning (Gross, 2010 p. 256). However, whether the students see writing as a useful aid to memory or part of any learning process is uncertain. When designing the intervention, careful consideration was taken to make explicit the purpose of any task that involved the use of writing.

4.1.3 Working Collaboratively

During their initial interview, all seven students stated that they preferred to work on their own. Previous research concurs with this finding, reporting that students categorised as having BESD are not naturally sociable and prefer to work independently (Wagner *et al.*, 2006). Research also suggests that students diagnosed with ADHD experience many social interactional difficulties (Staikova *et al.*, 2013) and frequently engage in creating negative peer relationships (Wehmeier *et al.*, 2010). It is not surprising then that students unanimously expressed this preference of working alone. When students were asked what made mathematics difficult for them, the majority of students cited other students' disruptive behaviour as a major factor. As Kat said:

> *I find it hard when people distract you, then you start talking then you forget what you are doing.* (Kat First Interview)

However students gave a variety of reasons for preferring to work independently.

> Me: *You've said that you wouldn't like to work as part of a pair, why is that?*
> Damien: *Because they would slow me down. I like to work at my own pace, I can't be waiting all the time for someone else to catch me up.*
> (Damien First Interview)

and:

> Me: *What do you find makes learning maths difficult?*
> Poppy: *The people in my group. I don't like them, they think I like them but I don't. I'm civil to them, I have to be, I see them every day.*
> (Poppy First Interview)

However, learning in isolation from other students is at odds with cooperative practices (Swan, 2005). Mathematics classrooms where students are actively encouraged to interact with each other provide the opportunity to construct meaningful knowledge together and to share the responsibility of learning ideas (Yackel *et al.*, 1990 p. 34). As Clayton commented:

> *Well, if Damien explained something to me, I would think about it, it would be a big difference to you explaining. A good friend explaining is different. You know they will have time to explain it. You don't know a teacher as well. So yes it would make a difference.* (Clayton First Interview)

Clayton articulates that he finds an explanation from a peer much easier to understand as his relationship with them is different to that of an adult. It is when a student is in their Zone of Proximal Development that learning occurs, but this situation requires cooperation between both the learner and the more knowledgeable other. For this

process to be successful, students need to demonstrate a certain level of social competence and a willingness to work together. This collaborative process can sometimes be difficult to create or maintain due to disruptive or asocial behaviour. The following extract is of a conversation that took place during the reconnaissance lesson and shows how quickly a disruptive episode can erupt and then be instantly forgotten!

Robbie:	*How many have you done now?* [to Rhys]
Rhys:	*All of them*
	[Kat starts counting her shapes]
Kat:	*1, 2, 3, 4, 5 ……*
Robbie:	*Oi! You're getting me messed up man, allow it* [shouting at Kat]
	[Kat throws her scissors and walks out the room and is followed by the LSA]
Robbie:	*I really don't like her.*
	Right, so basically I've got 3, 6, 9 done. I swear I've done that one.
Rhys:	*Done, done, done, done. I think I got all them shapes now Sir.*

(Reconnaissance Lesson)

It is therefore crucial to focus not only on the individual behaviours of students, but also on their peers' behaviours towards them. One of the greatest challenges of teaching students identified as having BESD is in managing negative social interaction. Often students exhibit a lack of respect towards one another which can manifest itself in either verbal or physical assaults making collaborative approaches difficult. In my professional experience this type of incident is commonplace in BESD classroom settings and as Strayer (1987) notes, students categorised as having BESD can be poor at judging the emotions of others and in their empathic response.

4.2 The Reconnaissance Lesson

Purpose of Lesson

Building on the findings from the students' interviews and the literature reviewed, a lesson involving practical activity was chosen that did not necessitate students having to complete any written work. Although the task could be completed by students independently, it was also selected in order to create a situation where cooperation and social interaction would make the tasks completion easier. The class were divided into two groups, three students in each. This decision was also taken to encourage collaborative working practices as a smaller group would give students more opportunities to talk and be heard.

The Activity

The task was introduced to the students simply as: '*There are twelve possible ways to join five squares together, however squares cannot be joined diagonally at the corners. How many can you find?*' These shapes are known as Pentominoes and are shown in figure 7.

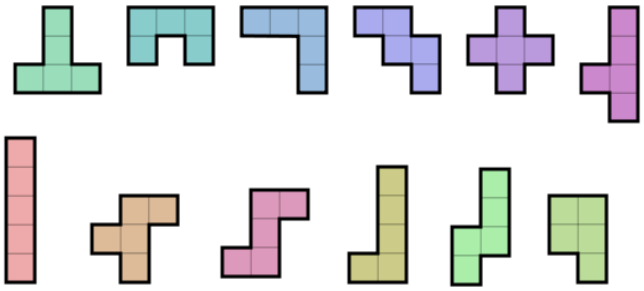


Figure 7 - The 12 Pentominoes

The students were given 3 cm squared coloured card, felt tips and scissors. Once the students had drawn and cut out all twelve shapes, the second part of the lesson was to fit the shapes together to form a rectangle (see figure 8).

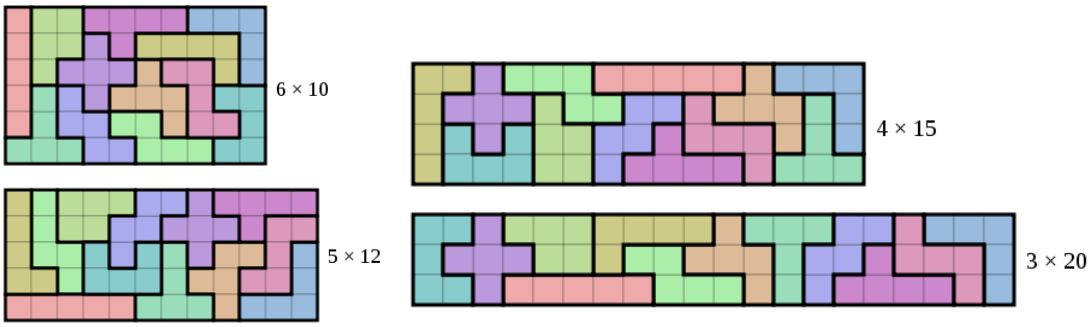


Figure 8 - Possible Pentomino Arrangements

Since I had divided the students into two groups to complete this task, the classroom tables were pre-arranged to form two separate working areas. Rhys, Kat and Robbie worked together in one group, with Poppy, Keeley and Damien in the other. The lesson was one hour long and 10 minutes of conversation between the first group of students was recorded whilst they completed the first part of the activity. The second group's conversation was then recorded during the second part of the lesson. This was done to ensure that all students felt included and were part of the research process and that they all had the opportunity to contribute equally to the data captured.

Unfortunately Clayton did not attend this lesson as there had been an incident between him and Kat in the previous lesson. My Learning Support Assistant left the lesson to find Clayton who was wandering in the corridor. She attempted to coax him into the lesson, but unfortunately she was unsuccessful. Due to the incident in the previous lesson, the group were livelier, louder and more unfocused than usual.

Learning Collaboratively

Once the students had calmed and the activity had been explained to them, the two groups instantly became very competitive with each other, wanting to be first to find all of the 12 shapes. I had hoped that the students would have shared their answers with each other within their group. However, the group dynamic was not sustained as individuals became competitive with each other.

Rhys: *You was looking at Kat's work to see if she had any that you didn't have.*
Robbie: *No, I was only counting them up, just to see if I had more than her. I got all her ones. Look I got all these ones if you don't believe me.*
Rhys: *Could we work together?* [directed at Kat]
Kat: *No, I'm just going to colour mine in! It's a bit hard this isn't it?*

(Reconnaissance Lesson)

Behaviours such as hiding work from each other and arguing about answers prevailed. In reflecting on whether the lesson encouraged cooperative problem solving between students, it was certainly easier to comment on the visible behaviours exhibited, rather than to make a judgement about students' learning. For example, during the lesson Kat threw a pair of scissors across the room and walked out of the lesson twice. There was also abusive language and shouting.

Kat: *You think everyone is scared of you Robbie.*
Robbie: *Yeah, you know it. Everyone is scared of getting slapped across their nose. Don't make me pull the trigger man.*
[Making his fingers into the shape of a gun]

and:

Rhys: *Stop putting all your rubbish here next to me. That's not my rubbish. Robbie, you got to put that in the bin.*
Robbie: *No, here's my mess here, so f**k you!*

(Reconnaissance Lesson)

Keddie (2007 p. 59) suggests that if students identified as having BESD do not get the attention they require instantly, they can often become disengaged and disruptive very quickly. It is often a difficult balancing act, when students are working together, to know when to intervene and provide support and when to let students persevere with a challenging piece of work. For example, during the reconnaissance lesson, Robbie began shouting at Rhys when he could not find the last of the twelve shapes.

Robbie: *I've only got three more to get.*
They're not very well drawn, but you get the idea.
Done, 2, 4, 6, 8, 10 [counting shapes on sheet] *... s**t.*
Well, I'm nearly done.
Rhys: *You've got two more to find Robbie.*
Robbie: *HELP ME THEN* [shouting at Rhys]
[I draw the missing shape on the board for Robbie to copy]
Robbie: *Ah, I got it now.* (Reconnaissance Lesson)

Although Robbie was asking Rhys to help him, the aggressive manner in which the request was made, makes it unlikely that this will result in a collaborative experience for either student. It is sometimes easier to give a frustrated student an answer, rather than let them work it out for themselves, in order to maintain the status quo of a positive learning environment. Working together, for students with BESD therefore, can mean a compromise of teaching ideals in order to reduce negative learning experiences of anxiety and annoyance.

There were however, during the lesson, some examples of peer conversations that focused on learning that developing understanding.

Kat: *If you move that square from here to there, it will be different* [to Rhys]
Rhys: *No it won't*
Kat: *Yes it will, if you cut it out and turn it around and around, it will never be the same as the others, will it?*
Rhys: *Yes, if you flip it over, then turn it upside down it's the same as that one.*
[Rhys points at one of his shapes] (Reconnaissance Lesson)

Overall the reconnaissance lesson suggested, not that students identified as having BESD cannot work cooperatively, but possibly that they lack the necessary social skills to be able to do so. It became obvious that just by providing a task that encouraged students to work together did not necessarily result in the students exhibiting any such cooperative behaviours. By the end of the lesson, Kat was the only student who had not managed to find all twelve pentomino shapes. None of the students managed to form the shapes into a rectangle.

4.3 Implications Drawn from the Reconnaissance Stage

Analysis of data collected from both the individual students' interviews and the reconnaissance lesson, would suggest that the students within this study prefer to learn on their own and through practical-based activities. This is consistent with previous research that indicates that students identified as having BESD are reluctant to complete writing tasks if the purpose is not clear (Lane, 2004, Cefai, 2010). It is also acknowledged that the disruptive behaviours that are often associated with BESD not only affect a student's own learning, but can also impact negatively on that of their peers (Cooper, 2007 p. 159).

The chosen methodological approach of this study was that of action research, as it is concerned with bringing about a positive change in a social situation. Hopkins (2014) defines action research to be:

> action disciplined by enquiry, a personal attempt at understanding while engaged in a process of improvement and reform. (Hopkins, 2014 p. 58)

It is through the intervention stage that change (action) will be implemented, based on the findings of the reconnaissance phase (research). Table 8 provides a summary of how the findings from both the literature review and reconnaissance stage informed the design of the intervention.

Previous Literature	Findings from Reconnaissance	Implications for Intervention
Collaborative / Active Learning In a meta-analysis of over 100 studies, entitled 'What Works in Teaching Maths? ' **Slavin *et al.* (2009 p. 43)** conclude that the most successful mathematics programmes encourage student interaction, particularly the use of collaborative learning methods.	During reconnaissance lesson, students worked competitively rather than collaboratively.	Lesson activities designed to be easier to complete with assistance from others. Not teacher led, but student centred and student driven.
Practical Learning Students identified as having BESD tend to favour learning that emerges from doing **(Cooper *et al.*, 2005, Cefai and Cooper, 2010)**.	During interview, 6 out of 7 students ranked 'Practical' as their first or second preferred learning style choice.	'Hands-on' approach involving out-of-seat activities using practical equipment in an experiential approach.
Literacy Difficulties Writing is a subject area that students with BESD show much aversion to **(Lane, 2004)**. Studies have shown that BESD and literacy difficulties commonly co-occur **(Brownlie *et al.*, 2004, Nelson *et al.*, 2005)**.	Clayton, Kat, Keeley and Rhys all demonstrated a negative response to completing writing tasks during their interviews. Students' attainment levels for literacy show that all are working below both the national and BESD average (see Table 2, page 34).	Students only required to write answer and any working out in note form or pictorially, as required. Worksheets pre-printed with relevant texts included.
Social Interaction Students diagnosed with ADHD often have social interactional difficulties **(Staikova *et al.*, 2013)** and frequently engage in creating negative peer relationships **(Wehmeier *et al.*, 2010)**. Students identified as having BESD prefer to work independently **(Wagner *et al.*, 2006)**	In responses to the question What do you think makes learning maths difficult for you? Three students cited other students' disruptive behaviour. During their initial interview, all seven students expressed a preference to work on their own.	Consider student groupings and deployment of LSA. Tasks designed to encourage collaborative learning.

Table 8- How the Literature Review and Reconnaissance Findings Informed the Development of the Intervention.

5. Data Analysis: Intervention Stage

This chapter begins by discussing the area of the GCSE Mathematics curriculum that was delivered during the intervention stage, which was the topic of estimation. Following this, consideration is given to how the intervention was designed to address each of the issues that had emerged from the reconnaissance phase. Next, details of the seven activities that formed the intervention are discussed and analysed. The lesson plans and resources used for these activities are included for reference as Appendix 5. Presentation and analysis of the data collected within this stage of the study are included within the discussion of each individual activity. The concluding section then discusses the key issues that emerged from this interventional stage.

5.1 Area of the Curriculum covered by the Intervention

The students participating in this research sat GCSE Mathematics at the Foundation Tier in June 2014. The awarding body was Edexcel. The topics that were covered during the term are detailed in the scheme of work which is included for reference as Appendix 6. The area of learning that formed the focus of this intervention was 'Making sensible estimates of a range of measures.' (Edexcel, 2012 Foundation p. 25, Higher p 57) which is examined on both the Higher and Foundation tier of entry. Examination questions which are designed to assess this topic at Foundation level, take the form shown in figure 9.

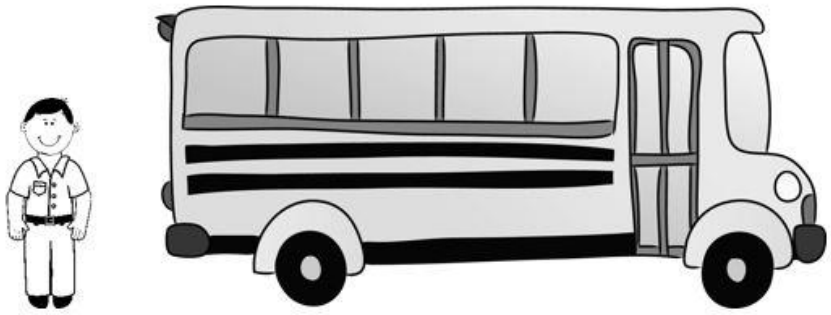
Complete this table.

Write a sensible unit for each measurement.

	Metric	Imperial
The length of a pencil	centimetres	
The weight of a tomato		ounces
The amount of milk in a bottle		pints

(Total 3 marks)

or:



The diagram shows a man and a bus.

The man and the bus are drawn to the same scale.

The man is of average height.

(i) Write down an estimate for the height of the man.

.....

(ii) Find an estimate for the length of the bus.

.....

(Total 3 marks)

Figure 9 – Style of GCSE Questions on Estimation

Being able to estimate quantities is a skill that comes with experience and is used sub-consciously almost daily by adults; it is however a skill that can be learnt (Joram *et al.*, 1998 p. 413). Generally speaking, the concept of estimation is understood to be the 'skill of making an educated guess as to the value of a distance, cost, size, etc. or arithmetic calculation' (Clayton, 1996 p. 87). The topic of measurement estimation was chosen as the focus of the intervention stage for two reasons. Firstly it lends itself naturally to practical activity and secondly, because it does not rely on the concept of right and wrong answers. Students categorised as having BESD often have low self-esteem and self-confidence (Cole and Knowles, 2011 p. 59) and any new mathematical learning that exposes students to an increased risk of making mistakes and of being 'wrong' may only serve to further exacerbate these issues. By reducing or removing the chance of 'getting it wrong', it was envisaged that the students would rely less on their need to gain teacher validation of the correctness in their answers.

5.2 Overview of the Intervention Activities

This section gives the detail of the seven activities that were carried out by the students during the intervention stage. The activities varied in duration as some were lesson starter activities and others formed the main part of the lesson. They were delivered over the course of six lessons, separated into three parts:

1. The first two activities were completed within the first one hour lesson. 'How long is a Minute?' as a lesson starter activity and 'Measuring and Estimating Every Day Objects' was the main learning focus.

2. The second group of activities commenced in lesson two which consisted of a further two activities, a starter task 'Who is the Tallest Person?' and 'Creating a Floor Plan' which was the main part of the lesson. However, this activity over-ran into a further two lessons. The activity 'Metric and Imperial Measurements' was therefore designed as a further starter for one of these additional lessons.

3. The intervention stage concluded with the final two activities 'Numerosity' a short starter task and 'Impossible Questions' which took two lessons for students to complete.

The intervention was carried out over a two-week period and the ordering of the activities is summarised in table 9.

Lesson	Starter Activity (5 – 10 minutes)	Main Activity (50 – 55 minutes)
1	How long is a Minute?	Measuring and Estimating Every Day Objects
2	Who is the Tallest Person?	Creating a Floor Plan
3	Metric and Imperial Measurements	Creating a Floor Plan
4	Creating a Floor Plan	
5	Numerosity	Impossible Questions
6	Impossible Questions	

Table 9 - Sequence of Intervention Activities

The presentation, analysis and discussion of each of the individual activities is considered together under each chapter division to aid clarity and coherence. Each section concludes with a summary of the key issues raised within the activity.

5.2.1 Activity 1: How long is a minute? (Starter)

Activity Overview

In this first activity students were asked to estimate how long they thought a minute was. The task was designed as an introduction to the topic of estimation and measurement and to develop students' awareness of time. Students were asked to sit quietly, with either their eyes closed or with their heads down. I informed the group that I would start a stopwatch and say 'Go' to begin the timing of a minute. When they thought that a minute had passed, they were to raise their hand without making a sound and their time would be recorded by the LSA on the whiteboard. When all students had finished, the class would then compare their results to see who was the closest.

This task required students to cooperate and be respectful towards each other, otherwise the activity would not have worked. This was however achieved and students waited quietly until everyone had finished the task. Interestingly, there was no shouting out – a behaviour often associated with BESD (APA, 2013 p. 461) The activity became very competitive, with students trying to be the closest in estimating a minute.

Me: *Well done everyone, you were all pretty close.*
Damien: *But who was the closest though?*
Me: *I think Keeley was the closest because she was just over by 2 seconds.*
Keeley: *So I win?*
Clayton: *No she went over; I was 8 seconds under, so I win.*
Me: *But Keeley was the closest to 60 seconds, we didn't agree about which way.*
Clayton: *Ok, let's do it again. Come on sir, I want a re-match.*

(Transcription of First Activity)

Competitiveness manifested itself on two levels, for Damien and Clayton it was to beat others in being the closest in estimating a minute, whereas for Robbie, Keeley and Rhys it was about bettering their own personal attempt. The extract below records the group's conservation after completing a second attempt of this activity and indicated individual students' intrinsic and extrinsic motivation for wanting to complete the activity again.

Robbie: *Errr, yes I was closer.*
Keeley: *Everyone was closer, but not me.*
Clayton: *I was spot on, you can't get closer than me.*
Rhys: *I'm two seconds better than last time, but still miles off a minute.*
Damien: *Just two seconds off sixty, that makes me second place.*

(Transcription of First Activity)

Scott (2014 p. 162) reminds us that 'discussion is most effective when it is not competitive but collaborative.' However, competition between students did not prevent them from sharing and discussing their strategies for estimating a minute:

Damien: *What I do is, I was counting in my head one one, two one, three one, four one. No look, if you go one and then another one the clock moves one space, because the one is the gap that it takes.*
Robbie: *No innit, what I do right, I counted to 50, so I need to go a little bit higher in my mind next time cos I was under a minute.*
Clayton: *One Mississippi, two Mississippi, three Mississippi.*
Let's do it again. (Transcription of First Activity)

Although in this extract, all three students share a broadly similar strategy for estimating a minute of 'counting in their head' there is no interrupting or talking over each other which enables each student's contribution to be shared. During this cumulative conversation (Mercer, 1995), the other students appeared to be actively listening to the discussion thereby making 'talk' a valuable classroom tool in developing understanding.

Talk also enabled students to confirm their understanding. In the conversation below, Poppy is confused as to why a digital clock displaying milliseconds changes quicker than the second hand on an analogue classroom clock.

Poppy: *Yeah, but see that …*
[points to online stopwatch displayed on interactive whiteboard]
… it goes faster than the clock on the wall.
Rhys: *No it doesn't, it's the same time. A minute is a minute.*
It's just that that clock has milliseconds on it as well and they are not on the wall clock, so it looks like it's quicker.
Poppy: *Oh yeah, suppose.* (Transcription of First Activity)

Although this conversation was between Rhys and Poppy, all of the other students paused and listened to Rhys' explanation. Poppy's misconception was publicly corrected by Rhys and his explanation was accepted by the group.

As an introductory activity to the topic of estimation, this task provided students with the opportunity to grasp and then practice estimation skills. According to Joram *et al.* (1998) the ability to estimate improves over time and with practice. As can be seen from the table 10, all students with the exception of Keeley improved their accuracy in estimating a minute.

	1st Attempt	2nd Attempt	Improvement
Clayton	52 seconds	60 seconds	8 seconds
Poppy	38 seconds	74 seconds	8 seconds
Robbie	47 seconds	56 seconds	7 seconds
Rhys	45 seconds	47 seconds	2 seconds
Damien	64 seconds	62 seconds	2 seconds
Keeley	62 seconds	68 seconds	-6 seconds

Table 10 - Students' Estimates of a Minute

Whether their motivation was intra- or inter- personal, nearly all students demonstrated the ability to refine their estimation strategy to improve their accuracy in estimating a minute.

5.2.2 Activity 2: Measuring and Estimating Every Day Objects (Main)

Activity Overview

This activity required students to firstly make an estimate and then measure various quantities within the classroom such as the height of their desk or the weight of a textbook. Once the students had recorded their estimate, along with their chosen units of measurement, they were then asked to measure the quantity by selecting an appropriate measuring instrument. Their answers were then recorded on a prepared worksheet.

Students were provided with a variety of measuring tools such as a trundle wheel, tape measures, one metre and 30 centimetre rulers, electronic weighing scales and stopwatches as well as access to the internet via laptops. In an attempt to encourage cooperative working strategies, some of the quantities that the students were asked to measure were deliberately chosen to be easier to measure by working together – for example, measuring their own height.

This activity focused on developing students' skills in estimating lengths, weights, passage of time and money and as can be seen from figure 11, the questions were carefully grouped and organised into a sequential order. For example, when grouping weight questions together, the first quantity (ruler) was lighter, the second (textbook) heavier than the third measurement (newspaper). This design allowed students to be able to compare the next measurement with their previous observations. The first measurement served as a benchmark for estimating the second weight – e.g. is about five times heavier. The first and second measurements then provided an upper and lower range for their estimate of the third weight. As a consequence of the task's design, students were instructed to make their estimate then measure each quantity before moving on to the next question and not to complete all of their estimates before carrying out any measurements.

The sequential ordering of the estimates in this activity however created the need to keep the group working together on the same question to prevent one student's estimate being influenced by another student's actual measurement. This however was not achieved as I recorded (see figure 10) in my reflective journal at the time.

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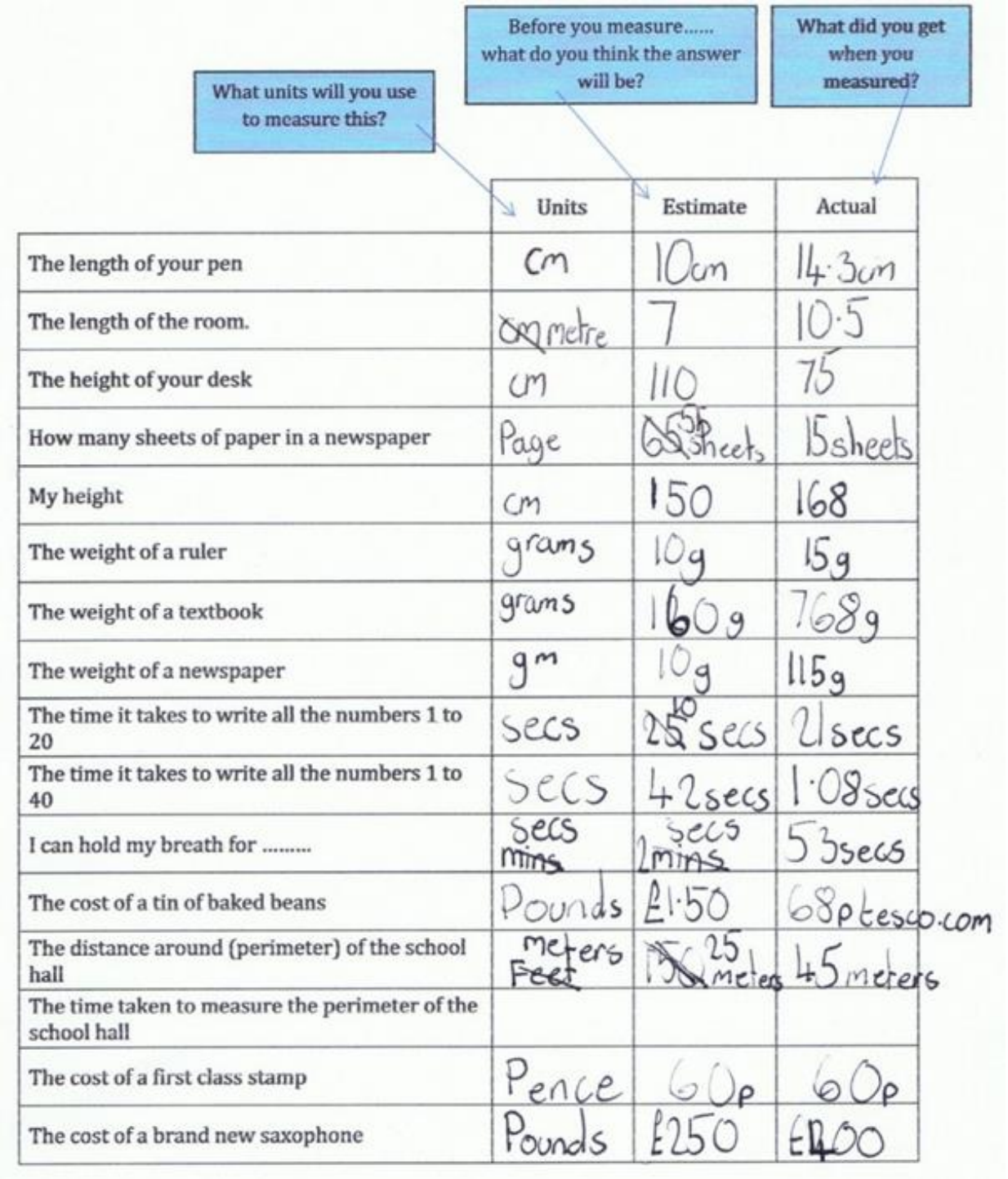
Both Rhys and Robbie felt the need to communicate their estimates out loud rather than recording them on their worksheet. However, once they had actually measured the item, this information wasn't publicly broadcast.

Figure 10 - Reflective Journal Entry 20th January 2014

The prepared worksheet which was completed by Poppy is shown as figure 11.



	Units	Estimate	Actual
The length of your pen	cm	10cm	14.3cm
The length of the room.	~~cm~~ metre	7	10.5
The height of your desk	cm	110	75
How many sheets of paper in a newspaper	Page	~~65~~ 55 sheets	15sheets
My height	cm	150	168
The weight of a ruler	grams	10g	15g
The weight of a textbook	grams	160g	768g
The weight of a newspaper	gm	10g	115g
The time it takes to write all the numbers 1 to 20	secs	~~25~~ 10 secs	21secs
The time it takes to write all the numbers 1 to 40	secs	42secs	1.08secs
I can hold my breath for	~~secs~~ mins	~~2mins~~ secs	53secs
The cost of a tin of baked beans	Pounds	£1.50	68p tesco.com
The distance around (perimeter) of the school hall	meters ~~Feet~~	~~150~~ 25 meters	45 meters
The time taken to measure the perimeter of the school hall			
The cost of a first class stamp	Pence	60p	60p
The cost of a brand new saxophone	Pounds	£250	£400

Figure 11- Poppy's Worksheet

The impulsivity of 'calling out answers' is one of the diagnostic criteria used to define BESD (APA, 2013). However Rhys and Robbie's behaviour served two very useful purposes, apart from being a possible way of avoiding having to write their answers down. Firstly it presented an opportunity for other less confident students, such as Clayton, to verify whether their own estimate was reasonable. Secondly, it served for them, a public way to seek affirmation of their own thinking. This calling out or thinking aloud seemed to bind the group together despite its apparent contradictory nature and appeared to somehow closely intertwine thinking between group members. Although shouting out answers could be seen as a lack of self-control, it can also serve as a mechanism of developing 'inter-thinking' (Littleton and Mercer, 2013) amongst students.

Talk as a Tool to Develop Learning

Throughout this activity, talk was seen to serve three distinct and essential purposes to aid student learning and understanding. These were developing thinking through verbalisation, explaining reasoning and confirming understanding, all of which Mercer (1995) argues are characteristic of exploratory talk. The exemplification of each of these uses of talk are now considered in more detail below.

Developing Thinking through Verbalisation

The process of thinking out loud can strengthen understanding, as 'it is through our capacity to verbalise that thinking, awareness and understanding develop' (Fisher, 2008 p. 106). Below is an example of how Rhys used talk to verbalise his thought processes of how he had estimated the number of sheets of paper that were in a newspaper.

Rhys: *I just look at the number on the last page and then divide it by two. That's my estimate.*
Me: *Why are you dividing it by two?*
Rhys: *Because each sheet has a front and back. Oh no hang on, I need to half it again, there are four pages on one sheet.* (Transcription of Second Activity)

In this extract, Rhys verbalises the technique that he used to arrive at his estimate, however when questioned he realised his error. It is through the process of articulating his thinking that Rhys was able to reflect and then alter his answer.

Explaining Reasoning

Talk was also used to explain reasoning, as in the following extract, Rhys justifies his explanation of how he calculated the height of the desk to Robbie:

Rhys: *I know my pen is about 15 centimetres from when I measured it before. So if my desk is 5 pens high then my estimate is say 5 times 15. What is 5 times 15?*
Robbie: *That's 75 centimetres. Do you want to measure it for real?*
Rhys: *No we got it, it's 75.* (Transcription of Second Activity)

The estimation strategy that Rhys described is defined by Hildreth (1983 p. 50) as 'Comparative' - where the object that is being estimated is compared to another whose dimensions are already known. Rhys demonstrates a clear conceptual understanding of the processes involved in estimation, which is an essential prerequisite to be able to reason mathematically. That is, competence in reasoning mathematically requires conceptual understanding.

Confirming Understanding

In the following exact. Robbie simply seeks confirmation of which units of measurement he should use to estimate the length of his pen:

Robbie*: It's about 5 or 6 inches.*
Me: *Ok, that's good, so write it down.*
Robbie: *Yeah, but is it right? The ruler has inches and centimetres on it, so can we choose?*
(Transcription of Second Activity)

Although Robbie was asking for confirmation of whether he should measure in centimetres or inches, an opportunity to discuss why both the metric and imperial measurement systems are still in use today was missed, as the conversation turned into what Mercer (1995) would describe as disputational talk:

Damien: *No, you have to measure your pen in centimetres not inches. You're not allowed to measure in old units any more. Mr [History teacher] said that now that we live in Europe, you've got to measure things in centimetres.*
Robbie: *That's crap, I'm English, I'm measuring my things in English units.*
(Transcription of Second Activity)

The conversation deteriorated into a dispute which carried on for several minutes about what it means to be British, the details of which were not recorded. Peer interactions between students identified as having BESD can sometimes be difficult to manage, with discussions becoming a distraction from the topic of intended focus.

Creating Dialogic Space

These three extracts illustrate how 'talk' can be used for different purposes. However, as the extracts show, classroom conservations were often scaffolded during this study, by an adult. Scaffolded dialogue or dialogic teaching, as defined by Alexander (2008 p. 37) 'harnesses the power of talk to stimulate and extend students' thinking and advance their learning and understanding.' Dialogic teaching is a pedagogical approach which involves students in the collaborative co-construction of meaning and is characterised by shared control over the key aspects of classroom conversation. However, when working with students identified as having BESD, consideration needs to be constantly paid to negotiating a balance between facilitating students' co-construction of knowledge through social interaction with a need to circumvent distractions and manage their learning environment. As has been described elsewhere in this study, conversations can quickly spiral into negative episodes due to the emotional vulnerability of the learners and these situations need to be managed immediately and effectively if learning is to progress.

Alexander (2008) suggests that when students are given the opportunity to contribute to classroom dialogue they can explore the limits of their understanding, which leads to deeper cognition. It was during the plenary session of this activity that a question was posed by Poppy that challenged the group's understanding of estimation that developed into a dialogic learning episode. The discussion that followed from her question tested the students' conceptual understanding that they had developed during this activity. It related to an incident that had occurred earlier, where Rhys and Clayton had counted how many steps (putting one foot in front of the other) as their 'estimate' for the length of the room:

Rhys:	*38 paces and 2 inches!*
Clayton:	*I've got 37 paces, we don't agree. I'll do it again.*
Damien:	*No you Muppet, your feet are not the same size as Rhys'.*
	Measure your foot and times it by 37 and you will get the same answer.
Keeley:	*Well that's not an estimate anyway.*
	You've just measured it using your foot.
Robbie:	*Yes it is a guess 'cos they didn't use a ruler to measure it did they!*

(Transcription of Second Activity)

It is clear from this extract that Rhys and Clayton consider using their feet as a guide is not actually measuring, because their foot size is an unknown quantity. Poppy's concern and the group's response were articulated thus:

Poppy: *Well estimating is guessing right?*
Me: *Yes.*
Poppy: *But then some people were measuring stuff, like without a ruler, but say with your foot. Well that's not guessing, that's working it out. It's like measuring with hand-spans, that's just measuring a different way.*
Me: *What do the rest of you think?*
Rhys: *I think guessing is having a rough idea, like comparing.*
Robbie: *Yeah, it's not measuring accurately; it's just what you think.*
[There is a pause in conversation]
If you don't know the measurements of the thing you are using to estimate with is, and you only used it as a guide then that is estimating.
Rhys: *Yeah, and if you know how big your foot is, then it is measuring.*
(Transcription of Second Activity)

This extract typifies the features identified by Alexander (2008) as being essential for dialogic learning, which are:

> collective, supportive and genuinely reciprocal; it uses carefully-structured extended exchanges to build understanding through cumulation; and throughout, children's own words, ideas, speculations and arguments feature much more prominently. (Alexander, 2008)

Here we can see that all six students contribute in debate and build a deeper understanding of their conceptual understanding of estimation. The distinction between measuring and 'estimating using a known measure' had become blurred during the lesson and Poppy's questioning was helpful in teasing out this issue. For Robbie and Rhys, it gave them an opportunity to demonstrate a quite complex conceptual point and provides evidence that they had both learnt during this task. They had correctly identified that using a quantity of unknown length (their foot) to guide their prediction of the length of the room was estimating. This method of estimation is known as unit iteration (Hildreth, 1983 p. 50)

Social Interaction

During this activity there were many 'missed' opportunities for students to work together. For example, in measuring the length of the room, Damien struggled to keep the end of the tape measure against the wall while he moved down the room. The tape measure wound itself up twice before he decided to put his foot on it. He did not consider asking other students to help, nor was it offered. It is difficult to ascertain whether this unwillingness to seek assistance was deliberate and consistent with his preference to work on his own. However, a reluctance to work collaboratively may be due, in part, to some students not appreciating the benefits of working together, or what is meant by this term. This was highlighted by Damien's comments recorded in the following extract, regarding the way in which Keeley and Poppy were working together:

> Damien: *Why don't you do it together, it would be easier?*
> Keeley: *Shut up, I've lost count now and we **are** doing it together, we're both measuring the room at the same time aren't we?*
> Damien: *Yes, you're doing the same thing, but you're doing it separately, on your own.*
> [Poppy whispers to Keeley when they have finished measuring and then both sit down and write their answer down.]
>
> (Transcription of Second Activity)

In general, Damien usually opts to complete tasks independently of the other students in the class, as was demonstrated earlier when he struggled to measure the length of the room with a tape measure on his own. However, it is interesting to note that he is the one who commented and identified the advantages of working collaboratively when observing Poppy and Keeley's attempt at completing the same task. If Damien can recognise the benefits of collaborative working practices, then his preference of working alone could be due to other factors such as lacking the necessary social skills required to orchestrate collaboration or a possible fear of rejection from his peers.

Although Keeley and Poppy had both used a metre ruler to measure the length of the room, they did not consider placing their rulers end-to-end as a way of marking their position in the room, preferring instead to work separately. It would seem from this extract that Keeley and Poppy consider 'working together' to be two individuals completing the same task, at the same time, but independently of each other. Collaboration in this task comes through agreeing and sharing their answer with each other and not through the completion of the task. On reflection, I had wrongly assumed that the mechanics and purpose of pair work were implicitly known and commonly understood; however for students identified as having social difficulties, this may not be the case.

5.2.3 Activity 3: Who is the Tallest? (Starter)

Activity Overview

Once all the students had arrived to the lesson and were seated, this task was introduced as the starter activity for this second lesson on estimation. The students were asked to guess and write down the correct order of their heights, shortest to tallest. Students would then check their ordering by sharing their results from the previous lesson, where they had measured their heights.

Although this task was planned as a five-minute starter activity, it was completed within less than a minute. Robbie and Clayton instantly called out the correct height order of the group without even having to pause and think about their answer.

Clayton: *Well that's pretty easy. Rhys is smallest, then her - Poppy, Damien, Robbie then Keeley and I'm tallest.*
Robbie: *Yeah, Rhys, Poppy, Damien, errr me then Keeley, then you.*
(Transcription of Third Activity)

On reflection, this group of students spend every school day together and are possibly very familiar with each other's height relative to their own. Unlike in a mainstream environment, students within a special school are often taught within much smaller groups (typically 6-8 students) and spend the vast majority of the time in school together. As a consequence, this task did not require the students to interact socially or discuss their answers together, as I had planned. This was reflected in my research journal entry and shown in figure 12.

Tuesday 21st January 2014

The starter activity was cut short by two students calling the answer out immediately. I abandoned the idea of asking them to stand in height order to confirm their findings, as it seemed superfluous at the time.

I am not sure whether the other students (Keeley, Rhys, Poppy and Damien) would have preferred to attempt the task, but they were somewhat side-lined from the proceedings.

Figure 12- Reflective Journal Entry 21st January 2014 (Starter Activity)

No ground rules regarding conversational protocols were established or agreed during this or any of the lesson activities. However, both Sutherland (2015) and Mercer and Dawes (2008) suggest that ground rules for talk are important for promoting dialogic talk and to ensure a certain social order exists within the classroom.

> Pupils who call out an answer without being asked are breaking a rule, and their contribution may thus be treated as 'invisible' until they have been formally asked to speak. (Mercer and Dawes, 2008 p. 58)

Their rule on calling out would be difficult to adhere to when teaching students identified as having BESD as it is not uncommon for the students in this group to share answers out loud with their peers. Social order is an important factor when involving students in group discussions and it may be possible that Keeley, Poppy, Rhys and Damien did not appreciate Clayton and Robbie 'rule breaking' but did not feel comfortable challenging their actions. The calling out of answers could also be an indication that the task set lacked sufficient challenge.

Expressing a Pedagogical Preference

The conversation below was recorded at the beginning of this activity and provides an insight into Robbie's preference for lessons based around discussion as opposed to more formal written work. His comment was in response to me asking the group to write down their estimate of their height order.

> Robbie: *Can you write it on the board Sir, what we think?*
> *I much prefer lessons where we just talk all lesson.*
> Me: *What do you mean, where you just sit and chat?*
> Robbie: *No like this, where we discuss stuff.*
> *When the lesson is not all about writing stuff, we talk about things, you know, discuss with the teacher. In our History lesson we talked all lesson and did no writing and we got full behaviour points for that lesson.*
> (Transcription of Third Activity)

Robbie refers to the school's behaviour tracking system, as discussed earlier in Section 1.3.3, where students are awarded 0-4 points depending on whether they have met their two behavioural and two learning targets each lesson. Interestingly Robbie articulated that he gained full behaviour points and not learning points in the discursive history lesson. This would suggest that discussion is a pedagogical approach that the group can manage well and consequently behave more positively to this style of learning. Robbie's comment identifies a preference for a more dialogic approach to learning.

One of the students[8] within the group has a diagnosis of Dysgraphia[9], which for them manifests itself visually through poor handwriting and more covertly as a difficulty in putting thoughts on paper. Dysgraphia does not however affect reading or intellectual ability. As this student commented during their interview:

> *…. part of the reason I like typing and computers is because of my horrendous handwriting. I can't read my own handwriting at all, so nobody else can.*
>
> (First interview)

A dialogic pedagogical approach could possibly ameliorate any identified literacy difficulties that often co-concur with BESD (Brownlie *et al.*, 2004, Nelson *et al.*, 2005).

5.2.4 Activity 4: Create a Floor Plan to Scale (Main)

Activity Overview

This activity required students to produce a scale drawing of the school by measuring the dimensions of each classroom and choosing a scale that would ensure that their sketch fitted onto an A3 sheet of 1 cm squared gridded paper. The group were given metre rulers, 5 metre tape measures and a trundle wheel to complete this task. They were left to decide which structural features to include and the level of detail of their plan.

This task was designed to encourage collaboration between students – sharing measurements, equipment and ideas and defining their own roles and responsibilities for completing the task. Unlike in previous mathematics lessons, the students were required to work outside of the normal classroom environment. They were allowed to move freeley around the school building which included access to other teaching rooms as well as office spaces. Risk will always be inherent in any practically based learning activity, however this task represented a heightened level of challenge due to the necessary increased level of freedom that was granted to the students.

[8] The student has not been named here, so as to protect their anonymity.

[9] Dysgraphia is defined as a deficiency in the ability to write, primarily handwriting, but also coherence.

With the exception of Damien, all students were slow to commit anything to paper during the early stages of this task as they were cautiously observing each other's actions to gain an idea of how to proceed with the task. Following this initial hesitation however, the activity was tackled in three different ways by the group. Rhys, Robbie, Poppy and Keeley approached the task by making a rough sketch of the school hall and then proceeded by attaching the rooms next to it individually. Their approach involved no measuring initially and the sizes of the rooms were based solely on their memory and experience of the building. Their method ensured that the rooms were positioned and joined correctly, but were not necessarily drawn to scale. Taking a slightly different approach, Clayton chose to sketch an outline of the external walls of the building first. However this method proved unsuccessful when he could not then fit the rooms inside his perimeter wall.

[Clayton screws his work up and throws it at the bin.]
Clayton: *This is too hard, can I do something else. This is doing my head in. I can't get the rooms to fit inside the walls.*
LSA: *What's the matter? It looked good, what you was doing.*
Clayton*: I'm not in the mood for this today, can I start again tomorrow?*
[Long Pause]
And I can't spell the names of the rooms.
LSA: *If I write them on the board, would that help?*
I think you should try drawing one room at a time like everyone else.
(Transcription of Forth Activity)

It is interesting to note from the extract above, that Clayton cites literacy skills as a barrier to him completing the task and not that the building outline is to blame. Once the Learning Support Assistant had written the names of the rooms on the whiteboard, Clayton restarted the task following Rhys, Robbie, Poppy and Keeley's method of drawing rooms individually. It is through the scaffolding provided by the LSA that Clayton was able to re-engage with the task, taking the same line of approach as his peers.

In contrast to the other students, Damien took a much more pragmatic approach to this task. He began by measuring the maths room with a tape measure, then deciding on a scale of 1cm equal to 1 metre, drew an 11 by 5 centimetre rectangle to represent the maths classroom. Although his rectangle was significantly larger than that of the other students, he continued undeterred and proceeded out of the classroom to measure the school hall on his own. Damien tackled this activity in a different way to that of other students in the group, he was undeterred and confident in his approach during the initial stages. His confidence seemed to stem from an assumption that he had made, based on his belief in a benevolence teacher-student relationship:

Damien: *Ok, so I know that if every square on here* [pointing to his 1 cm gridded paper] *is 1 metre, then my plan will fit.*
Me: *Why do you think that Damien?*
Damien: *Because you gave us this number of squares on the page for a reason.*
Me: *The squares are all 1 cm on an A3 sheet Damien. I haven't counted them.*
Damien: *Yeah right, course you haven't!* [said sarcastically] *You know that it will fit, otherwise why would you have asked us to do it on this sized paper?*

(Transcription of Forth Activity)

In this extract Damien suggests that his plan of the school will fit on the sheet of A3 paper, if he uses a scale of 1cm to represent each metre of the school building. He articulated that he believed I would control the learning environment and design learning tasks in such a way that makes them accessible. In essence, he assumed that I had engineered the task to ensure that it was possible for him to fit the school on the sheet of paper with ease. Although I chose to neither confirm nor deny Damien's assertion with him, it was on this occasion, not true.

Engagement

Brown (2007) asserts that sustaining a level of engagement in learning is possible for students with BESD if they are interested in the task.

> Students with BESD have a few specific activities in which they can focus well and for long periods of time. Yet they have difficulty focusing on many other tasks that they recognize are important and that they want to do well, such as completing an essay or preparing for a major exam. (Brown, 2007 p. 26)

An increased level of engagement and focus was witnessed amongst the students during this task as noted within my journal – figure 13.

Wednesday 22nd January 2014

There were several prolonged periods (of about 6-7 minutes) of near silent working during today's main lesson activity. Other than students occasionally checking with each about particular aspects of classrooms, there was little conversation or social interaction.

They seemed to be only concerned with their particular diagram and were not interested in collaborating, sharing or any other form of interaction at all.

Figure 13- Reflective Journal Entry 22nd January 2014

Student focus with this task was demonstrated clearly when Clayton and Robbie screwed up their work when their plan did not match their reality of the school building. They were sufficiently motivated and engaged to restart the task. The extract below describes why Robbie chose to restart the task, as he wanted to improve its quality.

Robbie*: I've ran out of room. There's no space to put the Science lab in.*
I'll have to start again and just do the same but a bit smaller.
Rhys: *You could make your page longer*
Just add another sheet of squares on the end of your work.
Robbie: *No I want to start it again anyway. It's a bit scruffy*.

(Transcription of Forth Activity)

I had not expected the students to remain so focused and engaged on their plans for as long as they did and this activity continued with all of the students, except Damien, working seated for a considerable period of time. They seemed able to self-regulate their frustrations with the task and remain focused. An example of the level of detail that students included within their work is shown in Rhys' Floor Plan - figure 14.

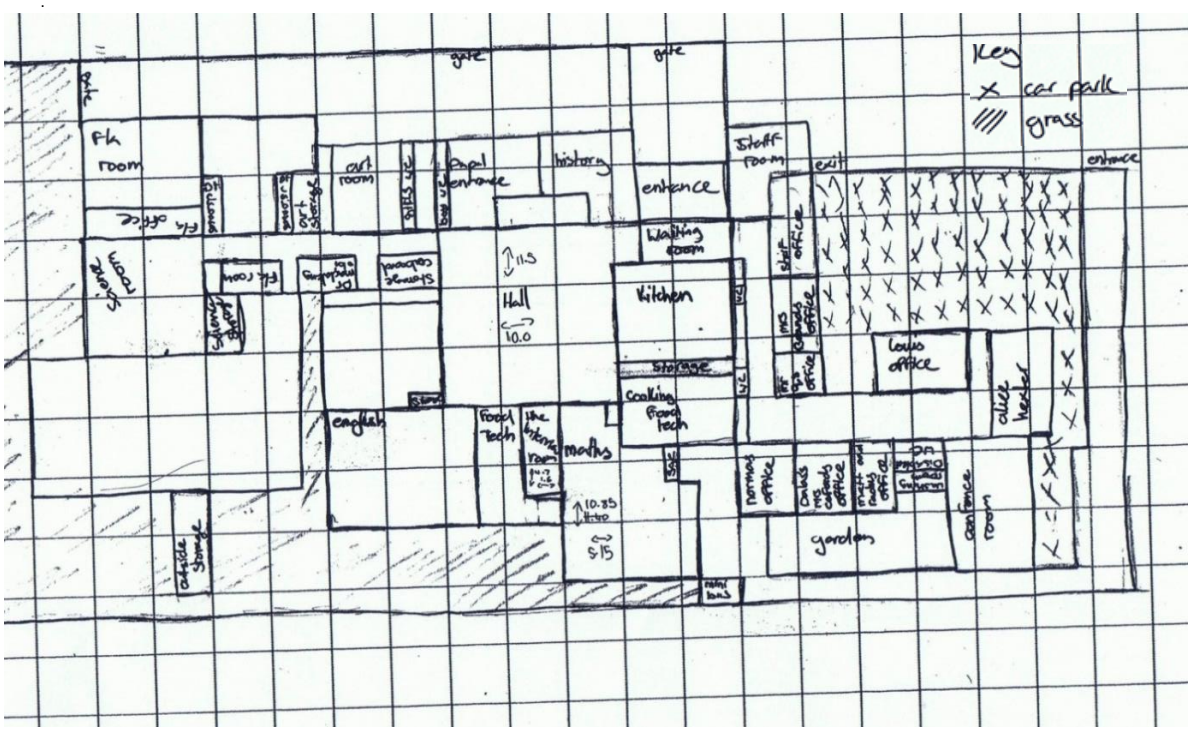


Figure 14 - Rhys' Floor Plan

It is often reported (DfES, 2001, APA, 2013) that students diagnosed as having ADHD struggle to focus on school work and are highly distractible due to a shortened attention span. However, Rhys appeared to be able to concentrate intently, putting a significant level of detail into his plan and was able to focus for a prolonged period of time. He completed his plan without leaving the classroom once. Rhys did however have to orientate himself spatially in the same direction as his plan to be able to complete this activity:

> [Rhys stands up and moves seat.]
> Me: *Are you alright Rhys?*
> Rhys: *Yeah, I've tried turning the paper around to be the right way as the school but I need to sit the right way. Look,* [pointing at his plan] *I'm sitting here and the school is the same way around. It's just got to be the same way around as in real life on the plan.* (Transcription of Forth Activity)

This would suggest that Rhys relies on his spatial memory to be able to complete this task and that he possibly learns through visual means. His ability to maintain concentration could be due to the intrinsic value that the task held for him or that the level of challenge was appropriately matched to his ability.

Working collaboratively

Although I did not instruct students to work in pairs, preferring to see if this happened naturally, both Keeley and Poppy did choose to work together at one point, although this did not last long with both students eventually working separately. This attempt at working together was unsuccessful as Keeley and Poppy chose to divide the task into two separate parts. Keeley focused on the measuring part of the activity whilst Poppy was tasked with drawing the plan. Once Keeley had left the room to measure the hall, Poppy was side-tracked into a short conversation with Rhys and made very little progress with their floor plan. Keeley then became frustrated that she could not put her measurements on the plan as Poppy had not drawn the school hall. Poppy and Keeley's approach to working together would fall into what Damon and Phelps (1989) define as cooperative rather than collaborative learning:

> In peer collaboration, a pair of relative novices work together to solve challenging learning tasks that neither could do on their own prior to the collaborative engagement. (Damon and Phelps, 1989 p. 13)

Whereas in cooperative learning

> the learning group tackles its task by dividing up the responsibility of mastering the task … each team member becomes an expert on one aspect of the task.
> (Damon and Phelps, 1989 p. 12)

Working as part of a pair does not guarantee that either cooperative or collaborative learning will take place. However unlike cooperative working practices, collaborative learning 'creates an engagement rich in mutual discovery, reciprocal feedback and frequent sharing of ideas.' (Damon and Phelps, 1989 p. 12). It is these aspects of 'learning together' that Poppy and Keeley seem to find difficult to master. This situation is similar to one noted earlier in Activity 2 – Measuring Every Day Objects, where Poppy and Keeley 'worked alongside' each other cooperatively in measuring the length of the maths room, but failed to do this in a collaborative way.

Although I had planned for this activity to be completed by students collaboratively, this was not the case as it was mostly performed by 'doing' in isolation rather than through any social dynamic. Although student engagement and motivation with the task was high, this was probably due to other factors such as the novelty value of the task and that it represented a concrete and practical learning experience.

The learning objective recorded on the lesson plan for this activity was for the students 'to be able to find a suitable scale for sketching a plan of the school building.' (see Appendix 6) Learning objectives are brief and specific statements of what the learner will know or be able to do by the end of the lesson. In terms of meeting the learning outcomes, every student did produce their own floor plan of the school. Student learning was most clearly visible during the period of uncertainty exhibited by the group at the start of this activity. Learning was, in part achieved through a process of covertly watching each other:

Tuesday 21st January 2014

Initially the group seemed to be concealing their need to discuss how to complete this task with each other. I'm not sure whether this was an attempt to avoid openly identifying themselves as being at risk or vulnerable to failure.

They appeared to be simultaneously communicating that they were disinterested in the task whilst watching and listening to each other in an attempt to develop their own ideas.

Students were constantly looking at each other's work, but then looking away quickly if they thought they had been 'caught'.

Figure 15 - Reflective Journal Entry 21st January 2014 (Main Activity)

This journal entry relates to the period of time when the task was initially introduced to the group and they seemed uncertain of how to start. It was through a sense making process, of observing and listening to each other, that the students navigated their thinking towards a collective approach to tackle this task, without formally engaging in discussion. In essence, the students were learning from each other by engaging in a process of covert collaboration.

5.2.5 Activity 5: Metric and Imperial Units (Starter)

Since the floor plan activity started in the previous lesson had not been fully completed, I decided to continue with the task in the following lesson as the students were keen to work on their unfinished plans. As a consequence, this Metric and Imperial Units activity was designed at short notice as a starter activity for this extra unplanned continuation of the session.

Activity Overview

The fifth activity involved students firstly cutting out cards with different metric and imperial units of measurement printed on them. Then working in groups of three, students stuck them into the correct space in the table, depending on whether the card represented a metric or imperial unit of measurement and by what they are used to measure.

This activity was intended to build upon and consolidate the students' prior learning experience of using measuring units that were developed in Activity 2 – 'Measuring Every Day Objects'. Only one set of cards and an answer grid were given to each group so that they had to work together and agree upon their decisions before gluing the cards in place. As Robbie, Keeley and Rhys were the first three students to arrive to the lesson I asked them to work together alongside me. Poppy, Damien and Clayton then formed a further group who worked alongside the mathematics LSA. Their work is presented as figure 16.

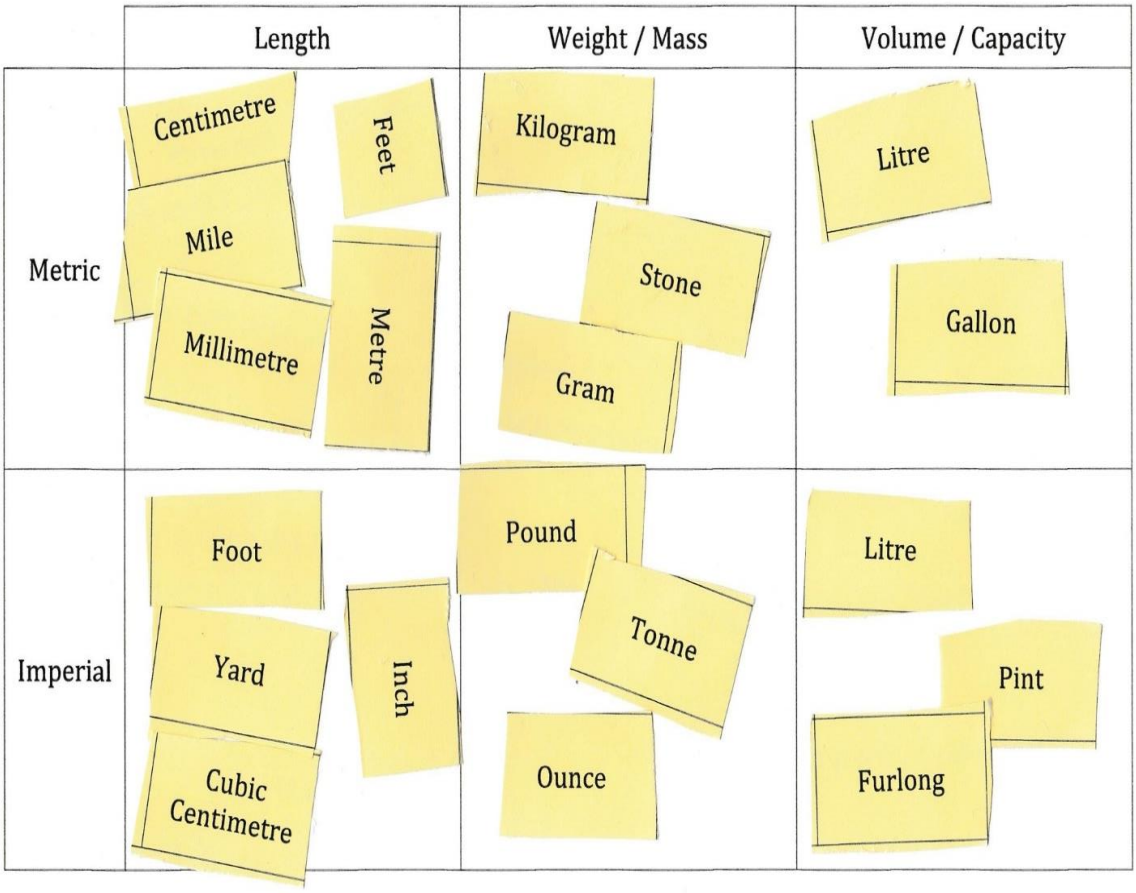


Figure 16- Poppy, Damien & Clayton's Metric / Imperial Unit Worksheet

This activity was not successful in developing collaborative working practices between students in either of the two learning groups. Although students worked together in placing the cards that they all felt they knew through group discussion, other cards were then placed randomly wherever there were any available gaps in the table with little consideration or thought.

Rhys: *Well, I know where inches, centimetres, metres and millimetres need to go, they are all for measuring lengths. They are on the rulers we used.*
Robbie: *Yeah and kilograms, stones, ounces and pounds are all for weighing stuff. So what about all the other words, where are we going to put them?*
Keeley: *Well, litres goes in metric volume and the other ones, I haven't got a clue. Just shove them in the empty boxes cos we haven't got anything to put in them.* (Transcription of Fifth Activity)

I recorded my thoughts on the failure of this task in the following journal extract:

> *Thursday 23rd January 2014*
>
> The imperial and metric card activity really didn't work.
> Discussion was limited and student interest in this activity was low. The students seemed to be in a rush to get this task finished as quickly as possible. On reflection however, the task was flawed – if the students didn't know collectively the correct answer, then how could discussion aid them to find the right answer?
>
> The task relied heavily on the concept of right and wrong answers, something that I was desperately trying to avoid!

Figure 17 - Reflective Journal Entry 23rd January 2014

Although the activity was practical in nature, this appeared to be an insufficient stimulus to engage the students purposefully in learning. Unlike the previous learning activities, it did not create the opportunity to learn in an environment that was free from the possibility of failure. The placing of each 'measurement card' in the table was either correct or incorrect. If the number of cards placed in the correct position were a measure of learning for this task, Poppy, Damien and Clayton's group only managed to score 12 of 18 cards (67%). In contrast to the other activities, this task only required factual recall of previously learnt knowledge and therefore reasoning and dialogical space were not developed.

However as can be seen below, for Keeley learning took place through a reliance upon teacher scaffolding to guide knowledge creation. The term scaffolding is defined by Wood *et al.* (1976) as a process 'that enables a child or novice to solve a task or achieve a goal that would be beyond his [or her] unassisted efforts' (Wood *et al.*, 1976 p. 90). An example of this scaffolding process is demonstrated in the following extract:

Keeley: *So what does imperial and metric mean?*
Me: *They are two different systems of measuring units. Imperial units were used before metric units. They are older units – like miles, inches or stones and pounds.*
Keeley: *So how do I know if they are old or not?*
I haven't got my Gran here with me to ask have I?
What's this one- Gallons, what is it used to measure? I don't know.
Me: *Well, can you think of something that you would buy in gallons?*
Keeley: *No.*
Me: *What about petrol?*
Keeley: *I don't buy petrol do I, I can't drive can I, I don't have a car!*
Me: *Keeley, you know when you buy a bottle of coke, how do you know what size it is?*
Keeley: *It's a litre and a half and a big bottle is two litres.*
So what you saying? Litres is for volume then, like how much coke is in the bottle?
Me: *Yes.*
Keeley: *And coke is a new-ish drink so it must be metric then.*

(Transcription of Fifth Activity)

It is through constant teacher guidance and probing that Keeley finally arrives at an answer. The scaffolding permits Keeley to work within her Zone of Proximal Development (Vygotsky, 1978 p. 86) and enables Keeley to achieve a solution that would otherwise have been too difficult for her achieve alone.

Although this activity was taken from Swan's (2006) book entitled 'Collaborative Learning in Mathematics', he warns:

> When using such card matching activities, we have found that students often begin quickly and superficially, making many mistakes in the process. Some become 'passengers' and let others do all the work. (Swan, 2006 p. 167)

This certainly appeared to be the case, as although I had inadvertently included the word 'litre' twice on the cards, it served as a useful indicator of student disinterest. Nobody had noticed that the word was repeated and as can be seen in figure 16, it was placed in two different spaces within the table. This task did not lend itself very well to developing collaborative processes – only one student in each group could cut the cards up while the others waited, then one student in each group glued the cards down. The Learning Support Assistant who was working with this group reported that both Poppy and Clayton took very passive roles during this activity, an outcome that I was trying to discourage during these interventional activities.

The failure of this task to create a positive learning experience could be due to a variety of different reasons. Firstly, when the students arrived for the lesson they were keen to continue with the activity from the previous lesson.

Me: *Hi Robbie and Keeley*
Keeley: *What we doing today?*
Can we carry on with the drawings that we were doing last lesson?
Me: *Yes, but I wanted you to complete this task for me first.*
[Rhys walks into the room]
Rhys: *What are we doing? Can I finish my plan of the classrooms?*
Me: *Hi Rhys, we will carry on with that later.*
Robbie: *But I want to carry on with my plan too.*
Me: *I'd like you to work together on this card activity first.*
Robbie: *Can't we do this after we've done our plans.*
It looks boring, am not doing it. (Transcription of Fifth Activity)

Although I had intended to only guide students with their learning during these interventional activities, the tasks set were non-negotiable and the students were not involved in the design or style of delivery. My insistence on completing this starter activity to form a three part lesson design (Starter, Main and Plenary) may have comprised the flow of their learning in this instance.

5.2.6 Activity 6: Numerosity Activity (Starter)

Activity Overview

Students were shown an A4 sheet containing a number of triangles, stars, rectangles and circles (see figure 18). The task was to discuss a strategy to estimate how many stars were on the sheet.

Numerosity is defined as the ability to visually estimate a number of objects without actually counting them (Ferrari and Vuletic, 2010 p. 110). Although I had intended for the students to discuss this activity in pairs, it very quickly evolved into a whole group debate. The discussion was a positive learning experience where students listened to each other's contributions and took turns moving the conversation forward to a conclusion. The transcription of part of this discussion, between Clayton and Damien is shown overleaf.

Me: *So you've divided the piece of paper up into sections?*
Damien: *Yeah 6 equal strips and there's 6 stars in the first bit.*
Keeley: *Where? Where's there six in a line? I can't see them.*
[Damien folds his sheet of paper and then shows Keeley]

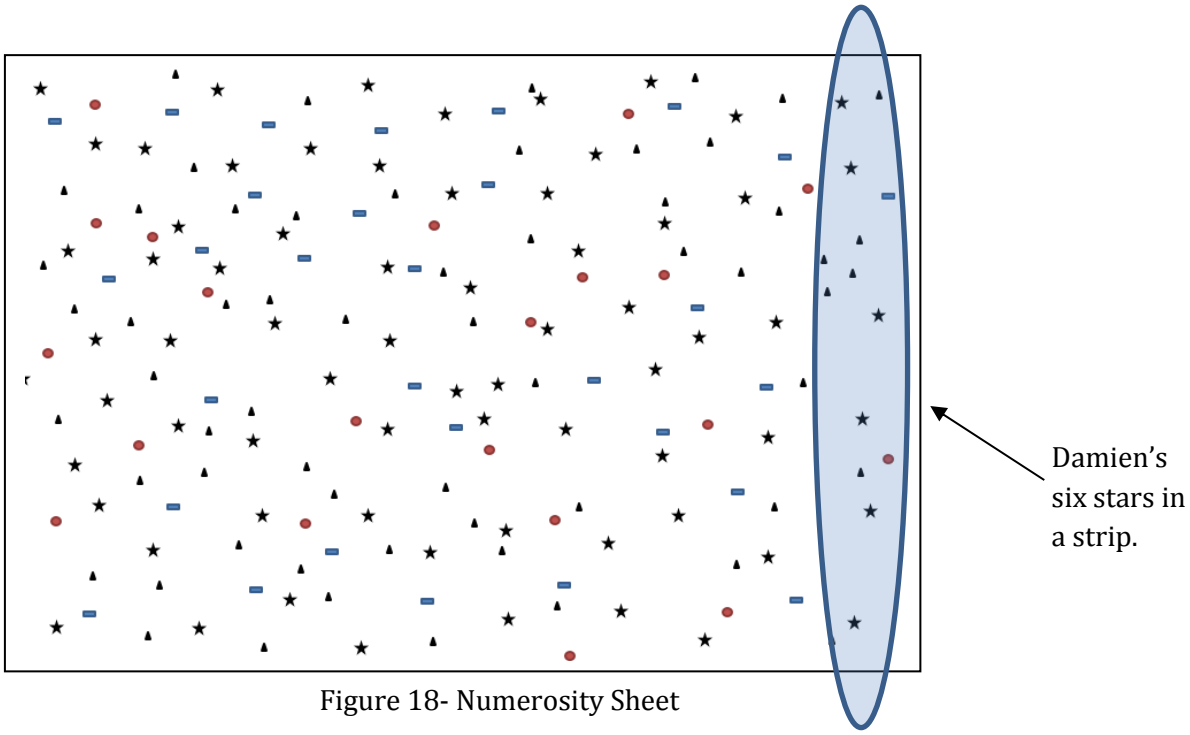


Figure 18- Numerosity Sheet

Clayton: *But you decided to fold the paper there, the fold might just be where there are a lot of stars on the sheet. You might not have any stars in the next section.*
Me: *So how could you make a better estimate then Clayton?*
Clayton: *Well what I would do right is, turn the paper over, so you can't see the shapes and then fold it in half then half again. Then count how many there are in one section.*
You know without looking at the sheet first.
Damien: *Try it then Clayton and see if you get the same answer.*
[Clayton folds this sheet into quarters, whilst the rest of the class watch, he then counts how many stars are in one section]
Clayton: *Well if I count the one on the fold, there are 16*
So how many is that altogether then Sir?
Me: *sixteen times four is 64.*
Damien: *That's way loads more than me. How many are there really Sir?*
Me: *Well there are in fact 68 stars.*
Clayton: *So my way was best then.* (Transcription of Sixth Activity)

As can be seen from the transcript, this task proved a very useful stimulus for discussion. For example, Damien and Clayton actively shared their strategies together until they eventually agreed that the best approach was to fold the paper into four and count how many stars there were. Although this exchange appears to be between Clayton and

Damien, the other four students were very much involved, listening and following the conversation. Damien and Clayton are engaging in a process of sharing each other's reasoning to reach a collective understanding, what Littleton and Mercer (2013) term 'interthinking'. The concept of interthinking concurs with Vygotsky's (1978) Sociocultural Theory of Learning, in that it connects intermental activity (social interaction) and intramental activity (individual thinking). In the extract we can see that although Damien comes up with the idea of folding the sheet of paper into equal strips, Clayton questions and then improves upon Damien's approach. Their social interaction develops and affects Damien's cognition and thinking.

Unlike the previous activities, this task did not involve any practical activity. The activity was designed to encourage paired discussion amongst the students. During the students' initial reconnaissance phase interviews, Damien and Rhys rated discursive approaches as their least favourite way of learning (see Table 6 – Students' Preferred Learning Style, page 70). However, the following extract which details a discussion which took place as part of the plenary session at the end of this activity suggests that both Damien and Rhys conceptualise discursive approaches to learning in a particular way:

Me: *I really didn't think anyone liked doing discussions.*
Damien: *I don't*
Me: *What do you mean?*
Damien: *Well that wasn't the same.*
When we discuss things in other lessons, it's about your opinion.
There isn't really an answer. It's what you think about something or someone.
Rhys: *Yeah, like when it's English, we discuss stuff but it's just random.*
Damien: *I was just telling everyone what I thought. It's just talking, not discussing.*

(Transcription of Sixth Activity)

The term 'discussion' can take different meanings and this extract highlights Damien's and Rhys' understanding of this term. In other curriculum areas such as English the term discussion describes a debate or the process to arguing a particular point. In the extract, Damien and Rhys seem not view discussion as a focussed dialogue that reaches a definite conclusion or outcome.

5.2.7 Activity 7: Impossible Questions (Main)

Following on from the Numerosity starter activity, this seventh task formed the main part of the lesson and also contained no practical activity but was based on developing discussion amongst the students.

Activity Overview

The task involved students working in pre-determined pairs, calculating an estimate for quantities that were ill-defined. Students were given a free choice of attempting any three of the following five questions:

1) About how many people could you fit into this classroom?
2) Would you rather have a column of pound coins equal to your height or your weight in 5p pieces?
3) Could you build a garage with 1000 house bricks?
4) Could you carry 1Km of toilet paper?
5) How many songs could you listen to in one day?

The questions were posed in a deliberately vague way so as to encourage discussion and to foster communication between students. Access to the internet was made available for students to be able to research any additional facts that they needed.

As a way of trying to reduce the students' dependence on adult intervention and to encourage autonomous learning, the students were asked to work together in pairs which were based on friendship groupings. Pairs of students would need to discuss with each other, any assumptions they need to make in order to find their approximation to the question. Friendships are based on a social basis rather than a mathematical one and it was hoped that this would afford students the ideal circumstance to develop more collaborative learning patterns. Damien was paired with Clayton, Poppy with Keeley and Robbie worked with Rhys. Poppy and Keeley decided to draft their working out on plain paper first before writing up their answers 'in neat.' Their work is presented as figure 19.

The activity was introduced to the students through an initial teacher-led group discussion of each of the five questions. The purpose of this was to open up debate and to get the group to think about what they would need to know in order to tackle each question. The discussion also provided each pair with an insight into what each question would entail as well as the time to negotiate with each other which of the three questions they would attempt. It also provided an opportunity to clarify and uncover any ambiguities with the task.

Impossible Questions?

With a partner, discuss if you could find a way to answer these questions. If you can, show how you worked out your estimate.

Question	Working out / Estimate
Population About how many people could you fit into this classroom?	40 square ~~4 x 4 = 16~~ 3 people x 4 people = 12 40 x 12 40 + 18 + 80 400 480 480 people
Money Would you rather have a column of pound coins equal to your height or your weight in 5p pieces?	168cm 3.15mm (Thickness of a pound) 168cm ÷ ~~0.00315~~ 0.315cm = [illegible] 5174 £517 63kg 3.25g (5p coin weight) 63 ÷ 0.00325 = [illegible] 19,384.6 19,384.6 x 20 = 969.2 £969.20 My weight in 5ps gets me more money.

Figure 19- Keeley & Poppy's Impossible Questions Worksheet

The nature of these questions reduced the possibility of calling out of an answer, as had happened in previous activities. Although some of questions could be answered with a simple yes or no, it was implicitly understood from the discussion held at the start of the lesson that an answer would need to be qualified with a reasoned explanation. These open-ended questions required a great deal of exploration and consequently generated much discussion and thought amongst the students. For example, in response to the question, 'How many songs could you listen to in one day?' these thoughtful comments were made by the students:

Rhys: *How long is a day? You can't answer this question unless you know what you mean 24 hours or 12 hours?*
Clayton*: I'd need to know if you can listen to more than one song at a time.*
Rhys: *When I go downstairs in the evening for dinner, could I still listen to music at the table? It might not be up to me if I have to stop the music and start again later.*
Damien: *You would have to have breaks from it! How about when you go to sleep? You can't be listening when you're asleep.*

(Transcription of Seventh Activity)

Engagement with this task was almost instant for all of the student pairings, in striking contrast with the previous lesson's starter activity using the metric and imperial cards. Interestingly, all three pairs chose the money question, which was possibly the most challenging question mathematically as it required students to convert between different units of measurement. The other two questions chosen by the pairs were different for each pair. I had anticipated that some students may have been uncertain about how to proceed initially, but all quickly formed their own path of inquiry. All of the questions involved many stages of working out and there was too much information to hold in mind to avoid having to write some of their decisions and calculations down. In each pair, the writing part of the task was completed by one person in all cases.

The purpose of this activity was to encourage discussion and independence in learning without the necessity for teacher intervention. However, when faced with uncertainty or lack of clarity, Keeley and Poppy did not discuss collaboratively between themselves, but instead sought guidance from the teacher.

Keeley: *Well how high is one pound?*
Poppy: *Err?* [Confused]
Keeley: *Have you got a pound coin sir?*
Me: *You will have to ask Mr Google, see if he knows?*
[Poppy searches 'height pound coin' on the internet.]

Poppy: *What's the diameter Sir?*
Me: *The distance across the front of the coin, from one side to the other side.*
Keeley: *So is that what we need?*
Me: *Not really, because the coins will be stacked on top of each other. You need to know how thick the coin is.* (Transcription of Seventh Activity)

In this extract it can be seen that every time a query is answered, it is met with a further question. This dynamic of knowledge giver and receiver was one that I had tried to circumvent by asking the students to work in pairs. However, the familiar teacher-student verbal model of interaction can sometimes provide students with a sense of safety with their learning. In this instance, talk provided an effective way for Poppy and Keeley to clarify what they did and did not know. It is also possible, as Sutherland (2015 p. 47) suggests, that Poppy and Keeley lack the necessary scaffolding skills or motivation to support each other. They were not able to move beyond this in order to determine what they needed to find out. In these situations, the role of the teacher is particularly important. The teacher needs to scaffold student-to-student dialogue, by providing additional information, clarification and explanation. In this situation, there needed to be interaction with a more knowledgeable other. It is possible that when the knowledge base of a particular student pairing is roughly equal, collectively they are unable to advance their knowledge. In this case, a pairing based on friendship did not ensure that there was a more knowledgeable other within the pair, but it was successful in developing collaborative working.

During this activity, all three types of talk defined by Mercer (1995) were evidenced – cumulative, exploratory and disputational and are discussed below. An important feature of each of the conversational extracts that follow, is that I position myself as the orchestrator of student talk that enables a more student centred approach to learning. As Mercer *et al.* (2009) comment, 'talk is considered to be more dialogic the more it represents the students' points of view and the discussion includes their and teachers' ideas' (Mercer *et al.*, 2009 p. 354). Adopting a position that is consultative rather than directive I placed the group at the centre of their own learning. My role was essentially to guide and scaffold dialogue where necessary.

Cumulative

The conversation between Damien and Clayton, where they considered the issues involved in building a garage, would be classified by Mercer (1995) as cumulative.

Me: *Could you build a garage with a thousand house bricks?*
Damien: *How big do you want the garage?*
Clayton: *Is the garage for one car or two? How big is the brick is important.*
Damien: *As well, we would need to know what car and how big it is.*
Clayton: *Yeah, it depends on the size of a car and space to walk around it.*
Damien: *and how tall the driver is, to be able to stand up when he gets out.*
(Transcription of Seventh Activity)

Both students add to each other's commentary and come to a conclusion that they both agree upon. Each building upon what the other said and neither taking a dominant role. It is through discussion that Damien and Clayton validate and confirm their thinking cooperatively without teacher assistance. The value of cumulative talk is that both students feel the satisfaction of success, which is an important consideration when working with students who have been identified as having low self-esteem and confidence. It is important to bear in mind though, as Barnes (1999) warns, 'In mathematics, a high incidence of cumulative talk may be a sign that the tasks set are not challenging enough.' (Barnes, 1999 p. 58). In this case however, cumulative talk was essential to enable Damien and Clayton to build a shared understanding of what the task involved. Exploratory talk generally leads to the generation of new knowledge and understanding, whereas the outcome of cumulative talk is essentially consolidation of material already learnt. For Damien and Clayton however, this cumulative talk was responsible for developing self-confidence which in time, ultimately promotes learning.

Exploratory

The second type of talk that Mercer defines is exploratory, which was exemplified through Poppy, Keeley and Rhys' conversation regarding how many people they could fit into a one metre square of floor space.

Poppy: *So how many persons, no people can we fit in 1 metres or 2 metres?*
Keeley: *Well let's do a 1 metre square.*
2…. 3……. 4. So we can get 4 people going that way.
Poppy: *So that's 4 rows by 4 rows is 16 people in the square.*
Rhys: *You can't do it like that. People aren't round like a circle are they?*
Keeley: *What do you mean?*
Rhys: *Well you measured four people that way, then you turned around and measured four people the other way.*
Poppy: *But we were working in that direction, so we changed.*

Rhys: *I mean you're not as wide as you are in thickness are you?*
Keeley: *People are more like rectangulars in shape.*
Rhys: *Look, if you stand here next to me, we take up more room than if I stand this way, back to back.*
Poppy: *So it's 4 people by 3 people then, 12.*
Keeley: *Ok now what? We can fit 12 people in a square? Times by 40 squares?*
Poppy: *12 times 40, what's that?* (Transcription of Seventh Activity)

In this conversation we can see that Rhys constructively criticises Poppy and Keeley's method of counting the number of people that they could fit inside a square metre of space. They had stood back to back and realised that four people could fit in a metre and then calculated 4 x 4 for a square metre. Rhys demonstrated to them why this was not correct, as people are generally wider across the shoulders than they are front to back. The two girls were happy to accept his explanation (visualised in Figure 20.)

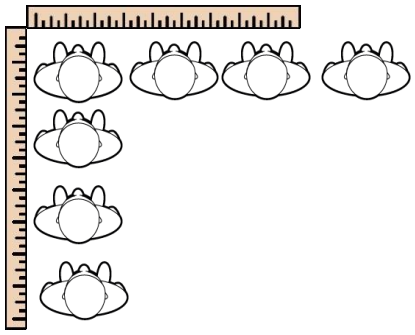


Figure 20 - Rhys' Explanation

It is interesting to note however, that although the girls accepted Rhys' help and explanation, there is no sign of acknowledgement. This extract clearly shows that exploratory talk creates new knowledge and understanding –twelve people will fit in the space because people require a rectangular space.

Disputational

In Mercer's (2006) dialogical framework for researching peer talk, a third type of talk, disputational is defined. This is exemplified by disagreement and individualised decision making, where there are few attempts to pool resources or to offer constructive criticism. The conservation below between Rhys and Robbie was in response to their differing interpretation of the question 'Would you rather have a column of pound coins equal to your height or your weight in 5p pieces?'

Robbie: *How can I estimate my opinion on what I prefer when I know?*

Rhys: *You've lost me there Robbie, what do you mean?*

Robbie: *It doesn't ask which is worth more, it asks which I would prefer. I know whether I prefer 5p coins or £1 coins. I would prefer to have £1 coins.*

Rhys: *But you're saying that you would rather have the pound coins, even if it's less money than the 5ps? But you're not really going to get the money anyway are we. It's not like you're going to have to carry the money around with you.*

Robbie: *Whatever Rhys, I just prefer £1 coins.* (Transcription of Seventh Activity)

Although I had thought that the question was worded clearly, its interpretation was disputed by Robbie. His approach to answering this question would render it insignificant as a mathematical activity. However, far from being argumentative, Robbie exposes and clarifies an ambiguity in the question and the misunderstanding is rectified.

5.2.8 Reflections on key issues from the Intervention Stage

Each of these seven activities brought to the fore several different issues regarding the challenges surrounding learning mathematics for this group of students. The two main areas that emerged were the importance of designing tasks that encourage collaborative learning and the value of talk as a mechanism to promote learning.

Collaboration and engagement

Being mindful that the students who took part in this study all had statements for BESD, the first two activities clearly highlighted that students could engage in cooperative learning effectively but not necessarily in a collaborative way. There were several incidents where, either due to a lack of social skills or through misinterpretation of the processes of collaboration, students worked along-side one another or chose to divide tasks into individual parts.

The importance of designing learning tasks that encourage collaboration was highlighted during the fifth activity – Metric and Imperial Units. Getting students to work together in small groups does not of itself guarantee learning. Although the students had worked cooperatively on many of the activities, learning was unsuccessful when they were not fully engaged or became dis-interested with the task. That is, if a task had a novelty value or was different to previous learning experiences, the activity was more successful. As Wheeler (2010 p. 57) states, 'BESD behaviour may be minimal or absent when the individual is in a novel setting or is engaged in an activity which they find especially interesting.' Task four had a high novelty value for the students as it was unlike any previous learning experience. However, as students focussed their concentration predominantly on the task, this led to a reduction in social interaction between students. In essence, the intervention suggested that opportunities for students identified as having BESD to work together, need to be carefully created and planned, but that the benefits can positively impact on the quality of learning and understanding.

Talk as a tool for learning

Talk within the classroom can serve many different purposes as Mercer and Sams (2006) point out; it is used to 'form relationships, develop social identities, and pursue off-task activities which may be more important to them than the tasks in which they officially engaged' (Mercer and Sams, 2006 p. 517).

Talk is a public way of sharing thinking and these activities highlighted two important issues regarding how this happens within the classroom. The first issue, which arose in both the second and third activities, was the extent to which group members 'called out'. There are many explanations for this behaviour, however it was seen to benefit learning for all students in that it created a collective understanding, that is, the group's thinking was shared and bound together. Although calling out can often be viewed as a disruptive behaviour that is not conducive to learning, in this instance it would appear to be a mechanism that supports learning.

Within this study, dialogue was seen to be used by students to both explain their reasoning and to articulate their thinking between each other and an increase in the amount of time that students are engaged in talk would therefore indicate more collaborative learning. Talk has been shown to increase student learning, motivate students and shift the mathematical authority from teacher to community (Cirillo, 2013 p. 1). Heightened awareness of the importance of talk for learning led to a review of the amount of time that students were engaged in independent peer talk. Table 11 shows that although the amount of 'teacher talk' remained approximately the same throughout this study, the amount of time that students spent in independent discussion doubled in length over time.

	Reconnaissance	**First Activity**	**Final Activity**
Percentage of Time Students are Talking[10]	79.7%	71.1%	70.9%
Longest Run of Student Sentences Before An Adult Intervenes[11]	15	28	30

Table 11 - Analysis of Classroom Student-Teacher Talk

These figures would suggest that the centrality of the teacher's role in learning decreased over time and this would indicate that the students could manage their own learning more effectively. Sutherland (2006 p. 108) suggests that an increase in student talk could potentially indicate heightened levels of higher ordering thinking amongst students.

[10] Each line of text that was created during the transcription of the lessons' audio recordings were numbered. The percentages were then calculated by counting the number of text lines spoken by the students divided by the total number of transcribed lines. For example, during the first activity, student talk accounted for 86 of the 121 data lines of text equalling 71.1%. All percentages were rounded to 1 decimal place.

[11] By searching through the entire transcription of each lesson, this figure represents the longest run of text lines before either myself or the LSA spoke.

6. Key Themes

Although practitioner action research invites continuous reflection at each and every stage of the process, it is also a critical step at the end of Elliott's (1991) action research cycle. As Mertler (2013) states:

> [Reflection] is a crucial step in the process, since this is where the teacher-researcher reviews what has been done, determines its effectiveness, and makes decisions about possible revisions for future implementations of the project.
>
> (Mertler, 2013 p. 45)

An important part of this action research study then was to reflect upon the effect that the intervention may have had on students' learning of mathematics. As Visser (2005) comments, pedagogy can either support or hinder learning for students identified as having BESD. Additional data for this section were drawn from student interviews that were conducted four weeks after the intervention phase, using the same approach and procedure that were adopted for the reconnaissance interviews. The interviews were conducted both individually and together as a focus group. Asking the students to reflect on their experience of the intervention adds an important and rich source of information. These interviews and the subsequent focus group discussion, conducted a week after the individual interviews highlighted several issues that had recurred throughout this study.

This section also draws on data from the responses from a staff questionnaire and written feedback from the mathematics LSA who supported the group's learning through this study. Both of these data sources were completed following the intervention stage. I also refer to a formal lesson observation conducted by the head teacher during the first intervention lesson.

6.1 Theme One: The Value of Practical Learning Activities

The first observation that came out of the focus group interview, was that all students could articulate what they had learnt during the intervention. They had understood the concept of estimation and this would indicate that a practical approach to learning was successful.

> *It's about guessing the amount, guessing the number like a guesstimate; having a rough idea how much something is going to be.*
>
> (Robbie Post Intervention Focus Group)

> *It's where you try to get close to something. You know like guessing and stuff. But you have to have an idea roughly of what it is first, before you actually measure it. Was it also that lesson where we drew the school out? I liked that one.*
>
> (Rhys Post Intervention Focus Group)

With the exception of Damien, all said that they preferred learning through practical tasks. Their preference for practical learning has been consistent throughout this study and students were able to articulate a variety of different reasons as for their preference:

> Keeley: *If I physically do it, it's better for me to remember it. I mean, I won't forget it straight after doing it. I don't get bored if I'm doing something physical.*
>
> Poppy: *Yeah, it's easier. I find it easier to do practicals because I feel like, it's like, it's explained more to me (…) and it's more fun.*
>
> Robbie: *I much prefer doing than sitting down.* (Post Intervention Focus Group)

The LSA who had supported the students during this study also commented that she felt the students had understood and retained learning better when approached through practical activity:

> As a way of learning, being more practical definitely seemed to make it easier for them as a whole to understand the concept of what was being taught.
>
> (Mathematics LSA Account)

She articulates that the use of practical activity affords a more holistic view which enables the students to develop a clearer conceptual understanding.

In a sense, practical activity represents a tangible and real world learning environment where understanding evolves through direct interaction with concrete materials and is free from the abstractness that is often associated with mathematics. Social constructivist approaches to learning naturally lend themselves to practical activity which affords increased opportunities for students to interact socially and to discuss their learning with each other.

6.2 Theme Two: Collaborative Learning

Special school students are generally taught in significantly smaller class groupings than in mainstream and spend a higher proportion of their time together. It would therefore be fair to assume that these students are more familiar with working together in small groups. However, it became apparent that some students held differing views of what working together actually means. For example, pair work could be two people completing the same task, at the same time, but independently of each other as articulated by Poppy:

> *Sometimes in lessons we are told to work in pairs, but we don't really. I mean it's two people next to each other, but working on their own, just nearer to another person.*
> (Poppy Post Intervention Focus Group,)

My implicit assumption that the students understood the concept of what it means to work together seemed to be flawed. Working collaboratively for students identified as having BESD is not always successful, as Keeley commented:

> *some people can be so annoying. It can be frustrating when the person that you are working with keeps messing around. When we was doing the drawing of the school, me and Poppy decided to work together yeah. So I say, you draw the plan and I'll do the measuring. But I couldn't put the measurements on the plan because she hadn't finished drawing it. So I'm waiting and then she's talking so I got fed up and did my own. So really it didn't work.* (Keeley Post Intervention Individual Interview)

The head teacher, who had previously taught mathematics for over 20 years, carried out a lesson observation of the first two activities with the specific focus of developing collaborative learning. He commented that although the students responded well to practical activity, their modus operandi seemed to veer towards working independently within mathematics.

With regards to the issue of pair work, staff questionnaire responses indicated that all teachers paired students to varying degrees. The majority of staff indicated that student pairings were controlled and based on behavioural issues rather than attainment.

> *Subject Teacher1*: *I mostly choose the pairs unless they promise to work well.*
> *Subject Teacher2:* *I tend to manipulate groups if disruptive.*
> *Subject Teacher3:* *I generally allow students to choose as long as they are able to work sensibly within the chosen pairing/group.*
> (Staff Questionnaires)

Paired working can present opportunities for a struggling student to learn from a more capable peer, however pairing of students considered as having BESD are not always based on academic considerations but behaviourally. Ideally when students are working in pairs or groups, they are working collaboratively in that they learn from and with one another. The students within this study however did not naturally form into pairs for any considerable period of time to complete any of the activities. Pair work only happened when it was pre-determined by me, which suggests that students generally prefer lone working unless they are directed. However there were many occasions when students formed into a group to discuss and interact, such as during the 'Numerosity' and 'How Long is a Minute?' activities. In summary then, collaborative learning is a positive way to learn mathematics, but it needs to be orchestrated, managed and planned for effectively.

6.3 Theme Three: The centrality of the Teacher to Learning

A significant theme that arose out of this stage of the study was the issue of the relationship that exists between both students and teacher. In order to learn, students must be prepared to have their understanding of mathematical concepts questioned. A student identified as having BESD may have learnt to be defensive and closed to new experiences that may have led to failure in the past. It is therefore essential that the teacher is viewed as a reliable and competent figure within the students' learning environment. This belief that 'the teacher is always right' was articulated by Keeley thus:

> *Yeah I trust you, I could ask another person but no, like, I'd trust them but I'd like to know if I'm right as well.* (Keeley Post Intervention Focus Group)

This central role of the teacher as the knowledgeable authority within the classroom is a difficult concept for students to unlearn. The issue of mathematical competency and trust formed a major theme in both the individual and focus group post-intervention interviews. As can be seen in table 12, students felt comfortable in asking for adult supervision.

	Definitely Agree	Agree	Neither Agree or Disagree	Disagree	Definitely Disagree
I always feel that I can ask an adult for help, if I don't understand something.	Poppy Keeley Rhys Damien Robbie	Clayton			

Table 12 - Summary of Student Responses to Post-Intervention Individual Interview Questions

However, an over- reliance on adult support reduces opportunities for developing more collaborative peer learning. This preference for seeking adult support however, could be due to a lack of confidence in other students' abilities to explain or difficulties with social interaction. This issue received a fairly negative response from the students (see table 13).

	Definitely Agree	Agree	Neither Agree or Disagree	Disagree	Definitely Disagree
I always feel that I can ask another student for help, if I don't understand something.			Keeley Clayton	Robbie Rhys Damien	Poppy
I understand maths better when another student explains it to me.	Clayton		Keeley	Rhys Damien Robbie	Poppy

Table 13 - Summary of Student Responses to Post-Intervention Individual Interview Questions

Poppy answered these questions by 'definitely disagreeing' which is not surprising since during the intervention activities, Poppy sought adult supervision probably more than any other student; her reasoning behind her response however was articulated thus:

> *I find it harder when everyone is saying different things in a group. I get confused. I prefer it if it's just you. You know when people say different things and it's not all the same way to do it.* (Poppy Post Intervention Focus Group)

Poppy's comment suggests that she does not consider her peers to be 'more knowledgeable others' and finds learning this way can be confusing. For Poppy, mathematical authority lies firmly with the teacher.

With the exception of Robbie, students acknowledged the benefits of working together, as Clayton articulated:

> *Yeah, it helped me to learn. You can see how other people work and think, not just me, but them as well. And they learn differently. And we can help each other out.*
>
> (Clayton Post Intervention Focus Group)

Reassuringly, the value of working together was acknowledged by the group as making learning easier. Their responses are set out in table 14.

	Definitely Agree	Agree	Neither Agree or Disagree	Disagree	Definitely Disagree
I always need someone to work with me in maths.		Poppy Keeley Rhys	Damien Clayton	Robbie	
Working with my classmates makes learning easier for everyone.	Damien	Rhys Keeley Clayton	Poppy		Robbie

Table 14 - Summary of Student Responses to Post-Intervention Individual Interview Questions

Robbie's response to these questions differ to those of his peers as he believes that the process of peer learning has little benefit for him, as he commented:

> *I'm too independent me. I prefer to work alone. I think that working with other people makes learning for them easier, but it doesn't make a difference to me.*
>
> (Robbie Post Intervention Individual Interview)

Promoting collaborative learning practices requires a renegotiation of the teacher's role within the classroom, one which ensures that students are actively involved in the learning process and that builds student autonomy and more importantly self-confidence and trust in each other. This renegotiation and sharing of authority however, needs to be carefully planned especially when working with students who at times, can be difficult to manage.

7. Conclusion

This chapter begins by acknowledging from the outset, the limitations of this research before moving on to consider the contributions to knowledge that this study makes. The chapter then summarises the key findings in relation to each of the research questions posed. The chapter then discusses the value of action research as an approach for teachers interested in improving teaching and learning. Drawing out the implications of this research for a mathematics pedagogy for students categorised as having BESD, the chapter concludes with reflection on my journey as a teacher researcher.

7.1 Limitations of Study

This section critically reflects on the limitations of this research and considers their implications. Weaknesses critiqued include the inherent difficulties of insider researching, questionnaire design and issues of clarity in defining terminology as well as that of interpretation.

The dual role of practitioner and researcher brings to this research two limitations, that of time constraints and experience. As a full-time teacher and deputy head, researching practice within my own classroom involved juggling my time between teaching commitments and carrying out research. Although this thesis reports on a single cycle of action research, time constraints prevented further investigation. Additionally, as an inexperienced researcher, I am aware in hindsight, that certain methodological decisions that were taken during the research process were not as robust I as would have liked. For example, although not part of the original research design, a questionnaire was given to teaching staff (see Appendix 4) to elicit their views of teaching the group of students who took part in this study. The decision to use this research tool was made late in the research cycle, based on the suggestion of the Head teacher. On reflection, both the wording and closed questioning style of the questionnaire were under-theorised, with three of the four questions leading to false dichotomous responses. For example question 3 (a) 'Do you think students can learn better from each other or from the teacher?' assumes that one of these two options improves students' learning.

A further criticism of both the questionnaire and students' semi-structured interviews is that terms such as 'practical', 'active' and 'passive' were introduced without being explicitly defined beforehand. The students' understanding and perception of these ambiguous terms were not confirmed with them and could have therefore led to differing interpretations. A further assumption made by this research was that the students who took part had the necessary skills to articulate and express their views clearly. It is also assumed that I have interpreted and narrated the students' meanings and intentions accurately throughout the research process. As with any qualitative research that is conducted by an insider researcher, a heightened level of reflexivity is required to ensure accurate interpretation.

This study was carried out over a single academic term involving only six participants and extending the study over a longer period of time would have led to a more thorough understanding of the multiple factors that interact within the mathematics classroom. Although it is not possible to generalise from a small scale qualitative study, its findings are certainly transferrable to other broadly similar learning environments. However, in terms of improving practice within my own context, the study revealed many issues that will need to be addressed.

7.2 Contribution to Knowledge

The purpose of this study was to explore opportunities for improving mathematical learning of students who attended a specialist BESD school. This thesis makes a number of contributions to current understanding of the factors that affect the learning of mathematics for such students. In the UK, students with BESD form the largest category of learners identified as having Special Educational Needs, yet research that focuses on improving the educational experience of these students is scarce. Results of a meta-analysis of mathematics interventions for students identified as having BESD conducted between 1976 and 2006 by Templeton *et al.* (2008) indicated that only four studies have ever been conducted with secondary school aged children. None of these studies were conducted in the UK. This thesis therefore contributes to what is a relatively limited knowledge base of research, addressing a specific gap in relation to Key Stage 4 mathematics within a special school environment. Further, by including the learners' views throughout this study, this thesis also contributes to research literature regarding the often unheard voices (Cefai and Cooper, 2010) of students identified as having BESD.

A further contribution to knowledge made by this study concerns the use of pedagogical approaches with students identified as having BESD. This study exposed learners to active and participatory pedagogies which might be considered to present an elevated risk of disruption to learning. However this group of students responded positively to these approaches and the negative behaviours often associated with this type of learner were in fact diminished. The particular aspect of the curriculum that this study focussed upon was that of the acquisition of estimation skills. The strategies that the students developed in making their estimates were developed through a constructivist approach to learning. That is, the students were able to demonstrate the ability to learn collaboratively with and from each other, to verbalise their mathematical reasoning as well as share their knowledge and ideas through engagement in practical activities. In essence, it provided clear evidence that students identified as having BESD can learn collaboratively when presented with learning opportunities which require both active and participatory engagement.

Secondly, although the students within this study have been labelled as having social difficulties, the use of 'talk' was seen as a significant factor in promoting mathematical learning. Dialogue was an instrumental tool in developing students' understanding as it provided opportunities to share, respond and reflect, all of which are essential mathematical and social competencies.

The final contribution made by this study is that it provides evidence to support the suggestion that students identified as having BESD **can** enhance their social interactional skills if they are provided with the explicit learning opportunities to be able to do so. Further, this study concludes that it cannot be assumed that these students have sufficiently developed these skills already.

Although this research was carried out in a special school with statemented students whose needs have been formally identified, there are thousands of students experiencing similar difficulties in other school settings (Cole and Knowles, 2011) to whom this research might equally apply. Importantly, it is estimated that in England and Wales between 10% - 20% of students experience BESD to a degree that significantly impairs their social and educational development (Cooper, 2001).

7.3 Discussion of Research Questions

The three research questions that were posed in section 1.4 were designed to explore the different aspects of the study. The first research question was created to give voice to the students and to determine their views on learning mathematics. Research question two teases out any challenges or difficulties in learning mathematics that were identified by this group of learners. The third research question provides a space to reflect upon the wider implications that the findings of this research has upon curriculum delivery and pedagogical approach. The following section now discusses each of the three research questions in relation to the findings of this action research study.

7.3.1 Research Question 1: How Do Students Categorised as Having BESD View Their Learning of Mathematics?

Data gathered from the initial reconnaissance stage showed that each student had their own individual and unique perspective of their mathematical learning; the students presented as a heterogeneous and diverse group of learners. That is, although the education system has grouped these individuals together as having the same category of need, they each have differing strengths, learning preferences and individualities. The group of students, however, did agree on certain issues. For example, all students initially expressed a preference to work on their own and cited practical based activity as their preferred way to learn. This preference to learn through active pedagogy is consistent with previous research with students identified as having BESD. For example, Cefai (2010) reports on a dislike of lessons that are restricted to written work with little interaction and application to real life. Groom and Rose (2005) further suggest that if students, deemed to have BESD, are not actively involved in learning activities, they are likely to become disengaged from the learning process.

Other than a preference for learning through practical activity, the group expressed no particular affinity to any of the other four learning styles that were discussed during their reconnaissance interviews. These approaches were discussion, teacher led exposition, using ICT and textbook based learning, which are not particularly active styles of learning. It could be argued that for students who can exhibit hyperactive and 'out of seat' behaviours, coupled with an inability to concentrate for prolonged periods of time, an active learning style may be more palatable.

Based on their responses to interview questions all but one student considered mathematics to be a difficult subject to learn, however there was general consensus of opinion that the way in which it was taught made a difference. When asked what makes learning mathematics difficult, other students' disruptive behaviour was cited as the greatest hindrance. The externalised behaviours associated with BESD not only affect students' own learning, but also impacts negatively on their peers' education.

7.3.2 Research Question 2: What Specific Challenges do Students Identified with BESD Face When It Comes to Learning Mathematics?

Although there are many challenges that can make learning mathematics more difficult for students identified as having BESD, three distinct areas became apparent throughout this study. These barriers to learning were sustaining motivation and interest, social interactional difficulties and poor literacy skills. Each of these issues are now discussed.

Sustaining Motivation and Interest

Students identified as having BESD have no less capacity to learn than any other group of students, rather it is that the learning process can sometimes be more difficult. This can be for a variety of reasons such as a reduced level of engagement with learning (Lerner and Johns, 2008). Zentall (1975, 2012) proposed a theory of optimal stimulation, suggesting that BESD students may have a greater need for stimulation than other students and would benefit from a more active approach to learning. The issue of sustaining an interest in learning is reported by Barkley (2006) as, '*more to do with lost interest than with an inability to concentrate*' and he suggests that increasing the interest of a topic will increase the student's ability to concentrate, focus and learn.

Increased student concentration was seen specifically during activity 4 – Create a floor plan where Rhys, who is particularly interested in drawing, concentrated for approximately 40 minutes without talking. Similarly, the student engagement witnessed during the first activity - How long is a minute? was created by providing an unfamiliar experience with high novelty value that caught the students curiosity and interest. The competitiveness that was generated amongst the students in 'being the closest to a minute' was a clear indicator of their heightened levels of engagement with learning.

The Social Dimensions of Learning

Social constructivist theories of learning (Bruner, 1960, Vygotsky, 1978) recognise that both social and cognitive processes play a central role in the learning of mathematics. However, students categorised as having social difficulties are not naturally sociable and often choose to work in isolation (Wagner *et al.*, 2006). This would suggest that there may be a tension between the approaches believed to be effective in the learning mathematics and the characteristic behaviours of BESD, which is the social element (Sutherland *et al.*, 2000). This study has shown though, that when collaborative learning activities have been designed well, the tasks have provided opportunities for the students to develop their social interaction skills. There were however many missed opportunities for social interaction identified within this study. For example, during the second activity – Measuring everyday objects, Damien struggled to measure the length of a room using a retractable tape measure. He did not seek the assistance of others, neither was it offered from those who sat and watched the tape measure rewinding itself. It was during this task that Poppy and Keeley were witnessed working alongside each other rather than together, avoiding the necessity for social interaction. Similarly, in the activity – Create a floor plan, Poppy and Keeley chose to divide a task into two parts which they then completed separately. These strategies adopted by the students could be seen as an effective way to avoid the possibility of social interaction.

Literacy Difficulties

Many studies have demonstrated that BESD and literacy difficulties commonly co-occur (Brownlie *et al.*, 2004, Nelson *et al.*, 2005). Although students with BESD can struggle in all academic areas, Benner *et al.* (2002) report that student difficulties are more pronounced in the areas of reading and by Lane *et al.* (2008) in writing. Morgan (2001) points out though, that traditionally mathematics has been a subject in which students had to complete relatively little writing and this has been a reason why some students prefer mathematics to other subjects (Morgan, 2001 p. 232). This view is supported by Urquhart (2009) who adds:

> When many of us reflect on our school experiences, we recall writing in English and history classes, but not in mathematics. Math classes previously relied on skill-building and conceptual understanding activities. (Urquhart, 2009 p. 3)

Students' reluctance to engage with writing tasks has been a recurring theme throughout this study. Although language is an essential tool to communicate mathematical thought and concepts (Vygotsky, 1964), the process of writing, the act of transferring knowledge to paper was questioned by Damien during the reconnaissance stage. He articulated his opinion that if knowledge was not recorded in written form, then learning would not be retained. This issue seemed to divide the students into two groups, those who saw it as a pointless process of copying and those who said that they needed to 'scribble down' a few notes to be able to work a problem out. The importance of capturing mathematical learning through writing had little appeal for students when it simply involved copying notes from a whiteboard. For students who are reluctant to write, the relevance and purpose of any writing task needs to be made explicitly clear. That is, writing needs to be purposeful and not used as a behavioural control mechanism.

7.3.3 Research Question 3: How can Approaches for Teaching Students Identified as having BESD be Developed to Increase Opportunities for Learning Mathematics?

This final research question was designed to provide a space to discuss how the findings of this study might impact on wider professional practice. Three main areas of development that would improve opportunities for learning mathematics were identified. These are concerned with addressing students' social skills, developing learning tasks that rely less on literacy competence and building trust relationships between students within the mathematics classroom.

Social Interaction

For students identified as having BESD, mathematics lessons that promote opportunities for social interaction would significantly add value to students' learning as well as developing their ability to learn. The social development of students is an important and often cited purpose of education and should be a core goal of mathematics teaching. Mathematics lends itself naturally to creating opportunities for students to learn through social activities such as class discussion, working cooperatively through use of investigation and group work. Sutherland *et al.* (2000 p. 236) comment that collaborative learning practices are an effective instructional approach for students identified as having BESD and it is essential that the social and communication skills required to be able to do this are explicitly developed before engaging in such tasks.

Unfortunately, managing behaviour will always be of paramount consideration when working with students identified as having BESD and this can ultimately influence the choice of teaching style. Collaborative learning can lead more easily to off-task behaviours such as chatter and disruption than more teacher-led methods. It is therefore essential to ensure that collaborative activities are planned to be fully inclusive, so that every student can participate productively. As was seen with Activity 5, the 'Metric and Imperial Units' card task, interest with this task diminished quickly when students were not actively occupied. In essence, collaborative learning tasks involve an increased risk of failure if they are not well planned and thought through. Pedagogical approaches that present an increased risk of disruption are less likely to be considered for use with students who can be difficult to manage.

Literacy

A significant challenge identified by both students and researchers is that of writing. As Ollerton (2009) comments:

> writing for some students will be harder than doing the mathematics itself, so it is important to offer students different ways of recording what they think they have learned. (Ollerton, 2009 p. 29)

With greater use of discussion, teacher observation and the use of diagrams and drawings, the recording of student learning would reduce its reliance on written methods which students categorised as having BESD find difficult. For example, pre-printed worksheets were used in four of the activities to reduce the amount of writing the students had to complete.

Building a Climate of Trust

Students identified as having BESD are often referred to as 'challenging' because they represent a challenge to the traditional assumptions of education. In addition, they are students who are not always compliant. Looking at education from the students' perspective however, it is the classroom itself that is challenging as it can represent failure to any student with low self-esteem and a lack of social skills. Every time a student answers a question in front of their peers, they are placing their trust in the teacher. In this situation, the student accepts the possibility of being wrong, but within a climate of mutual trust they are free to experiment with mathematics without risking damaging their self-esteem. Therefore, what is needed is a change in the common perception of mathematics as being a subject composed of only right or wrong answers.

7.4 Pedagogical Implications

This section returns to the question of developing a mathematical pedagogical approach that supports learning for students categorised as having BESD. It addresses the tendency of professionals and researchers working with these students to focus on behaviour rather than productively on improving learning.

Lessons within specialist BESD provisions typically involve far fewer students than mainstream settings. This situation however is based on behavioural management issues, rather than being a pedagogical approach. While smaller class sizes certainly intensify the level of individual support for students, they do not automatically provide students with more motivation, engagement or understanding. Norwich and Lewis (2009) reported that special education does not necessarily mean specialised pedagogy. However, this study contests that there are certain factors that can enhance the learning for students identified as having BESD.

Almost thirty years ago, McLean (1987) found that disruptive behaviour in schools was traditionally analysed in terms of individual students and the causes were generally located within the child and the child's family background and circumstances. Research suggests that the 'within child' model continues to be prevalent in schools (Roffey, 2013 p. 9) and there are a wide range of factors that contribute to this. Traditional approaches for addressing students with BESD primarily focus on behaviour (Duarte *et al.*, 2013). Teachers often consider good behaviour as a prerequisite for learning to be able to take place (van der Worp-van der Kamp *et al.*, 2014). As this study and other research (Wheeler, 2010) has shown, when students are actively engaged in learning, behavioural issues are minimal. The benefits of focussing exclusively on addressing the learning needs of these students are twofold – improved learning and behaviour. That is, any behavioural issues that arise from difficulties in learning could be ameliorated at the same time as improving academic outcomes.

7.5 The Value of Action Research

My initial decision to adopt an action research methodology was based on Elliott's statement that 'action research is about improving practice rather than producing knowledge' (Elliott, 1991 p. 70) which was the primary goal of this research. His action research approach was ideally suited to an insider-researcher as it embraces the researcher's advantageous position of being able to live the research and participate in it. A participatory approach to research blurs the line between the researcher and the researched, that is, the research was, as far as possible, carried out with people rather than on people which is an important factor when working with students who can be difficult to manage at times. This study reported on data collected from six pupils, through pre and post interviews, audio recordings taken during three interventions and a final focus group interview. It can only hope to represent a moment in time for these particular students and cannot make generalisations to a wider group of learners. It is important to stress that in such case studies of singularity that any transferability lies with the reader and interpreter of the text. However, the advantage of carrying out this small-scale qualitative study was that it generated a richness and depth of detail which gave a better insight and understanding of the issues regarding the learning of this group of students.

7.6 My Learning Journey

In this final section I reflect on my own personal journey and development whilst carrying out this study. It would be naïve to suggest that I have not developed as both a teacher and a researcher over the period of this study and I believe this has changed my approach to both research and my daily practice within the classroom. In completing this study I have also become acutely aware that the roles of teacher and researcher cannot be performed in isolation from each other, but are inextricably intertwined.

Completing this study has challenged and changed the way I view, how and who I teach. When working with students who can be difficult to manage, it is often easier to provide worksheet based learning that students can complete independently. This study however involved taking risks, trusting students with more freedom in their own learning whilst encouraging peer interaction. Doing something very different ultimately proved more beneficial to student learning than using more teacher centred approaches.

Although planning and preparing activities that were practical and collaborative in nature was more time consuming, the improvement in student behaviour and learning which I witnessed during the course of the intervention stage far outweighed the time and effort involved. As a result of this study, my approach to teaching is increasingly focused on providing students with opportunities to discuss mathematics with each other and to learn from each other.

I do not claim to have found an all-encompassing pedagogical approach that is always guaranteed to engage students in learning mathematics, only that I have a better understanding of the issues that this group of students face, which at times, can make learning more difficult for them.

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9. Appendices

Appendix 1 *Letter Requesting Consent from Head Teacher*

Simon Quigley,
[redacted]

[redacted]

Tuesday 9th April 2013.

Dear [redacted],

I am writing to ask for your permission to carry out empirical research which will involve working with students from the school as part of my doctoral studies that I am undertaking at the University of Sussex.

Following our conservation today, I have included with this request for your consent, a copy of my research proposal along with ethical review documentation which includes a certificate of approval from the university's Ethical Review committee.

Data for this research project will be anonymised and collected during the students' normal timetabled daily mathematics lesson. No curriculum or staff changes will be made and students' learning will not be disrupted at all. There will be no deviation from the current scheme of work for mathematics and lessons will continue in the usual way; the only difference will be in the teaching style adopted by the researcher to deliver the lesson.

I intend to focus my research on four students aged between 13 - 15, who have been diagnosed as having ADHD. Information sheets will be given to both students and parent / carers that explain the purpose of the research along with a consent from. Students will be informed of their right to withdraw at any stage during the process should they which to do so without any detrimental consequences to their education.

I hope that I have provided sufficient information for you to be able to make an informed decision to giving your consent for my research project.

Yours faithfully

Simon Quigley

Appendix 2 *Information Sheet for Students*

Information Sheet for Students

I would like to invite you to take part in a project that I am doing for my studies at University. The project will look at how using different teaching styles affects how you engage with learning. Before you decide whether you wish to take part, it is important for you to understand what it will involve. Please take time to read the following information carefully. Please ask me if there is anything that is not clear or if you would like to know any more information.

What is the purpose of my project?
You have been chosen to take part in this project because you have a diagnosis of ADHD. I am interested to find out whether different styles of teaching make a difference to how well you learn. During your normal maths lessons I will be trying different ways to teach you, like using laptops, working in pairs and groups or doing practical activities. Everything else will be the same.

Do I have to take part?
It is up to you to decide whether or not you want to take part. You will still have to come to your lessons whatever you decide! If you do agree to take part, you can change your mind at any time without giving a reason. If you decide to stop, or to not to take part, will not affect you in any way.

What do I have to do?
After each lesson I will ask you questions on what you think went well or not so well for you, with the different things we try. All that I ask is that you will be able to tell me honestly what you think. This will probably only take about 10 minutes each time. Any information that I collect from you will only be used for my project and not shared or talked about with anyone else. I may need to photo-copy some of your class-work but I will not put your name on it. Everything you tell me will be treated as confidential and you will be completely anonymous.

What to do next
If you decide not to take part, you do not need to do anything. If you would like to take part, please let me know and make sure that your parent / carer completes your consent form.

Any questions?
If you would like to discuss anything or if you have questions, please let me know during your next maths lesson or at lunchtime.

Thank you for reading this

Appendix 3 *Parent / Carer Letter and Consent Form*

Friday 3rd May 2013

Dear Parent/Carer,

My name is Simon Quigley and I am the mathematics teacher at XX School. I am completing a research project at the University of Sussex as part of my Educational Doctorate. In my project I want to look at whether learning maths for young people with Attention Deficit Hyperactivity Disorder can be improved by using different teaching styles. During your child's normal maths lessons I will be trying different approaches to teaching, like working in pairs and groups or doing practical activities. The mathematics curriculum will remain unchanged.

I would like to tape record an interview with your son/daughter to help me remember what your child has said about their experience of the lessons. The interviews will be confidential and the only people who listen to the interview will be myself. Your child's name will not be used and they will remain anonymous in any work that I write. I would also ask for your consent to analyse and record some of their class-work to help me better understand how s/he learns.

If you are happy for your son/daughter to take part, I would be very grateful if you could sign the attached form and return it to me at the school. There is no compulsion to take part in this project and should you not wish for your son/daughter to take part, I can assure you that there will be no detrimental effect on their education.

If you would like to know more about the project, please feel free to contact me, either by email simonquigley@ .sch.uk or by phone XX.

Many thanks for taking the time to read this letter and for your help.

Yours sincerely

Simon Quigley

I am happy to let my son/daughter

(Print name) …… to take part in the research project.

✓ I agree to audio recording of an interview with my child.

✓ I understand that my son/daughter can stop the interview at any time.

✓ I understand that my son/daughter has the right to change their mind about having their recordings or class-work used in this project at any time.

✓ I understand that if my son/daughter does not want to take part, it will not affect him/her if help is needed in the future.

Signed……Parent/Carer

Appendix 4 *Staff Questionnaire*

Dear colleague,

I am currently completing a research project as part of my Educational Doctorate with the University of Sussex. The focus of my thesis is primarily the extent to which pedagogy has any effect on the learning mathematics for students with Attention Deficit Hyperactivity Disorder.

I would like to invite your thoughts on how you think the XX group learn best in your subject. Please be assured that any information that you offer will not be used for any other purpose, other than to inform my research project.

Working Together?

1. a) Does your subject area require students to work in pairs and/or groups?

   b) If so, to what extent do you allow students to choose their own groupings?

   c) Do you think that the students work well in pairs and groups?

Practical Activity

2. a) Does your subject area involve practical activity?

   b) Do you think that group XX learn better through the use of practical tasks?

Peer Learning

3. a) Do you think students can learn better from each other or from the teacher?

   b) Do you offer opportunities for students to discover knowledge for themselves during your lessons?

4. In considering group XX, in which way do you feel this group learn best?

Thanks, your help is great appreciated.

Simon

Appendix 5 *Lesson Plans and Worksheets*

Teacher: Mr Quigley **Group:**

Assistant: Learning Support

Subject: Mathematics	**Date** Monday 20th January 2014
Assessment : Use metric units to measure length, capacity and mass (AT3 - Level 3) Use correct units of measurements to read measurements (AT3 - Level 4)	**Planning:** First part of three lessons looking at units of measurement and estimating.

Learning Objective: To be able to make a reasonable estimate of a quantity.
Learning Objective: To be able to recall commonly used measurements.

Must: Demonstrate an understanding of which units of measurement are commonly used for length, mass and time. (All students)
Should : Be able to measure and record measurements accurately.(Kat & Poppy)
Should Be able to make a reasonable estimate. (Clayton & Damien)
Could: To be able to differentiate between metric and imperial units.(Rhys, Robbie & Keeley)

Curriculum Links
Literacy: 'Estimate' means to have a rough idea, 'Strategy' means to plan to achieve a goal.
Numeracy: Select and use appropriate measuring equipment.
PSHE: Using peer/self-assessment to communicate effectively in given situations (peers/adults) using both written and verbal skills.

Starter: *How long is a minute?*
Students to sit quietly with eyes closed and estimate how long they think a minute is. They raise hand silently when they think a minute has passed and their time is recorded on whiteboard.
When all students have finished, compare to see who was closest and discuss any strategies that they may have used to estimate one minute.

Explain what is meant by estimating and that students will be measuring items using common metric units of measurement.

lain: Students to discuss/decide which would be best units to use to measure items on orksheet. They will also need to decide what measuring tool they should use. Students will ake an estimate of the quantity before measuring.

Notes: First Class stamp is currently 60p, saxophone anywhere between £400 - £1500 and price of a tin of Heinz baked beans is 60p – 90p

Deployment of LSA: Ensure students have understood that they need make an estimate, before measuring and to make sure measuring equipment is available. Recording times and using stopwatch.
Resources: Recording sheet, 30cm rulers, metre rulers, trundle wheel, stopwatch, weighing scales, newspapers.

Teaching Method: Practical / Kinaesthetic activity **-** Whole Class

Plenary
Gather the whole class and select student to demonstrate what they have learnt. Teachers to clarify any misunderstandings. Complete Attitude to Learning Points for lesson.

Lesson Plan

Teacher: Mr Quigley **Group:**

Assistant: Learning Support

Subject: Mathematics	**Date** Monday 27th January 2014
Assessment : Develop strategies for solving problems and apply these strategies in a practical Context. (AT1 - Level 4) Draw simple conclusions and give an explanation of their reasoning (AT1 – Level 5)	**Planning:** Third of three lessons looking at estimation skills.

Learning Objective: To be able to make a reasonable estimate of an unknown quantity.
Learning Objective: To understand the processes of making an estimate.

Must: To be able to measure accurately and record in a table, all students' heights (Clayton)
Should : To provide a reasonable estimate for one of the impossible questions with a justification / explanation**.** (Kat & Poppy & Damien)
Could: To produce a written account of working out and thinking to arrive at an estimate. (Rhys, Robbie & Keeley)

Curriculum Links
Literacy: 'Prediction' means to make a reasonable guess as to what will happen.
ICT: Use of internet search engines to select required information or fact.
PSHE: Working together and communicating effectively as part of a paired group.

Starter: *How many stars?*
Students are given A4 sheets containing numerous triangles, stars, rectangles and circles. Working in pairs for 3 minutes, they must discuss a way to estimate how many stars there are on the sheet.

Who is the tallest?
By estimating and starting with the tallest, can you put everyone in the group in order of height? From previous lesson's worksheet where students measured their own height, is the order you predicted correct?

Main: Students to work in pairs or small groups to find estimates for at least two questions of their choice from the sheet. Students may use internet to research any facts that they may need.

Note: Roll of toilet paper, on average weighs 227 grams.

Deployment of LSA: To offer support to those struggling getting started but minimal suggestions on how to approach work.
Resources: Laptops, worksheet .

Teaching Method: Discursive activity **–** Pair work

Plenary
Student to volunteer to share what they have done during the lesson.
Complete Attitude to Learning Points for lesson.

Worksheet – Impossible Questions

Garage Could you build a garage with 1000 house bricks?	
Toilet Paper A roll of toilet paper has 280 sheets. Each sheet is 14cm long. Could you carry 1Km of toilet paper?	

Lesson Plan

Teacher: Mr Quigley **Group:**

Assistant: Learning Support

Subject: Mathematics	**Date** Tuesday 21st January 2014
Assessment :	**Planning:** Second part of three lessons looking at units of measurement and estimating.

Learning Objective: To be able to estimate a suitable scale for sketch of school.

Must: to recognise which units are metric measures (All students)
Should : to make sensible estimates for the dimensions of at least two rooms (Kat, Keeley & Poppy)
Should : to be able to make a rough plan of at least two rooms of school with measurements. (Clayton, Damien, Rhys & Robbie)

Curriculum Links
Literacy: The word 'Sketch' in this context means the same as rough outline, or draft.
PSHE: Students to work in groups, deciding between themselves, their own roles and responsibilities for the task.

Starter: Students to cut out cards with different metric and imperial units of measurement. In groups, students to place cards in correct place in table. Cards to be grouped by whether they are Metric / Imperial measures and by what they are used to measure.

Main: Ask students to estimate the floor area of school, classroom and hall. Students are to make an approximate sketch of the school. Students will need to choose a suitable scale to use so that the plan fits on an A3 sheet of paper. They will need to record measurements on their diagram and decide what units they will use. Students will have to decide which features and the level of detail to include in their plan.

Note: The School Fire Evacuation Plan with fire escape routes (which is a plan of the school) is on the wall in every classroom!

Deployment of LSA: To ensure students are on-task around school
Resources: Trundle wheel, 7.5 metre tape measures

Teaching Method: Practical / Kinaesthetic activity **-** Whole Class

Plenary
Gather the whole class and select student to demonstrate what they have learnt. Teachers to clarify any misunderstandings. Complete Attitude to Learning Points for lesson.

Appendix 6 *Scheme of Work for Autumn Term 2013*

School XX

Mathematics

Scheme of Work

Year: Term: Autumn

Topic	Objectives	Resources
Reading and converting units Interpret scales on a range of measuring instruments, and recognise the inaccuracy of measurements Convert measurements from one unit to another Make sensible estimates of a range of measures	• Interpret scales on a range of measuring instruments including mm, cm, m, km, m*l*, c*l*, *l*, mg, g, kg, tonnes, °C • Indicate given values on a scale • Know that measurements using real numbers depend upon the choice of unit • Recognise that measurements given to the nearest whole unit may be inaccurate by up to one half in either direction • Convert units within one system • Convert metric units to metric units (Metric equivalents should be known) • Convert imperial units to imperial units (NB: Conversion between imperial units will be given) • Convert between metric and imperial measures • Know rough metric equivalents of pounds, feet, miles, pints and gallons, ie **Metric Imperial** 1 kg = 2.2 pounds 1 litre = 1.75 pints 4.5 *l* = 1 gallon 8 km = 5 miles • Estimate conversions • Make sensible estimates of a range of measures in everyday settings • Choose appropriate units for estimating or carrying out measurement	Mathematics A Foundation Student Book Chapter 11 MyMaths.co.uk links Measures
Scatter graphs and correlation Draw and interpret scatter diagrams Recognise correlation and draw and/or use lines of best fit by eye, understanding what these represent Look at data to find patterns and exceptions	Draw and interpret a scatter graph Look at data to find patterns and exceptions Distinguish between positive, negative and zero correlation using lines of best fit Interpret correlation in terms of the problem Understand that correlation does not imply causality Draw lines of best fit by eye and understand what it represents Use a line of best fit to predict values of one variable given values of the other variable	Mathematics A Foundation Student Book Chapter 25 Mymaths.co.uk links Scatter Graphs Line of Best Fit

Appendix 7 *Post Intervention Individual Interview Questions*

Final Interview Questions

1. Do you agree, disagree or have no opinion for each of these questions.

	Definitely Agree	Agree	Neither Agree or Disagree	Disagree	Definitely Disagree
1. Maths is a difficult subject.					
2. I always feel that I can ask another student for help, if I don't understand something.					
3. I always feel that I can ask an adult for help, if I don't understand something.					
4. I always need someone to work with me in maths.					
5. Maths is about real-life?					
6. Working with others help me understand better					
7. The way that I am taught maths makes a difference to me.					
8. Working with my classmates makes learning easier for everyone					
9. I understand maths better when another student explains it to me.					

2. We have been looking at the topic of estimation over the last few lessons. What do you think estimation is?

3. There were no right or wrong answers in the work that we have been doing, just a range of possibilities. What do you think about that?

4. A lot of the work that we have done involved you doing practical tasks?
a) How did this help you to learn?
b) Would you like to learn this way again?

5. You had to work with other people, for a lot of the time.
a) How did this help you to learn?
b) Would you like to learn this way again?

Appendix 8 *Key Stage 2 SAT and Teacher Assessment Results Recorded for Students in Study*

	KS2 TA			**KS2 SAT**				
	English	**Maths**	**Science**	**KS2 Reading (Test)**	**KS2 Writing (TA)**	**KS2 English**	**KS2 Maths (Test)**	**KS2 Science (TA)**
Keeley	4	4	4	4	4	4B	4C	4
Poppy	3	2	2	3	3	3C	N	2
Robbie	M	M	M	4	4	4B	4B	M
Rhys	3	3	4	3	3	3B	2A	4
Kat	3	2	3	3	3	3	N	3
Clayton	2	1	1	Bel	Bel	Bel	Bel	1
Damien	2	1	1	2B	2	Bel	Bel	1

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