How can task design be used in a year 7 mathematics classroom to allow for, and encourage, the development of harmonious and cooperative relations amongst peers?

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Introduction

The purpose of schooling is undoubtedly to prepare students for life after school, in the majority of situations that means to be successful in the workplace. A recent list created by Forbes list these ten skills, in order of importance, as being the most desirable traits that employers are looking for:

> "1. Ability to work in a team structure
> 2. Ability to make decisions and solve problems [joint first]
> 3. Ability to communicate verbally with people inside and outside an organization
> 4. Ability to plan, organize and prioritize work
> 5. Ability to obtain and process information
> 6. Ability to analyze quantitative data
> 7. Technical knowledge related to the job
> 8. Proficiency with computer software programs
> 9. Ability to create and/or edit written reports
> 10. Ability to sell and influence others."
>
> (Forbes: 2014)

As a mathematics teacher most people would agree that it is part of my role to take care of traits five and six but whose responsibility is it to prepare students for the rest? I am not including point two in this list as it would be entirely possible to teach the Mathematics Curriculum procedurally, thus never requiring students to make any real decisions for themselves. No one is born with a true mastery of these skills and therefore they need to be learnt or developed over time. It is my opinion that whilst some individual teachers may take it upon themselves to do so, there are very limited opportunities in a school where the first three skills are explicitly taught, required or assessed. I believe this to be an injustice and a disservice that, through no fault of any teacher, has been prevalent in education for years and something that shows no sign of changing soon.

Jaworski (1998) claims that 'developments in mathematics teaching occur when teachers address "hard" or "difficult" questions about their teaching and the thinking which motivates their teaching' (Page 3). I hold the issues discussed above to be an important

aspect that is lacking in many children's education that I have encountered and, as a fairly inexperienced teacher, currently have no way to remedy the situation in my classroom. As a result the aim of this assignment is to discover and then implement strategies in which mathematics can be taught to a Year 7 class in order to try and instil some valuable skills that will serve them well later in life through the careful design and implementation of classroom tasks. Specifically I will be researching how cooperation and harmonious relationships can be developed amongst peers; two skills closely related to at least the top three desirable traits that employers wish to see.

Background

The motivation for this was born out of time in my previous school where there was a noticeable amount of disharmony amongst the cohort at the school. I started to wonder what my role in tackling this was as a mathematics teacher. I started to read around the subject and subsequently based my end of year assignment on this topic. By the end, I had realised the importance for every teacher to work collaboratively to instil these values and, whether you were a teacher of the arts or sciences, the burden of responsibility was the same. The purpose of this research is to build upon the work I did last year and will endeavour to now find practical ways to complete these aims.

I have since moved school but see the need for this action research to be carried out here as well. This research will be carried out in an International School in Spain that is teaching the English Curriculum. The nature of the school means that it is fee-paying so the majority of students come from affluent backgrounds, something that is in stark contrast to my previous school. I chose to focus the research on my Year 7 group as I felt they would be the most open to new ideas I trialled due to their relative inexperience of Secondary School. Throughout the course of the year some students joined or left my class either due to set changes or because they left the school. On average the class had twenty-one students aged 11 or 12, typically there were around five females and sixteen males. The results given in the findings section later only include those students who stayed in the class throughout the entirety of the research process. This was 17 students, 4 females and 13 males. All but one of them were Spanish nationals with the other one being Brazilian.

Literature Review

This part of the assignment will critically look at the research literature, white papers and recent media sources surrounding strategies behind creating cooperative and harmonious relations amongst peers. It will first analyse the issue from a more holistic point of view that encompasses nationwide problems and legislation on the matter. It will go on to evaluate various benefits, difficulties and possible limitations that this approach to teaching may create before looking specifically at the practical strategies needed to implement it in a class, firstly through anything that needs to be in place pedagogically to complement the structure of the task, and then the task design itself.

The Wider Issue

'Eisner reminds us of the simple but seemingly elusive fact that the goal of school is not to do well in school but to do well in life' (Boaler, 2008:168). With this being the case, any major aspect of modern day work life that a school fails to prepare students for should be addressed by people in a position to implement necessary change. One of the biggest changes that has occurred in the past generation is how much more globalised the world has become (Boaler, 2008). With the current ease of communication and travel, making our planet seem ever smaller, the likelihood is that a 21st century student will be untouched by increasingly multicultural environments in either their personal or professional life is unlikely. A recent example of this is the report from the Airports Commission that claims a third runway at Heathrow airport will add £147bn in economic growth by 2050 (BBC, 2015), thus demonstrating, in part, how international relations are becoming a cornerstone of any strong economy. As well as international transport literally bringing people together the ability to instantly communicate with people anywhere in the world at any time will almost certainly increase the importance that employers put on someone's ability to socialise and work well with others in a wide variety of situations.

Even without these changes to our world, few would argue that being able to cooperate with someone or to work well socially is not important. Despite the skills discussed having been an important part of a student's life for some time and the necessity for these is not a new idea, though perhaps now they are more important than ever, there are still a large number of people stating that things need to change as they are currently not up to task. The Council of Europe (2008) stated that schools should be increasing the opportunities that students have to practice intercultural dialogue in order to develop themselves both socially and personally in preparation for a more globalised world. As recently as this year, Lin et al (2015:95) have felt the need to state 'given that interaction with peers becomes increasingly influential during middle childhood and adolescence, schools should give priority to establishing positive contexts for students to experience peer interaction'.

A major barrier to this at the moment is a seeming increase with pupil indiscipline in schools. Whether it is the government blaming teachers (BBC, 2014), the head of Ofsted blaming head teachers (The Guardian, 2014), teachers blaming parents (Daily Mail, 2013), unions blaming the lack of corporal punishment, (Daily Mail, 2012) or journalists blaming MPs (BBC, 2004) everyone seems to have an opinion on student behaviour. One commonly proposed solution to this, as mentioned in the majority of the above articles is to ensure that teachers become stricter and more draconian. Claxton (2009) paints a common picture of what can happen in this circumstance by commenting on one specific teacher and how, through her ability to maintain a calm environment in a class where students work well, they were deprived of the chance to develop social or cooperative dispositions for themselves. Instead, they can only work well under the strict and clear instruction of an authoritative presence, thus meaning that once the presence of the teacher is taken away or the students leave school they would find it difficult to be calm or work well.

Staples (2007) and Jacobs et al (2006) claim that there is an alternative to this and a way to get students to work well collaboratively and harmoniously, a way that has been substantially researched in the past but whose outcomes and suggestions are not being used or implemented in the classroom. Before looking more in depth at these, the legal responsibility placed on teachers, and then in particular mathematics teachers, to develop these social skills with their students will be analysed.

In 1988 a statutory duty was placed on schools to prepare students for the types of experiences and responsibilities that adult life would entail (Education Reform Act, 1988). It also put an onus on schools to develop a broad social skillset in every pupil. A decade later the Qualifications and Curriculum Authority (QCA) said that is was 'unfulfilled expectation in [the] national agenda' (QCA, 1998:8) but that they were preparing new strategies to remedy this problem. Part of the new strategy included the specific requirement for students who are finishing Key Stage 3 to be able to:

> '- contribute to small group and class discussions on matters of personal and general significance and present the outcome to a class;
>
> - work with others to meet a challenge of shared significance through negotiation, accommodation and agreed action, and be able to reflect on the process' (QCA, 1998:49)'

This report by the QCA went on to comment on the specific duty that different teachers would have in promoting this ideology and developing these skills, suggesting that the weight of responsibility a teacher has to these duties varies depending on the subject taught. It suggests that history, geography and English teachers will be the most likely candidates needed to promote this but that teachers of mathematics can help by contributing '...to a knowledge and understanding of electoral systems and opinion polls and the skills to get the best from them' (QCA, 1998:53) for example. This supports Boaler's (2008) claim that there is almost no responsibility from the National Curriculum for teachers of mathematics to develop any sort of personal characteristics in pupils.

Eventually the responsibility was almost entirely taken off all teachers when, in the 2002 National Curriculum, Citizenship lessons became compulsory and the place where students would develop these skills. For a variety of reasons including: lack of funding, poor resources and having non-specialist teachers however, these lessons have, in the past, been shown to not have the desired effect (Klein: 1993, Taylor: 1994, Whitty et al, 1994 and Saunders et al, 1995). Noddings (2005) and Boaler (2008) argue that all subjects should help contribute, and Hansen (1993) and Carr (1993) make a stronger point and claim that teachers will inevitability help contribute. They state that whilst being seen in a position of

authority in students' lives that teacher will, in some way, play in part in shaping their social and moral standpoints and as such have a responsibility to act accordingly.

In terms of promoting the skillset in a pupil to develop socially harmonious and cooperative traits, it is therefore the duty of each individual teacher to play a part. This next section will be looking at the benefits, difficulties and limitations of adopting a pedagogy that promotes this with a focus of it being implemented specifically in mathematics classes.

Benefits, Difficulties and Limitations

In order to develop the skills necessary to have socially harmonious and cooperative relations amongst peers, students need to practise working together. Due to this taking place in a mathematics lesson it is obviously necessary that whilst doing so they are learning and engaging with mathematical content in a meaningful manner. To get adolescents to either work well together or to engage in mathematics can be a challenge and to try and ensure both happen simultaneously seems an even bigger one. Cohen claims that 'the research on cooperative learning has been moving past the necessity to defend this strategy as a legitimate method of instruction' (1994:30). Geest and her colleagues noted that, during their endeavour to record how low-attaining students can work at mathematical levels not normally expected of them, a surprise to them was 'the variety of ways in which interaction in the classrooms between student and student… promote[d] learning' (Geest et al, 2003: 18). In a meta-analysis of international mathematics teaching, one of five notable aspects of a classroom where students will be able to progress mathematically was where students are 'encouraged to work in non-competitive ways with their peers' (Gutiérrez: 2002, 15). Black et al (2007), Boaler (1997), Brighouse (2003), Hiebert et al (1997) and Watson et al (2003) all speak highly of the potential benefits cooperative learning has in the classroom both socially and academically. The passage below highlights these benefits and again, demonstrates the variety of sources available for evidence on the matter:

> 'Advocates argue that it fosters learning academic content and social skills (Antil, Jenkins, Wayne, & Vadasy, 1998; Cohen, 1994; Johnson & Johnson, 1991; Slavin, 1996; Webb & Palincsar, 1996), supports democratic and social justice goals (Cotton,

2001), and leads to greater intergroup harmony (Aronson & Bridgeman, 1979; Slavin & Cooper, 1999)'

(Esmonde, 2009a:1009)

There is a multitude of evidence that being given the chance to work cooperatively can have beneficial effects for a student's mathematical skillset, yet Slavin (1990) notes that this is not always the case and groups do not always work well together. There are various examples where teachers have attempted to produce cooperative learning and they have not found it beneficial. In the case of Stuart (1994) she claims that the time spent on ensuring people work well together could not be justified as it detracted too much from their time the class had to cover course content. Staples (2007) also notes that if it is not the norm for the students then any change in a classroom environment may be met with resistance and uncertainty and therefore end up being detrimental to their learning.

Along with the possibility of it not being time-effective Weissglass (2000) and Baker and Clark (2011) agrees with Cohen et al who state that 'rather than increasing equity, cooperative learning has the potential to reinforce a severe educational and social problem' (1999:80). This seems to happen most often when students perceived as being of a high status will dominate tasks, and therefore the learning, whilst lower status students will be at the periphery of any activity and will have little chance to engage with the materials. Boaler (2008) states that trying to create equal status relations amongst students that could lead to productive and equitable group work is hard as many classrooms themselves are not equitable in their nature.

Even if the task is not completely dominated by students of a high status, Pescarmona (2014) notes that those dominant members may split the task up into different individual activities that can end up excluding some, a process which can essentially turn the group exercise into a mixture of individual tasks rather than a group one.

Esmonde (2009a) goes on to highlight another difficulty by stating that even if the relationships are harmonious and cooperative then, depending on the nature of the task itself, it may not be appropriate to work or learn in this manner. An example of this is that 'in rote or procedural tasks, students might be encouraged to strictly follow a protocol without considering alternatives; as such, a different set of interactions might be

appropriate - in fact, some even argue that group work is inappropriate for such tasks' (Phelps & Damon, 1989) in (Esmonde, 2009a:1017).

Pescarmona (2011) and Cohen (1998) both state that another difficulty when trying to implement this kind of change in a classroom is the difficulty it takes to do so individually. Pescarmona observed a group of teachers trying to implement this kind of change into their classroom and noted a considerable about of stress, resistance and demand that it created. Cohen gives a list of resources that a teacher would need in order to implement this properly, these include: colleagues with a background in social science or psychology, a group of well-qualified educators and a group of teachers who will lead the change in the classroom.

To also highlight the difficulties involved Kilpatrick (2003) claims that there is not enough information regarding cooperative learning about what goes on in the classroom in order for the approach to be adopted properly and Ridgway et al (2003) claims that a combination of professional development or importing someone else's materials into a classroom is not enough to really implement classroom change.

There seems to be a clear need for a multitude of changes to be implemented in the classroom in order to foster a truly cooperative and harmonious environment. Each practitioner at their own school will inevitably encounter certain obstacles to overcome. This research was no different and a few barriers were encountered in trying to fully enact the strategies suggested in the literature.

Firstly there is some evidence that when bilingual students work in a cooperative setting that a beneficial strategy is for them to us their first-language (Echevarría et al, 2000; Gutiérrez, 2002). This goes against the message delivered by the school's management who insist that, whatever a student's first language, they should be speaking English for the entirety of their time in class. This issue is particularly relevant to this piece of action research as, due to the cooperative nature of the work that will be undertaken by the students, there will need to be an increased amount of communication between them. Baker and Clark (2011) notes that when students do not speak in their mother tongue that language problems can be a big difficulty. It could also be argued that this English-only practice in some way suppresses their culture and fails to recognise the diversity of students

that are in the class, a strategy which Pescarmona (2014) claims is one of the benefits of an education based on a truly cooperative and equitable approach.

The final difficulty was the demand and structure of the scheme of work in place within the mathematics department I was working at. At certain points throughout the year little time was allotted to certain topics and due, to the frequency of assessments, there was little flexibility within the scheme itself. Whereas some plan would have included topics as part of a wider theme to be worked at over a prolonged period of time these items became stand-alone items. This meant that no premade schemes of work, no matter how tried and tested elsewhere and how good they could have been at creating a cooperative environment, could be used as it would not have fitted the sequence that some topics had to be taught in.

This section then, as well as highlighting the plethora of studies that support the benefits of cooperative learning has brought to light some of the difficulties that will need to be addressed in order to do it effectively, these included: language barriers, rigid schemes of work, the danger of enhancing inequalities and the appropriateness of group work all the time, to name a few. The next two parts will look at strategies that can be put in place to attempt to see how to ensure groups work well together whilst actively trying to negate the damaging effects that peer status and unsuitable task design can have.

Pedagogical Theory Behind the Approach

Creating a cooperative and harmonious atmosphere in a classroom is no simple task and a multitude of factors need to be considered in order to foster the desired outcomes that this assignment is looking for (Pescarmona, 2014; Stuart, 1994). Merely sitting people together and asking them to work cooperatively is rarely enough, social abilities need to be taught.

Martino & Maher paint a picture of the kind of things one should see in a cooperative classroom and the types of activities that should be used:

> 'Students must be willing to engage with new ideas, build models, listen to input from other sources, and sometimes expose their own confusions or misconceptions... A task should provide the opportunity for student reinvention of

> mathematical ideas through both exploration and the refining of earlier ideas. The task should also be open-ended in design to allow students to build a powerful repertoire of mental images to draw upon for the construction of representations and mathematical ideas.'
>
> (1999:53-54)

This kind of classroom environment is the aim and to create this involves overcoming some of the aforementioned obstacles. To do this Esmonde (2009a and 2009b) found that task design by itself is not enough. Even when students are given identical activities different groups of learners can approach the tasks in different ways, some cooperatively and others less so. Esmonde goes onto to say therefore that task design must be accompanied by an appropriate pedagogy that will foster the desired outcomes. Claxton (2009) agrees with this by stating that stand-alone activities in a classroom will not be enough to create the dispositions that students need to have in order to work cooperatively and harmoniously on a task and that a suitable culture should be 'infused' into the classroom.

It is therefore essential that for task design to be used to promote and encourage cooperative and harmonious relations in a class that a suitable pedagogy is adopted as well; task design by itself is simply not enough.

A popular pedagogy to follow in this regard is one called Complex Instruction (CI), developed by Cohen and Lotan (see Cohen, 1998). Pescarmona (2014) states that 'the goal of CI is to systematically attain social justice by means of dialogue and reciprocal understanding among learners with different viewpoints and abilities' (Pescarmona, 2014:189). Whilst the aspects of social justice will not be analysed in this assignment the outcome of producing a harmonious and cooperative classroom will be. Through the techniques used in CI, students act as resources for each other and it develops openness to their peers (Cohen et al, 1999).

Boaler adds some extra techniques onto CI that she noticed in Railside School where 'the goals of high achievement and equity were achieved in tandem through a mixed-ability approach that is not used or well known in the UK' (2008:167). At this school, she claims the teachers were adopting the strategies of CI namely: multiple ability treatment, assigning roles, assigning competence, and that students were actively encourage to be responsible for each other along with three other techniques that she noticed were prevalent in these

classroom, these were that: the teachers had high expectations, praised effort over ability and teachers emphasised learning practices (Boaler, 2006 & 2008). It should be noted that there is a report that claims the effects of these techniques were not as successful as claimed by Boaler (see Bishop et al, 2012).

One of the problems highlighted earlier was that certain students will be perceived as having a lower status than others, either by themselves, by their peers, or both. As a result these students may not feel comfortable contributing to a task as much as others, alternatively their peers could consciously or unconsciously exclude them. To combat that CI adopts two strategies. The first of which is to implement a multiple-abilities treatment. This is where the class are told that mathematics is not something that people either are or are not good at but that mathematics is a discipline that requires a multitude of different abilities and that every student is good at some of these but that no student is good at all of them. The second strategy is more subtle and involves the teacher being aware of, whilst students are working on a task, a member of the group being perceived as having low-status and for the teacher to intervene in some way to raise the profile of that student amongst the group. This can be done in various ways, a few examples are ensuring their opinions are heard, publicly praising their ideas and highlighting contributions they have made (Cohen et al, 1999).

Another one of the problems highlighted earlier is the need for students to learn how to act in a cooperative and harmonious manner. Firstly Cohen and Ball (2001) recommend making it clear to students by explicitly telling them how to work. Additionally they suggest activities known as skillbuilders that help develop these cooperative learning strategies. Pescarmona (2014) elaborates on these and says that they enable students to interact with each in a positive and harmonious way. She also notes that the process of improving a student's skillset itself may involve arguments and disruptions along the way.

Baker and Clark (2011) break up their ideas of how cooperative learning should take place and agree with a lot of the strategies mentioned here. These include recognising low status students and endeavouring to raise their profile, to internalise norms of how to work well together, ensure students use each other as resources and additionally to give specific roles in a group to ensure everyone has a part to play.

To avoid students having a stark contrast in their status positions amongst their group, Lin et al (2015) suggest getting them to work with friends. They use Azmitia and Montgomery (1993) to back up their claim as they found that friends were more likely to work together in a harmonious yet critical way and are able to evaluate each other's work in a way which helps them learn. This strategy however, despite going some way to ensure students work in a harmonious and cooperative manner, will never develop their social skillset fully as, in real life, the people you need to interact with are not always going to be your friends. The aim of this study is to try and find ways of getting students to work together cooperatively. Although it may be considered a success then if students are placed with peers they work well with already, most likely friends, the purpose is more specifically to teach students the skills to be able to work cooperatively with as many different people as possible. This will not only increase their social abilities but also emulates real world situations more closely and will provide greater preparation for life after school. This means then that although it may be an easy way to produce cooperative groups this assignment considers grouping students how they would chose to group themselves as a bit of a shortcut and a cooperative classroom of that nature will not fully satisfy the goals of this research. Other suggestions about seating include Stanford's (1997) suggestion of random groups as it is claimed that this will be the fairest way to assign students.

Task Design and Implementation

If all the appropriate skills and mindsets are ingrained within the students in the classroom than the next important element would be the creating task itself. A task that compliments the pedagogy of CI, which is also designed to be carried out and assessed in such a way that all other problems mentioned so far are addressed, whilst all the while being suitable to the unique environment of the school and the specific class in question.

Baker and Clark (2011) created a general list of attributes that a task should have, particularly with international students studying a subject in their 2nd language in mind. They state that teachers should:

- include multi-ability tasks, problem solving, decision-making, creative and inventive thinking

- avoid emphasising writing as it will discourage 2nd language speakers

- ensure assessment is not unidimensional

- avoid tasks that can be done easily by one person

- avoid tasks that require a lot of prior knowledge that may favour domestic students

- build discussion into the evaluated requirements of the task and train students in interaction skills

Slavin (1996) argued that the most prevalent factor that a student needs to have in order to effectively learn cooperatively is motivation. Students should be motivated to do the work and to do it together. In his review of cooperative learning strategies he found that if interdependence is an underlying property of the task at hand that the group will be more engaged and more likely to work together on it. With this in place, there will be more communication within groups and more collaborative thinking. He also found that if a group being rewarded for good work and accountability for anything where little effort was put in by an individual are ingrained within the task then this often ensures that teams work well together.

As well as individual accountability Cohen (1994) states that if a group has tasks that are too individualised then good group work, and the expected social gains of engaging in group work, may not be achieved. Some criteria that may make a group task too individualised are if they need to each submit a version of the work that has been set or if the whole task is too easily separated into components that do not obviously rely on one another.

Just as there seems to be an appropriate name for the type of pedagogy suited to creating classrooms with cooperative and harmonious relations there also appears to be a name for the tasks that endeavour to do the same. They are called 'Ill-Structured (IS) tasks' and, by their design, seem to tackle a lot of the barriers in the way of this cooperative classroom. These tasks can have either a variety of answers or an undefined answer, have multiple entry points, will require the skillsets of more than one student and cannot be accomplished individually (Esmonde, 2009a; Cohen, 1994).

The issues behind needing tasks which: require various skills, cannot be accomplished by an individual or, which have multiple entry points have been discussed previously. The reason of why a task may need more than one answer however has not and is explored below.

Cohen (1994) states that variable-answer tasks will, by their nature, create far more opportunities for students to discuss the task along the way. It also means that by the end of the task there can still be plenty more to discuss. Brabeck and Wood (1990) suggest that these tasks will inevitably create some conflict if people end up with varying answers, but that the resolutions of these conflicts can be greatly beneficial in improving both the academic and social outcomes of the task. Chizhik (2001) points out that students should become comfortable with encountered these kinds of problems as they come a lot closer to simulating the kinds of experiences that people will face later on their work lives.

One of the strategies used that enable multiple-entry points, engages students and allows certain students to more easily access the task at hand, is the use of manipulatives. In the mathematics room these could include multi-link cubes, Cuisenaire rods, nets and solids etc. Cohen (1984) and Cohen and Lotan (1995 & 1997) all state how these can be used to get more members of a group engaged and to tackle the problem cooperatively. Although some students may need to use the manipulatives because without them the task is too abstract or they are unable to grasp certain ideas, Cohen and Lotan (1997) note that students who chose to use the manipulative do so without any loss of status, namely that they are not perceived as being less mathematically apt just because they are using the materials at hand. Foote and Lambert (2011) witnessed how students were able to use manipulatives in order to share solutions with a class in a situation where they would have been unable to do so without them. They also noted how over time certain students' confidence grew in presenting and by the end of a school year were more able to present solutions and tackle problems without these manipulatives.

An important aspect of designing a task is deciding upon how to assess it. Depending on how it is done can dramatically alter the way in which students access the task itself. This part of the task is tied in very closely to the motivational aspect discussed earlier. Assuming that students will want to complete a task successfully, the definition of success, something normally defined by the teacher, can strongly influence what happens when the students are actively working on the activity. Whilst Stuart (1994) states that certain assessment

strategies by themselves are not enough to ensure cooperation without other strategies in place, they can certainly encourage it. Esmonde and O'Connor (2008) note that if an assessment is based solely on correctness than this may be more likely to exacerbate inequalities and may encourage students of a higher status to be in control. As an alternative, they suggest grading on positive group interactions. Esmonde (2009b) suggests choosing one student at random from a group to present the group's findings and then grading the whole group on that presentation, she also suggests summatively assessing each student and then giving the group the mean score of its members. Other strategies are to grade them on their discussions and for this she recommends giving a rubric with the different levelling criteria on so students are aware what constitutes good group discussion. Boaler (2006) observed similar techniques being used effectively and also saw teachers asking a question to a group member, if that student was unable to answer the question the teacher would leave that group for a bit of time before asking the same student again. In that time the group members were expected to explain whatever concept had yet to be understood to the student who originally failed to answer the question.

Summary

This literature review has shown that there is a growing need for students to become proficient at engaging with each other in cooperative and harmonious ways. Firstly the assignment demonstrated how highly held this ability is by modern day employers and then showed how truly relevant it is due to students living in an increasingly globalised and communicating world. It also outlined the statutory duty of each teacher, including mathematics teachers, to try and ensure students learn these skills in their classrooms and went on to describe some of the ways this would be possible taking both task design and pedagogical practice into account.

Whilst this assignment is focused on task design it became evident that, by itself, that is not a sufficient tool to produce cooperative learning. This is due to various issues that arise by just putting students together with an activity, no matter how well designed it is. Mainly this was that status issues may drive some students to not meaningfully engage with the task but other factors did play a role. Complex Instruction was a model designed to

overcome this and other barriers that can arise when attempting cooperative learning and will form the basis of the pedagogy used in the classroom during the action research. Along with this, tasks appropriate to the needs of CI, namely Ill-Structured ones, will be used to help combat potential pitfalls whilst giving students the best chances to work together and simultaneously engage with mathematical content.

Methodology

Action Research

The model adopted for this study was one of action research, one of the most common and effective types of research used in school settings (Kelly, 1985). This meant that the process was very reflective in its nature, as described by Adelman (1993), McAteer (2013) and Thomas (2009). The process was completed in a series of continual stages each of which had some element of planning, implementing and reflecting in order to try to refine certain aspects of the tasks designed (Denscombe, 2010).

This was carried out on one class of twenty Year 7 pupils though only seventeen of them were present throughout the entirety of the research; the class averaged twenty students throughout the year. This group had been set based on their year 6 SATs scores and were placed into a set four out of five. All of the data and quotes used in this assignment are of the seventeen students that stayed in the class throughout the entirety of this process.

Method

Whilst not wanting to carry out so many different types of information collection that there was an overabundance of data that may have covered a wide breadth but in not much depth Edwards (2010) does recommend collecting data from a few different methods in order to gain different perspectives on certain issues. With this in mind there were three main sources of information that were used, each with a different purpose, to collect evidence for this research.

Interviews

The plan for the interviews was to conduct it in a semi-structured nature. This was chosen in order to give students enough freedom to express opinions in their own way (Jones, 1985) whilst having enough structure to try to ensure the conversations remained on topic. Thomas (2009) states that another benefit of this is that with that element of freedom participants will be more relaxed and as a result more forthcoming. The interviews took place in their mathematics classroom instead of an office as it was hoped they would be comfortable in this setting and would feel less nervous as opposed to a more formal arrangement (Bassey, 1999).

Although this was originally going to be the main source of rich data to be collected from the students, it was soon abandoned on ethical grounds. After starting the interview process with 3 different pairs of students each one yielded little more than one word responses to questions with students often arbitrarily agreeing with the person they were paired with. The students seemed unduly nervous and anxious. I put this down to them being asked to speak in fairly close quarters in their second language on a topic they did not feel able to fully articulate themselves on, where any length of silence or thinking time in order to express their response felt awkward and as if it were highlighting their lack of competency with the English language. After trying and stopping the process early with three different pairs of students who had a relatively high level or English compared to the rest of the students as they all appeared unusually uneasy and distressed this process was changed in favour of open questionnaires where students would hopefully feel more at ease to express themselves with less time constraints and less of a chance of rely on their partner to answer for them.

Questionnaires

Before any aspect of my pedagogy had changed the students were given a questionnaire (appendix 1) that covered a variety of questions designed to get a baseline reading on their opinions on some of the aspects that this assignment was aimed at addressing. The students were also given this at the end of the research as an indicator to see if any of their

opinions had changed. Closed questionnaires by themselves are a good way to get a quick and easy read on the class' opinion but due to the limited nature of the responses they only gave a very superficial idea of students' thoughts on the matter (Munn, 1995).

Questions that were originally made as a guide for the semi-structured interviews were rewritten so they became suitable for an open questionnaire (appendix 2) and this was given to each student near the end of the investigative process. These questions were created by me but each is linked to some aspect discussed within the literature. More detail in the rationale behind each question is given with the analysis of the responses in the findings section. Students were given ample time to fill it in and told they could answer the questions in which form they felt comfortable with (bullet points, full sentences etc.). Students were also told that the quality of their written work was not going to be assessed. These strategies were designed to try to make the process as stress free as possible for them and to avoid the issues that arose during the interview process.

Field Diary

Due to the continual nature of the research, with most lessons for a series of months to include an aspect of what had been researched it was unfeasible to be constantly carrying out questionnaires. As such, a field diary was kept in order to be able to constantly evaluate the strategies used. Koshy (2010) mentions how useful the writing process can be for self-reflection and also for critical analysis of what has occurred. Notes were made within a day of the lessons and, where possible, straight after, in order to keep entries as detailed and accurate as they could be. Despite every attempt to make it this way Koshy and Edwards & Talbot (1994) note that due to this process being internalised there is every possibility of misinterpretation, bias and self-censorship. It was taken into and out of school every day and throughout the course of the academic year it was used for reflective, planning and research purposes. Entries could vary from something interesting a student or colleague had said and short ideas for an upcoming lesson to a few pages of writing which attempted to evaluate how a lesson went, what went well, what would need to be improved or scrapped for next time with an emphasis of why this may have been the case.

Collaboration

This research was carried out in collaboration with almost every member of the mathematics department to varying degrees. They were all aware of the project going on and often became involved in discussions based around the planning and implementation of certain ideas. The teacher of the mathematics set below the focus group was particularly involved. She was sometimes involved directly with the planning and was able at times to try out ideas for herself that could be discussed afterwards. This also helped ensure that certain entries in the field diary were not entirely from my own point of view thus eliminating an element of self-bias towards this source of data.

Towards the end of the year a project was designed across all of Year 7 and 8 with the collaborative mentality behind this project in mind. I took the lead in creating this project but contributions were made from almost all the teachers in the department to put this together.

An area of particular difficulty in carrying out the kinds of tasks that were undertaken was the relatively large amount of literacy skills that were needed to partake successfully. Due to the increased amount of demand on the students' English skills I worked with the Literacy Coordinator in the school to discover certain strategies that would aid students at our school with the different strands of literacy: reading, writing and oracy.

She claims that whilst there are a large amount of the cohort who speak English with great proficiency, students lower down the school and particular those in lower sets have a level of English comprehension that is comparatively lower to most students in England of the same age and are certainly not fluent. She went on to explain specific difficulties that could emerge when these students were required to work together cooperatively. Of these problems, the most notable was that if students are working with peers with a vastly different English level to themselves the less competent students could be left out and not engage- another example of something with the potential to cause status differences amongst peers. She also re-emphasised the school's policy of ensuring they worked in English for the entire time. Below is a table of the difficulties and possible strategies to be used for each of the three strands of literacy as suggested by the Literacy Coordinator with a

specific focus of the type of work that would be undertaken by the students during this research.

	Difficulties	Strategies
Literacy	- Spelling and grammar - Missing vocabulary - Accuracy in their answers	- Note keywords in their books - Look at examples of good final pieces of work - Have a structure to work to
Reading	- General comprehension - Understanding nuances in the language - Understanding and being able to look for instruction words (e.g. expand, factorise...)	- Scan for keywords - Make a list of instruction words
Oracy	- Expressing ideas - Ability to challenge each other's ideas - Lack of confidence	- Have keywords around the room - Always speak in English - Playing language games - Give them time/prior warning to formulate an answer - Place students in groups with equal language abilities

If these strategies were to be fully implemented then some would be contradictory to those suggested in the literature. Firstly, if they are only allowed to work in English this contradicts suggestions from other international reports that suggest working in a student's first language is sometimes beneficial and something to be celebrated at times, not repressed. The Literacy Coordinator did concede by saying that 'doing it in Spanish is better than nothing at all' implying that at times it may be useful but not to the same extent that Echevarria et al (2000) and Gutiérrez (2002) were referring to.

The second place where a contradiction emerges is in the suggestion of placing them in groups where students have equal grasps of the English language. This goes against ideas of classrooms free from status where everyone is treated equitably, something Boaler (2008) claims is an essential component of any truly cooperative environment. In general the

school's policy was enforced. On occasion however, such as when students seemed visibly frustrated at not being able to articulate their point well enough, some Spanish was permitted by me.

In the Classroom

As part of this process various displays were put up around the classroom in order to help with the tasks or to help try to instil the kind of mindsets referred to in the literature.

Keywords were placed around the room depending on the topic being studied. The same words were also given on a sheet complete with their definitions on and, where appropriate, its use in a sentence. Words were chosen for their difficulty in spelling, usefulness during conversations, difference in use between conversational English opposed to in a mathematical context and occurrence in written questions on the topic. For example during a short module on probability the words probability, independent, chance, calculate, relative frequency, and, or, odds, numerator, denominator and outcome were chosen. At times students were asked to define them or to use them in sentences. The hope being that the more comfortable they became with these words both their mathematical competence and their English confidence would increase and make them feel more comfortable working orally in a group on various tasks.

A display at the front of the classroom was created with about 50 verbs on. This was a list created during my PGCE with my peers where we were asked to think of as many different processes that 'doing mathematics' required. The list including words like imagining, calculating, working in geometry or algebra, organising, etc. and was often referred to at the beginning or end of a task. This list was supposed to encourage the idea of multiple-ability treatment where students were either told before attempting a task the types of processes it would require or were asked to reflect their task afterwards and decide which processes they had used. This was then used to reinforce how multidimensional mathematics is and how it would be impossible for any one student to be good at all of them and, equally, how impossible it would be for any one student to be bad at all of them.

Another decision of what to put up around the room was inspired by Claxton (2009) who suggests not just putting the finish product of work up on display but to show the entire

journey that it takes to go from start to finish of a mathematics problem (rarely a neat and smooth ride). Work from a different class was displayed but it was referred to with the class in question. This was to help reinforce the idea that effort will be praised over an accurate final product. Seeing the messy workings out some people made and the incompleteness of others being displayed in place of where you would normally only expect to find a pristine, accurate and beautifully presented final product was designed to demonstrate the idea of trying being more important than succeeding. In conjunction with these attempts was a quote on the wall which read:

> 'Well some mathematics problems look simple, and you try them for a year or so, and then you try them for a hundred years, and it turns out that they're extremely hard to solve'
>
> Sir Andrew Wiles.

The grouping of the students was created at the start of the year randomly with a seating plan created using no more information than just the students' names. The only thing taken into account was gender where tables were created so no girl was the only female around the table. This was due to the large proportion of boys in the class and my fear that the class may become male dominated but that some gender balanced groups may go some way to ensure this does not happen. These groups changed slightly over the year as students were added to and taken off the register. One original group were separated due to a consistent lack of concentration a minor behavioural incidences. By and large though the groups were random and consisted of groups of 3-4 students that were either all boys, or had two girls and one or two boys.

Teacher Intervention

During the period of time where this research takes place the best efforts were made by me to ensure that the teacher's role in helping to create a cooperative environment, as discussed in the literature review, happened whilst the tasks were being undertaken by the students. This included referring to the multiple-ability treatment, raising the profile of low-status students, general classroom management, various techniques to try and ensure language apprehension and comprehension was happening etc. This assignment, however,

will not go into these interventions in any more detail due to the main focus being on task design.

Tasks

This section will be looking at some of the tasks themselves that were used in the research to help foster harmonious and cooperative relations between peers.

One of the trickiest and most time consuming aspects of this assignment was the need to carefully plan and resource the lessons in a way that was different to the majority of lessons I had previously taught. The website www.nrich.maths.org was a great source of material and inspiration with two of their core beliefs:

> 'to extend peer assisted learning into a distance learning mode and so to contribute to the personal and cognitive development of both the pupils and the peer teachers
>
> and,
>
> 'to foster a community where students and teachers collaborate and support each other in developing their understanding and skills and where effort and achievement are celebrated'
>
> Nrich (2015)

lining up very nicely with the kind of pedagogical ideologies that this research was trying to deliver. Other tasks were taken from a variety of sources including, but not limited to, some of the articles referenced in this assignment, which were then adjusted slightly by me to try and make them as best suited for the class and our specific syllabus. Alternatively the tasks were made from scratch by me.

I will outline in detail two of the activities used, one which lasted for two lessons and another which went on for a couple of weeks.

Probability Activity

The first activity was based around a section of probability in the school's Scheme of Work. The main resource for this two lesson long task comes from Dan Meyer and can be found at

threeacts.mrmeyer.com/yellowstarbursts. It is a problem where students are required to find the expected number of packets (each containing two sweets) out of a set number of them that contain either one or two of a specific flavour. Other than it being ideally suited to cover the required content this resource was chosen for a number of other reasons.

Firstly this problem was posed in a slightly different manner to typical mathematics questions. To introduce the tasks students are shown a video with no dialogue in but instead they see someone opening up packets, a visual cue (skull and crossbones) then signifies his disdain for a certain flavour and finally the camera pans over to a heaped pile of packets. This was well suited for two key reasons. Due to the lack of any written or verbal cues it meant that everyone started off on a level ground and that language was not going to be a barrier in the first instance. Secondly, due to the first resource not having any questions itself students were left curious about what the problem was and groups could come up with their own ideas of what the task was going to entail. This led to an increase in motivation and attachment to the task.

Once the question has been posed the next step for the students is to decide what information they needed in order to complete the task as accurately as they can. Once they have decided what information they need and it is given they can then start working on the relative probability. Despite this problem only having one correct answer and therefore not being entirely an IS task I felt that due to the multiple methods of finding the answer and the general structure of the activity that it was still appropriate.

Once students got an answer it wasn't checked by the answer to the relative frequency being revealed but by the pile of sweets being opened and the number of packets containing one or two of the disliked flavour being shown and recorded. Due to this being a question based on probability the answer from the clip was not the 'correct' answer which simulates a real world problem and led to further discussion.

Aside from the task itself other strategies put in place to best encourage cooperative and harmonious relations were that students were given a maths book per group to work in, they wrote a group name on the front of it and proceeded to ensure all the relevant working out was in there. This was something that was going to be collected in at the end of the two lessons and be assessed. This strategy was intended to create a group responsibility to ensure they performed well. Students could use their own books if they wanted but anything that they deemed worthwhile needed to end up in their group's books.

Secondly, at some point during this task it would have been necessary for students to calculate all the possible combinations of packets that would have been available given there are two sweets in each and four different flavours available. To aid with this, if anyone was struggling, a box of multi-link cubes was available for students to use if they so wished. Access to these manipulatives was an attempt to allow all students to make some progress at working out the different combinations that were available without a perceived loss of status.

Finally, at the end of two lessons one randomly selected person from each group would have to present the work they have done from the beginning to end of this project and again, the whole group were assessed based on this person's presentation. This was an assessment strategy used to help group cohesion and was an attempt to encourage each student ensuring that they understood whatever had been written in their group's book.

Shape SOW

Unlike the first probability problem which used someone else's resource as the template which was then slightly altered, this second activity that will be looked at was made with a mixture of resources pulled together to make a 2 week (8 lessons) long scheme that was created by myself. The scheme of work had singled out this period of time to be focused on 3D shapes; this included studying their names, properties and nets but was left fairly vague.

Due to the amount of time allotted, as it was after their end of year exams and this part of the year was normally seen as 'filler' time, it was the ideal setting to test out a more rigorous attempt at an IS task. The increased amount of gain time I had due to examination classes being on leave meant I was able to create the template for this scheme from scratch without working extra hours, something I felt unable to do fully in the past due to various time restraints and the fear that if it all went wrong this would be something the students would be formally assessed on soon.

I tried to incorporate as much of the techniques given in the literature as possible to give students the best opportunities of all working together cooperatively. At this point in the year I felt that I had been able to hone how best to implement these strategies through reflections on the previous attempts. The table below provides a brief overview of what

was created and what happened in some lessons will be expanded upon in more detail beneath that.

3D Shape Scheme of Work Questions: How many different fair dice can you make? How can you be sure it is fair?		
Part	**Content**	**Resources**
1	Shape vocabulary	Language Game
2	Tessellations	Stained Glass Tessellations Sheet
3	Interior/exterior angles of polygons (recap)	Interior Angles of Polygon Table
4	Nets of 3D shapes	Nets of various 3D shapes Match the Net with the Solid Sheet
5	Properties of shapes (faces, edges, vertices)	Vertices, Faces and Edges table for polygons
6	Fairness	Noughts and Crosses 3x3 vs 4x4 grid
7	Platonic solids	YouTube Video
8	Experimental probability	Which Dice is Fair? activity

The overall mathematical aim, as well as getting students to study the properties of 3D shapes, was to give them the necessary background to be able to informally create or at least understand the proof of there being only 5 platonic solids and to do so as a group. It should be noted that each part is not necessarily a lessons worth and that some parts overlapped into 2 or 3 different lessons and others were completed within a lesson. The table purely provides a chronological order of the tasks that were undertaken.

The first lesson was designed to get students comfortable with the language they would be using throughout the course of this topic in order to make them more competent communicators within the group. It was influenced by the research earlier stating that non-

first language speakers may not be as confident in contributing and the Literacy Coordinator's suggestion of playing games in order to help combat this. Students were given cards with a target word on that they had to describe to their partner. There were a series of 'taboo' words beneath the target word that could not be said however. Pairs were given a point each time a successful guess was made and where in competition with the others pairs in the class, which helped as a motivational tool.

For the work on tessellation, students were given two half completed patterns to begin with and were then asked to complete the tessellation. Once a group had all managed this task they were given paper and were tasked with creating their own tessellation from scratch.

The work on the interior and exterior angles of polygons was a recap from work done earlier in the year and did not take up much lesson time. It took the form of a short discussion and students recorded the relevant facts on the table given to them.

When students were working with the nets they were first asked in groups to see if they could match up the nets of various shapes with the name of their 3D form. Once students had correctly done this they called me over and a few students were chosen at random from the group to answer what the match-ups should be without their previous work in front of them. This assessment strategy was mentioned by Esmonde (2009) in the literature review. Where students disagreed on an answer they were given time to resolve it, if I felt they could visualise the solid but not name it then they would have to describe what the net would look like once constructed. Upon completion each group was given approximately 15 nets on card, scissors and glue and were told to make whichever solids they wanted. These varied in complexity from the likes of cuboids and triangular prisms to icosahedrons and dodecahedrons. All of the platonic solids were available to each group to be made.

Following this groups were asked to list the number of faces, edges and vertices that each solid had. Whilst the resource did contain a small picture of each one at the point in the sequence there would have been a solid version of each shape around the room somewhere, in case students were struggling or needed to self-check their work. The availability of these manipulatives was a techniques designed to ensure all students could access the task at hand in a group situation without any perceived loss of status.

The next concept that students studied was the idea of fairness. I believe this to be quite a wordy and complex idea to define properly but understanding it in practical situations seems slightly more accessible. In this vein, when the students walked into class there was a standard 3x3 nought and crosses grid on the board and I was inviting students to play me and go first, about half the class had a go and each time the game was a draw. The board then changed to a 4x4 grid and the game was repeated, this time, sometimes with the help of classmates, I lost every single time. From this a discussion about the two games occurred with the words fair and unfair being introduced. This was then linked to what a fair dice might be. Once the definition of a fair dice was understood groups were given time to think of what sort of solids that we've been working with would make fair dice and, if possible, what properties in general the solid should have. They were told that a random person from each group would be selected to answer.

The penultimate step was to look at the 5 different solids that were available in the room that had been classified by the class as being fair and find out if there could be anymore shapes that had the same properties, namely that they are a concave solid where each face is a regular polygon. Due to the success earlier in the year of a very visually orientated video, a very visual demonstration of the proof of five platonic solids was found and shown to the students. Their task as a group was then to recreate the proof. They had time to work on it themselves where Polyhedra were available along with their previous work on interior angles and tessellations. At the end they had to present their version of the proof as a group with each member participating. Not all groups would be chosen but they would be selected by me so all groups knew they had to be ready and could not rely on other students volunteering.

The final activity in this scheme was for students to test out the fairness of the solids they had made earlier if they were made into dice, i.e. with a different number on each face. In pairs students chose a solid, they did not have to choose a platonic solid but they understood that in theory these should be the fair ones, and had to devise a way to test its fairness in a set time frame. The lack of instruction here and there being no set answer added to the Ill-Structured nature of this task.

Other Tasks and General Structure

Throughout the course of this research a wide variety of other tasks were used, some with a similar design to these but with varying content and others that had a life of their own. It would not be feasible to go into great depth with all of them but these two were chosen as they best typified the types of activities that were going on within the classroom. Despite this there were some common elements that frequently occurred in these series of lessons with respect to how tasks were introduced, the sorts of interventions I would make with the students, and how some tasks were summarised.

It should be noted that some tasks in this time were completed with no emphasis on the aims of this research for a variety of reasons. Whether it was to develop some independent learning skills, because I could not find an appropriate task in time for the lesson or, due to some other external factors.

Ethics

During the research considerations had to be made to any potential issues that could be deemed unethical. The elements involved during this that were the most ethically sensitive were the interviews and questionnaires that were conducted with the students, ensuring the lessons themselves ensured students were still learning and in assuring anonymity.

To begin with, permission was sought from the Central University Research Ethics Committee (CUREC) at Oxford University. This was to ensure that the actions planned for the duration of the assignment did not breach any ethical guidelines as set out by the university. Once this approval was obtained, permission was needed to conduct the research on the participants. Due to the age of the students and the setting of the school that this took place in the participants were not old enough to be considered able to make the informed decision to opt in or out of the research themselves (Check, 2012). As a result of this, approval was sought from the head teacher of the school who assumes an in loco parentis responsibility for their time in school and was thus able to approve their participation in the research.

The interviews and questionnaires completed throughout this research generated a lot of data. From an ethical point of view this data needed to be kept securely during the process and, once no longer needed, had to be destroyed (Lankshear, 2004, McKernan, 1996). Prior to the interviews taking place, students were informed that this would happen. They were also informed of the nature and purpose of the interview before it started and that they could, at any point, decide to stop or not answer a question for whatever reason (Kvale, 1996).

Other efforts to keep this research ethically sound were to ensure confidentially and anonymity of the school and students, to monitor that no negative impact on the student's studies was occurring and the all participants were treated fairly, were as well informed as they could be and were treated with dignity, all in line with the British Educational Research Association's (BERA) ethical guidelines (BERA: 2011). To ensure anonymity no names have been used in this piece of research that allude to either the school or the students themselves. To ensure the students were still progressing mathematically they were regularly assessed, in line with the school's policy, and their results were monitored.

Findings

This part of the assignment will describe and analyse the data collected during this piece of research. As discussed in the methodology this will include information obtained through open and closed questionnaires, school assessment data and entries written in a personal journal spanning the time of the classroom intervention and a brief period of time either side of it.

Closed Questionnaire

The data obtained from the closed questionnaire that was conducted before and after the intervention showed no significant change for any of the questions given except for one. The statement 'Most people are either good or bad at maths' began with thirteen out of the seventeen students disagreeing with this idea. At the end of the year this proportion

changed to nine out of the seventeen agreeing with the remaining eight giving responses that neither agree nor disagree with the statement. I was expecting to alter students' opinion in this matter throughout this intervention but in the other direction. By trying to infuse a multiple-ability ethos in the class I expected the opposite outcome. The reason why this is did not happen is unknown and the amount of other factors a student experienced from January to May could all have played some part in this outcome. Perhaps the dangers highlighted by Weissglass (2000) about potentially increasing inequalities as mentioned in the literature review happened. I hope that the strategies put in place by me in the students' mathematics class did not impose this change but without further research no definitive conclusion on this result can be reached.

Open Questionnaire

The open questionnaire provided the richest source of data collected from the students about this experience. It consisted of 6 questions, below are brief summaries of the class' feelings along with specific examples of students responses that illustrate these. Each sub-section starts with the question that the students were asked to respond to.

Question 1 and 2

What should you learn from a Maths class? (Try to think of any answer different from topics you would find in your textbook, e.g. not fractions, algebra etc.)

What things that you do in class do you think might help you when you leave school and in what situation will they help?

The responses given to these two questions overlapped or complimented each other quite considerably so they will be analysed together. The purpose of these was to see if the students felt there was any need for them to learn how to act harmoniously or cooperatively in a mathematics class. From the seventeen pupils whose responses are being considered eleven of them gave answers to both questions purely relating to mathematical competences. The other six all indicated that social skills and teamwork are an important skill to learn how to master. These responses included:

"I think when we (do) group work to solve a answer might help us in our work we we're older because are teamwork increases every time we do work in class in pairs or groups",

"In class we do teamwork this might help me when I leave school because this gives you a capacity for working with different people. This will help when I work with people"

and

"When you do in the university a project with someone else. You need to have good teamwork skills. Social skills. You have to work as a group".

This indicates that some students understood and believed in the need to develop a wider set of skills than just academic ones from school. One of the worries for me in carrying out this kind of research is of encountering some sort of resistance from the students who just want to get their heads down and learn independently in the way they may see as being best for them. These results suggest that at least not all students felt this way at the end.

Question 3

How important is it to be able to work well with others? When might you need to do this? (Think about times now and also in the future)

These questions took the context of working cooperatively out of the mathematics classroom and asked if students felt that it was an important to learn in general. Three students still made references to a mathematics classroom but all seventeen of the students highlight the importance of these skills in life. Thirteen of them briefly mentioned the need to work with others in order to be successful either at university or in their careers. One student went further and referenced the importance of teamwork in sport as well. The uniformity of answers here suggest that all students in the class see cooperative work as being an important life skill but when analysed in conjunction with questions one and two they do not all necessarily see mathematics lessons as a place where it should or could happen.

Question 4

In class this term there has been more of a focus of working with the other students in class. Do you think this has helped you in any way? Explain your answer.

This question was aimed specifically at the lessons they had been through and was asking them to evaluate their effectiveness and to what extent they may have benefitted the students, it was deliberately worded to elicit a positive response in contrast to the next question in order to get students to reflect upon the benefits and limitations separately that this approach may have had. Fifteen of the students gave positive responses but two suggested that the majority of the time it had not been worthwhile for them. Those two students replied:

'No because my friend and I do the same things and get them well so we don't learn really'

and

'At the start I was focus but then they... people and I [was with] got distract[ed]'.

The first point raised here has to do with not feeling the need to work together in class, particularly with the students he was with all year, due to a sense of gaining nothing extra from his peers. This response indicates that this student was next to someone he was friends with. This finding appears to be in contrast to suggestions that sitting with friends is the easiest way to establish cooperative classrooms, there is however a possibility that this student may have been even more averse to learning in this way if he were not sat by a friend. The second relates to groups getting distracted after being given the freedom to talk to each other and it sometimes perhaps going off topic. Both situations were clearly frustrating for the children in question. Relating to the literature review the second issue seems to be a mix of a problem to do with motivation during the task and then also my behaviour management. Throughout the course of this research I witnessed both these students producing good work collaboratively and helping their peers out. The fact they did not find it worthwhile overall though is an interesting result as I felt it was when every student in the class produced their best work and learnt the most. To try and combat these beliefs in the future perhaps the need for me or the students to explicitly highlight and reflect upon processes and contributions that group members have made during a task either at the end of the task or end of a lesson may be an appropriate strategy to help

promote the advantages of cooperative working. There is also the chance that some students will just never take to learning in this manner and will always believe it is less useful than independent work.

Positive responses included:

'yes, so you can learn to work in a team and not just by yourself',

'yes I think it helps you because it makes you have a higher level of concentration',

'yes, it has improved my social learning which has improved my work in class'

and

'this helped me in a way because I got to debate if things are correct in maths or not and sometimes friends help me with things I don't know and I help the[m] with things they don't know'.

These four points, echoed by the rest of the positive responses, highlight at least some effectiveness of the strategies put in place. Throughout the course of the research I did mention the reasons that we were doing these different tasks and there is a chance that demand characteristics (Orne, 1969) played a part in this and that students were simply writing what they thought I wanted them to (or, in the case of the first two quotes above, the opposite). Some of the quotes given, for example the last one above, explore aspects I never mentioned and are certainly explained in the student's own words. This provides evidence of the opinion expressed coming directly from that student.

Question 5

In the class this term there has been more of a focus of working with the other students in class. What have been the difficulties, if any, in your experience, of this approach?

This question was designed to get students to write down any pitfalls they felt there were over the course of the lessons even if they believed that, on the whole, it was a positive experience.

Five students reported no difficulties, five reported that it was sometimes hard to work as the group did not always work effectively together. Two students felt they were not able to

get their own ideas across in group tasks. Two students claimed they were easily distracted, one found it hard due to the extra effort that was required to work in this way, one found it hard to choose what task to complete or how to approach it and the final student was frustrated he was not allowed to ask his friends questions.

This is a very positive collection of results to me as the majority of the difficulties that they expressed were the exact reasons this research was being undertaken. The fact that students found it difficult to sometimes work together, communicate or share their ideas shows that there was a need for someone to try and develop these skills within the students. Whether these difficulties eased as time progressed was not asked but with the overall positive responses to question 4 it seems evident that they did. The kind of problems that these students were facing seemed to resonate well with situations that will be encountered once they leave school. It would not be hard to imagine adults coming out with the kind of lines describing frustrations in their own jobs that these students did when describing the sorts of difficulties they encountered in class. Two students wrote that 'not having the same ideas' was a problem as were times 'when we disagreed'. Another two students went further by expressing their annoyance when:

'you need to discuss the things so much and you can get mixed up in a fight'

and

'each person has different ideas or method to work out the problem and you thin[k] the answer is wrong and get [frustrated]'.

Question 6

If you had a choice would you chose to work with the other students in class all the time, independently all the time, or a mix of the two? Why?

Whether students agreed or not with my feelings of this being a worthwhile experience was tested in the final question. If students really felt there was some sort of value in the work they had been doing then they should answer with at least a mix of group and independent work being their preference.

One student did not answer this question, perhaps due to time constraints. One of the two students who could not think of any benefits for group work from question 4 indicated that

working independently at all times would be best. This is 'because there is more chance to have separate answers'.

Ten of the students would prefer a mix of both independent and group learning and gave justifications for this choice. These included:

'because you can discuss but sometimes by myself because I can test my own knowledge',

'It can be helpful… but if you or they are going faster maybe you want to work alone!'

and

'you need to be able to be independent in an exam and teamwork in a project'.

It is important to be flexible in how you work and the aims of this research were not to ensure students are always working in a cooperative manner but just to find ways of doing it in a worthwhile manner throughout the course of an academic year. The students here seemed to grasp this idea and it is a very encouraging sign that they share the same thoughts.

Five students would have preferred to always be working in groups with the reasons like:

'I prefer doing my work with [partners] because they have always good ideas',

'because we can ask each other if we aren't sure of what to do'

and

'you can help others and be helped'.

These notions of group work do not seem to fully incorporate all the aspects of Complex Instruction and I would argue that work could be mostly independent with these factors only playing a minor role in tasks set. In that sense I do not believe that these students are asking for IS tasks all the time, merely that during a task they are able to communicate about the content with others around them. I think with the freedom they are describing being given to them during tasks that are mostly independent that these students would also be content with a mix of group work on IS tasks using a Complex Instruction approach and independent work. A split that I believe is optimal for a mathematics class.

Field Diary

When writing these up the pieces relevant to this assignment will be included and, due to the state of most of the notes taken, paraphrased into full sentences. The entries below will be given in order of a relevant theme instead of chronologically so as to best reach conclusions about specific areas of the research.

Planning

The planning process for the lessons that were going to be delivered was a time consuming and often complicated affair. The planning for this class often took more time than any of the other classes that I was teaching at the time. This seems to agree with the findings of the literature review which stated that it is a tricky, time consuming and, at times, frustrating process Pescarmona (2011). In the articles there were several references to work schemes used in the United States that teachers were able to use and adjust slightly to fit with their course requirements. To my knowledge the equivalent does not exist in England. Whilst carrying out this research I was following the structure of the current Scheme of Work that the school I work in implements. This was little more than a list of discrete lesson objectives with textbook page numbers referenced in. It was a fairly restrictive school document that had to be rigorously kept to due to the assessment practices of the department. At times it was difficult to plan an in-depth IS task for a 45 minute lesson that appeared to have little connections to the content from the lessons that had to be taught either side of it. I found that more time would have been beneficial where certain problems or stimuli can be explored for a longer period thus allowing students to explore mathematical ideas in their own way and make their own fruitful links between connected concepts. My belief from this stems from the number of resources I found available online that were suitable for this research but, in order to use them properly in class, would have taken more time than was available.

There were some exceptions to this and, occasionally, the resources found overlapped nicely with the time allotted in the Scheme of Work. One example of this was the Probability Activity. A task I was already familiar with but one which I felt suited the aims of this research nicely. Having already found and delivered the task in a previous year was incredibly advantageous. It made adjusting the task for this class easier to manage and I

was confident that the aims of this research could be achieved through it. I added the use of manipulatives and chose how students would approach the problem but overall the activity was almost a ready-made IS task. This demonstrates the potential availability of resources that are out there, unfortunately the majority of tasks were not as simple to come across as this but it is reassuring to know that after more years of teaching I would, presumably, have a larger bank of pre-prepared tasks to call upon.

When the Shape SOW was delivered there were no longer any assessment constraints and the specified content to be covered was fairly vague. I found the freedom to create an extended programme of inter-related content with plenty of opportunities to work cooperatively, independently and with a variety of different stimuli ingrained into the tasks easier to do at this time than any other time of year. Also, due to the timing, as the academic year came to an end, other members of staff in the mathematics department had more free time and were more willing to help collaborate on the making of this project. Although this scheme did not involve me creating any of the resources from scratch the combination was unique and the original intention of the resource was sometimes changed. The scheme lasted for 2 weeks and the idea for it was first thought up 2 weeks prior to it starting. It took approximately an hour a day of my time up until the final lesson was delivered doing a combination of searching for resources, planning the order it was to be delivered, organising ideas with other teachers, collecting resources, printing and photocopying tasks. This time taken would be unfeasible for an individual to do this during the normal timetable of a school. Departmental collaboration would be an essential component of continuing this for one year group, yet alone a whole Key Stage. This is very much in agreement with Cohen (1998) and the types of requirements she says are essential for CI to be implemented in a school.

As this task was rolled out across all of Year 7 and 8 there were a lot of times I had to consult with the other teachers, in stark contrast to the probability task. This practice did make the creation of the Shape SOW last longer- finding time to consult with other teachers will inevitably do that. As a result the planning did not feel as time effective as it could have been. This would seem like a problem, if however each of the teachers across Years 7 and 8 (six in total) created their own scheme at different points throughout the year and went through the same process, with themselves taking the lead and merely using other teachers

for consultation then in the same space of time a three month long scheme could have been created with little extra demand than I experienced. This is something which definitely would have been time effective and feasible to create over the course of a normal working week. This would require all teachers to be on board and to work towards the same aims. This again seems to link back to the requirements that Cohen (1998) says are essential.

One of the issues that did not come up in the literature at all which is very much relevant when comparing these two tasks completed is the how many elements of CI or IS tasks should be incorporated into a task. The amount of strategies discussed would not feasibly be able to be done in a five minute section of lesson and, I found, could not all be suited to one task all the time. Across the course of the eight lessons as many of the strategies as possible were included but whether they were too thinly spread out across the two weeks and whether they occurred for a long enough period of time is something I am unsure about. I suppose these constraints will vary with each class and task and is therefore something to be judged individually by the teacher in each situation.

I believe that from all the lessons that were carried out and have been discussed that the Shape SOW ended up being the most successful in achieving the aims of this research. It had the longest and most varied periods of sustaining the aims of cooperative working as referred to by Boaler (2008), Baker and Clark (2011) and Martino and Maher (1999). I also think students worked well with some complex mathematical ideas. In this time I believe that the biggest factors that lead to this were the longevity of the tasks (students were frequently coming in and eager to carry on where they had left off last lesson) and the freedom I had in the content that had to be covered and therefore the combination resources that could be used.

Assessing

One of the easiest strategies I found to be successful in getting students to work in a desirable manner was to change how a task was to be assessed. Tasks I had used in the past in a very independent nature suddenly had students explaining concepts to each other and helping one another with their understanding. An example of this was one task where students were working out of a textbook and were working through standard questions about expanding single brackets. Students were told after this that there would be a test on

this content and the table would receive an average mark based on their table's results. Lessons like this had happened in the past without this assessment at the end and instead with me trying to encourage students to help each other if needed verbally. This change in assessment strategy suddenly made their peers' understanding more important to them than it ever had been. The change was instantaneous and students became effective collaborative workers throughout the task.

I found the most effective of the assessment strategies discussed by Esmonde (2009b) to be where the class were told that they could not move onto the next task, or at times leave the lesson, until I received the correct answer or explanation to a question asked to a random student on their table that they should be able to answer. In practice, the student was not always random and, if I had observed someone struggling at points throughout the lesson, they may have been deliberately chosen.

The strategy suggested of ensuring all students have completed the same piece of work on I table lead to some difficulties. At times I observed this sometimes leading to copying and shortcuts to produce the correct final outcome. As a result I found this to be the least effective type of assessment strategy. In general though, changing the assessment structure behind a task did appear to be an effective and relatively easy way to promote cooperative learning.

Ill-Structured Tasks

The main pre-existing model used for the designing of activities in the research were IS tasks. The thinking behind the setup of these tasks seemed to fit perfectly with the aims I was trying to achieve and I have little doubt that when carried out expertly they can be incredibly effective. Whilst trying to use and design tasks of this nature I found a few obstacles in the way of delivering all of the desired outcomes, some of these issues I believe would vanish with practice of me delivering and creating the tasks and with the students' practice of dealing with tasks of this nature.

A problem I found was the element of a task having multiple-entry points. When this was possible I found that instead of this making the beginning of a task easier that it did, on occasion, make it more difficult. At times I saw groups struggling at the start and, when asked, admitted they did not know where to start. On the majority of occasions it was

because students claimed there was too much information to deal with. In a few cases groups did not start because they had discussed different ways to commence the task and could not decide which one was the 'correct' way. It was good that students had the chance to cope with these types of problems as both issues relate to real life situations when solving problems but it sometimes felt like it was detracting from groups ever really getting started on time. Despite this being an issue I am confident that with more practice it is an aspect that may be averted.

My main issue with one of the defining aspects of the IS tasks was the idea of there being no single correct answer. Whilst this can of course be the case with certain tasks it was incredibly difficult at times to find or create tasks in mathematics with this outcome. Due to the nature of how students are assessed in mathematics as well, both in school and at a national level, I do think it beneficial for students to spend a large part of their time coming to the one accurate answer of a problem. When tasks did have just one answer I did not find that element detract too much, if at all, from the cooperative outcomes that the IS nature if the rest of the task was designed to promote cooperative working in the students. Evidence of this comes from the Shape SOW which had one overall answer for the project yet I felt that is was the biggest success in terms of promoting cooperative and harmonious relations amongst the class.

Manipulatives

In a separate series of lessons multi-link cubes were made available to students who were engaged with the Painted Cube Problem (Appendix 3) whilst completing work on sequences. In this situation they were used much more in the way described in the literature review, namely to aid students in a more abstract situation. They were made available to the class who were told they could chose to use them to help with the problem if they wanted to. I found that what followed was almost exactly what Cohen and Lotan (1997) and Foote and Lambert (2011) had suggested might happened. All students were able to engage with the problem either with or without the aid of the blocks and those that did chose to use them to help understand patterns that other members of their group had already grasped did so without any apparent loss of status. As well as this, when students were sharing their answers, the availability of the resources they had been using aided in their explanation by

often making it more fluent and more complex. When students were asked probing questions during the Shape SOW and got stuck explaining something it was often the case that they would grab an appropriate model near to them and use it to carry on their explanation.

Throughout the research time a variety of manipulatives were used to aid in pupils' understanding of different topics. The majority of these were to do with the shape related topics where certain manipulatives like Polyhedra, multi-link cubes and nets seem almost a necessary requirement for the topic. Despite that, it was clear to see how engaged with the materials the students were (with the majority of that engagement being mathematically related). The biggest engagement seemed to come when they were able to construct their own models, perhaps giving students more ownership and investment in the materials that would be discussed later. Their use in this context was helpful for their mathematical understanding but mostly of concrete ideas like which shape is which, what a vertex is and, why some solids would make a fair die and others would not.

Language Difficulties

As suggested by the Literacy Coordinator a game was played at certain point to help students negotiate the language barrier that could potentially hold students back from certain tasks. This game started and finished in just 35 minutes but the transformation in the students confidence in dealing with the shape specific language of the topic they were about to study was astonishing. The game in question was a Taboo style game where students had to describe words without using any from a given list, e.g. describing square without saying four, right angle, etc. To introduce the game it was modelled twice in front of the class, firstly with myself and a student volunteer and secondly with two students. Finding a volunteer was hard for both examples in front of the class and the rounds were not completed with great confidence or ability. It served the purpose of explaining the concept to the rest of the students though. After students had time to play the game with each other, which they appeared to do with great enthusiasm and proficiency, the lesson ended with some students modelling the kind of descriptions they had been using to the whole class. This time most of the class volunteered to model the game.

I think a lack of confidence hindered the willingness to present in front of the class, as seen by Foote and Lambert (2011), but once they had time to try out the game with their peers in an environment I believe they felt safer making mistakes in the reasons for them not wanting to perform publicly were vanquished. Although no other language games were employed during this research project I believe the Literacy Coordinator's idea to have students play games in order to become more proficient in the topic-related language was successful and helped students work together cooperatively later on other tasks. This success would be dependent on the type of activity used but it certainly has the opportunity to work. Now that they were more able to understand the language used in the tasks that followed and were more confident in using the language themselves, it made them better contributors. I also believe that, due to the subject specific vocabulary that mathematics is rife with, this technique could also be effectively employed with students who have English as their first language already but that are not always confident in 'talking mathematically'.

Another strategy that was used to help with the language barrier to these tasks was to pose questions visually, as with the probability task and the demonstration of what 'fair' means in probability. Despite students eventually needing to understand how to interpret mathematics questions in English I do not think that it has to be a goal of every lesson for this skill to be improved. On occasion it was beneficial to get started on an IS task without students lack of fluency in English being a barrier. Students were able to understand a question that would have been very complex to word otherwise.

The other key strategy used to help with the students' language barriers were the keywords placed around the room. Students were encouraged to refer to them in their conversations and knew to ask if they were unsure on any definitions. This seemed effective when they were up. Students were noted as using mathematically accurate language of a sophisticated nature during certain conversations. Another problem however, with a sporadic scheme of work meant that with the constantly shifting nature of the topics it became impractical to change the keywords every time a new topic started (sometimes every lesson). This strategy worked best when the words were up for a prolonged period of time and students had time to get used to seeing them on the board, in the context of questions and to hearing their peers and I use this language in context.

Student Ethos

This change in strategy obviously required students to work and act in a different way to how they had previously in class. I am aware that this was not a common way of students learning in many of their other lessons either. I therefore thought that the shift would be hard for the students to deal with and that it would take a sizeable amount of time to get students working together in the desired way as described in the literature- this turned out not to be the case. From the very first lesson where I explicitly laid out the expectations of how I wanted students to work this lesson they surpassed all my expectations and worked almost perfectly. I recorded the fact that students were helping each other with concepts they could not understand, checked each other's working, approached tasks with the kind of team skills that I have rarely seen secondary school students do. There are a few contributing factors that I believe led to this.

Firstly, there is the background of the students. Whereas normally students I have worked with that are placed in a set 4 out of 5 are more likely to come from more socially deprived backgrounds (FSM), have special educational need (SEN) requirements and be labelled as having behavioural, emotional or social difficulties (BESD), the students in this class come from financially secure backgrounds and none of them had any sort of recognised SEN or BESD requirements that could sometimes hinder cooperative working. These students all came from affluent backgrounds where students typically perform better in school (Marks, 2006).

The second reason I believe the students were so well prepared to converse and cooperate with each other is in part due to their cultural upbringing. Spanish children are subjected to a much larger about of time experiencing groups of people conversing and are rarely shy of expressing their opinion. It is not uncommon for children to be involved in family discussions over the dinner table which can go on for hours every night, something that pupils I have previously taught would not have had as much experience with. This quote from Julia Margot who works for the

Institute for Public Policy Research sums up this comparison by saying that "In Britain, as opposed to countries like Spain and Italy, adults are less likely to socialise with children in the evenings" (BBC, 2006). A large majority of the studies referenced in the literature review, e.g. Boaler (2008), were based in schools where students came from slightly more deprived backgrounds where again, working with this kind of cohort, would be more of a rarity.

I was slightly worried after this first lesson with how easy it was for students to work in this manner as I thought the rest of the time I had to try to encourage students to do this would be almost pointless. This was not so; just as quickly as students could switch into this harmonious and cooperative way of learning they could switch out of it. Just the next lessons where I did not feel the need to reinforce the expectations of how I wanted students to work as strongly they had reverted to much more independent workers who approach tasks designed to be solved as a group by treating the task as a collection of individual activities rather than as a complete one.

Throughout the course of the research their way of working would seem to change in relation to several factors. Firstly, and I believe most importantly, was the expectations that I laid out before a task of how I wanted them to work. Whilst I had hoped that this would eventually become unnecessary, it never seemed to be the case. Each of their other teachers mostly likely had their own wishes in how they wanted their students to learn and act in class as well and for students to be constantly adapting their way of working for the whims of their teachers is an incredibly complex and demanding process that most adults, yet alone adolescents would most likely struggle with.

I think the task structure was the second most important aspect and without this being able to properly facilitate a cooperative ethos the students would not be able to work in the desired manner. The other aspects discussed so far in this assignment were all contributing factors as well but I believe these two were the most important.

Due to the nature of my position in the school and the way the research was undertaken it did not become something that would have truly immersed any of the students in the class, unless their other teachers were independently adopting similar strategies. The idea that a change should be infused amongst the students and the schools could not happen, something Cohen (1998) identifies as a necessary component of producing students who can work well collectively.

Conclusion

Results of the Research

The biggest surprise for me to discover was the amount of other aspects that would have to be in place in order for a task to be successful. I originally envisaged coming out of this with sets of refined resources that could be rolled out anywhere and at any time. It did not take long to discover that this was certainly not the case and almost every aspect of a student's experience in your lesson should be geared towards producing a cooperative and harmonious environment if it is to have the best chance of succeeding. From the pedagogy used to what goes up around the classroom, there are so many extra components that need to be considered in conjunction with the design of the task to create the best chance of students working well together.

For me, the most exciting results to come out of this assignment where the responses to the fifth question in the open questionnaire about all the problems students were facing during this research. Whether or not students were successfully able to deal with these situations or not, half of the challenge of this research was in producing these kinds of situations in the first place. The fact that each student's attainment ended up being at or above the school's expectations and that they were able to be involved in and try to overcome these complex social situations, successfully or not, was, in my opinion, an incredibly worthwhile and valuable experience for them.

It transpired out that one of the easiest ways to ensure students seemed to work well cooperatively and harmoniously was in changing the goals of a task by choosing an

assessment type where students will be judged in some way on the group's performance and understanding. My concern about overusing this is the motivation with which students would be helping each other. Whilst from a glance it may have looked like cooperative learning was taking place I am not convinced it was a good enough strategy to instil the desired skills. Students were, in essence, still serving their own purposes and were only extrinsically motivated to work well together. It could be argued that no matter what the motivation is, if students are acting in this way then it is good practice for them and the aim of the task has been achieved. Despite this I would argue that acting in this way because of intrinsic factors is a much more powerful action, will be easier to evoke again in other lessons and will hold the student in better stead later in life. Whilst this is undoubtedly a harder target to achieve, in my opinion, it should still be the overall goal.

The way that students seemed to flippantly switch between working cooperatively when prompted but not so otherwise was a frustrating aspect but was probably to be expected, the students' maths lessons took up just 11% of their lesson time at school and only 1.8% of their time in a week. At this rate for something to become an ingrained aspect of a students working ethos it would most likely have to be continued for a very long time or the about of time spent working this way would have to increase. That would mean either a wider school policy in getting students to work this way. The fact that the students always needed reminding, despite their impressive capabilities when they did work in the desired way, was, to me, an indication that this research was not a complete success.

Implementing the Strategy

As well as the students having to change how they approached tasks in a lesson a teacher would also have to alter his or her approach as to how they deliver their lessons and introduce their tasks. Whilst this research was very much for my own benefit and my personal beliefs in teaching aligned with the kinds of mentality that were required in order to try and enact a CI based pedagogy with a largely IS task design. If this were a model to be rolled out across a department or a school I can foresee some aspects of this being at odds with other teachers beliefs. A belief that all students are better at some aspect of

mathematics than others, that anyone can achieve, any student will, at some point, be able to help any other student, that there's more to school than getting a good grade in your exam and that students learn best when they learn together. These are all ideologies that some teachers may not entirely agree with. I believe it would be difficult to enforce a whole school or even a whole department initiative to align with the sorts of values that this pedagogy is geared towards. Whilst it seems to have been achieved in the school that Boaler (2008) was working in and the primary school referenced in Pescarmona (2011) it cannot be assumed that it could seamlessly be rolled out anywhere.

The set of circumstances described that had to happen in order to create the resources needed for this type of intervention occur very rarely throughout the year. However all of the resources and materials made for this sequence of lessons are now readily available to the school and would now take little preparation or planning time to implement again. This agrees with the literature review (Pescarmona, 2011), where the difficulties in planning a set of lessons and tasks with these aims were highlighted by. It would take a considerable amount of time and hassle to prepare. Although if the time can be found to create these then they can be kept and recycled saving staff a large amount of effort in the future.

In short I believe in order to create a year-long scheme of work designed to create cooperative and harmonious relationships amongst peers would take a huge initial investment from the department but once it is complete and repeated the year after the work load would be drastically reduced and focus can move onto improving aspects of it rather than creating something from scratch.

Difficulties and Limitations

This research was carried out on a very small group and in a very rare school setting; any conclusions made here cannot be implied in any other context. The amount of external factors not accounted for also means that my intervention may not even have been the cause of any of these results in the first place.

The data collected was widely taken from my own accounts and as a result could easily show a misrepresentation of the truth as well. The time taken between the class finishing and the entries being written, and then the time taken between me rereading the entries

and typing up my interpretation of them gives plenty of scope for events to have become distorted. The data collected from students is not entirely reliable either with me being present in the room and the students knowing that I would be reading their responses with their names attached to the top. Both of these factors could have led them to not answering honestly.

Follow-up

Unfortunately a large part of the strategies that were suggested by Echevarria et al (2000) and Gutiérrez (2002) could not be implemented due to them involving students talking in their first language. This was in direct contradiction with the school's policy and therefore could not be thoroughly tested. It would be interesting to try these strategies out again with the possibility of exploring students speaking their own language in parts.

At the end of this research I had many questions or ideas that interested me in relation to this topic that could be further explored in the future. I would like to analyse in depth one group during a task instead of having to cater for a whole class in order to see what sorts of interactions occur from that start to end of an IS task. I would also like to try out the same strategy with a class who can perform comfortably in an interview situation where I feel it would be easier to draw more concrete conclusions about results obtained. Additionally, I would like to track any long-term effect that these teaching strategies may have and find out how much of an impact this kind of teaching could have on a student's life. Finally, and most importantly to me, I would like to find ways to truly ingrain the ethos of this research into students so that they would work like this without needing prompts. If that was achieved and sustained over a long period of time then I believe the students would have truly learnt a valuable skill that could stay with them for life.

Going Forward

I have ended this process believing that the possible benefits of combining Complex Instruction with Ill-Structured tasks are incredible and well-worth pursuing. I will look to continue building up a bank of resources and will endeavour to find other members of staff

in my department who share a similar ambition and who are willing to collaborate in the creation of and search for ideas to implement these strategies more effectively with an increasing range of year groups. I hope to one day be in the position to be able to create a full scheme of work based around the themes of this research, in conjunction with a mathematics department, that could be implemented across an entire year group, Key Stage or school.

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Appendix 1

Answer either in full sentences or bullet points the questions below. Ask for more paper if the space in the box is not enough

1) What should you learn from a Maths class? (Try to think of any answer different from topics you would find in your textbook, e.g. not fractions, algebra etc.)

2) What things that you do in class do you think might help you when you leave school and in what situation will they help?

3) How important is it to be able to work well with others? When might you need to do this? (Think about times now and also in the future)

4) In class this term there has been more of a focus of working with the other students in class. Do you think this has helped you in any way? Explain your answer.

5) In the class this term there has been more of a focus of working with the other students in class. What have been the difficulties, if any, in your experience, of this approach?

6) If you had a choice would you chose to work with the other students in class all the time, independently all the time, or a mix of the two? Why?

Appendix 2

Whole Class Questionnaire

Answer each question on a scale of 1 to 5. 1 means you strongly agree and 5 means you strongly disagree. Circle the number that best represents your answer.

Most people are either good or bad at maths

Strongly agree 1 2 3 4 5 Strongly disagree

If I get stuck I immediately ask the teacher for help

Strongly agree 1 2 3 4 5 Strongly disagree

Mathematics is a subject that needs to be learnt independently

Strongly agree 1 2 3 4 5 Strongly disagree

How I work with other people is important for my learning of mathematics

Strongly agree 1 2 3 4 5 Strongly disagree

I have a responsibility to help my classmates if I think they need it

Strongly agree 1 2 3 4 5 Strongly disagree

Being able to work well in a group is an important skill to have in school

Strongly agree 1 2 3 4 5 Strongly disagree

I feel comfortable contributing to whole class discussions

Strongly agree 1 2 3 4 5 Strongly disagree

I feel comfortable contributing to group discussions

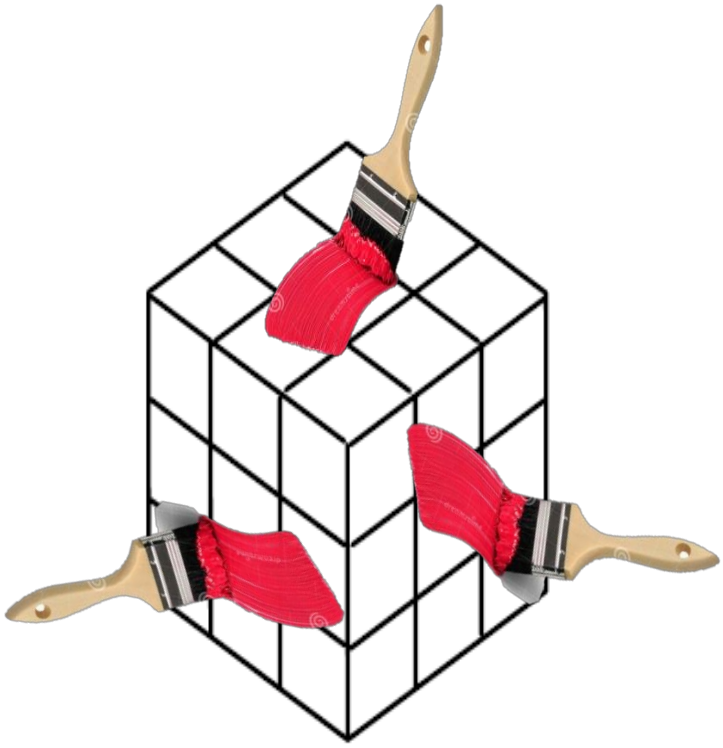
Strongly agree 1 2 3 4 5 Strongly disagree

I think my classmates can say or do things that will help me learn maths

Strongly agree 1 2 3 4 5 Strongly disagree

Appendix 3

The Painted Cube



Imagine the *outside* of this 3x3x3 cube is painted. It is then taken apart piece by piece. How many pieces have 0, 1, 2, 3, 4, 5 and 6 of their faces painted? To what extent can you *generalise* this result?