Investigating Talk Moves in Key Stage Three Mathematics Classrooms

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Abstract

This study aims to explore whole-class discussion in Key Stage 3 mathematics classrooms. It is widely recognised that the quality of language heard and spoken by students during such discussions influences mathematical progression. Despite this recognition, literature demonstrates that achieving productive mathematical speech during whole-class discussion is difficult. American researchers Chapin, O'Connor, and Anderson (2009) advocate a five-step talk move framework which helps support teachers in such endeavours. This study uses their talk move framework as a lens to examine the speech of teachers and students during whole-class mathematical discussions in my school setting. Through use of video recordings and subsequent classroom transcripts it aims to understand which talk moves are currently used by teachers in their classrooms and then seeks to understand any changes following the teachers' participation in focused professional development. This research also explores students' verbal reactions to observed talk moves. Analysis of our teachers' talk moves reveal some noteworthy themes. These themes include: how teachers use talk moves in reaction to student error; students' verbal engagement with peers following talk moves; and how participation structures vary according to teachers' individual use of talk moves. Classroom discussion remains on the agenda for next year's department development meetings and has also been added as a feature in my school's upcoming professional learning calendar. It is hoped that findings from this study will help guide the professional conversations in these settings.

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Introduction

This assignment considers and examines classroom discourse within Key Stage 3 mathematics classrooms. More specifically, this assignment explores the dialogic strategies available to teachers to improve students' mathematical learning and thinking in whole-class discussion.

The rationale behind this project stem from personal experiences as a teacher. In recent years I have felt discouraged whilst orchestrating whole-class discussion. I have noticed, despite efforts, participation structures remain predictable during discussions. Disappointingly students appear overtly competitive and seemingly undervalue the contributions of their peers. I suspect not all my students consider their contributions valuable. Furthermore, developing a group's collective knowledge whilst engaging all students remains difficult. Such experiences have made me consider what strategies are available to teachers to better support students' learning through whole-class discussion.

These development goals reach beyond my classroom. At the start of this academic year I shared with colleagues my concerns and development endeavours. Frustrations like my own were common. Subsequently developing dialogic teaching strategies to better support mathematical learning became an integral part of our yearly, departmental-wide development plan. It was decided learnings from this project would help inform and guide the department.

Orchestrating productive classroom discussion has relevance beyond my professional context. Talk between learners is widely recognised to be valuable for knowledge construction (Mercer, 1995; O'Donnell, 2006). Ollerton and Watson (2001)

reason; should students be denied discussion, they are denied a valuable way of understanding mathematics. Watson additionally reminds us 'social-cultural perspectives of education see learning mathematics as entering a discourse' (2006, p.37). Our own National Curriculum for mathematics also emphasises the quality of language heard and spoken by students is key to progressing mathematical learning (Department for Education, 2014). It is argued that if mathematics work is structured so students must talk, either with each other or with teachers, learning will improve (Ollerton & Watson, 2001).

Despite these curriculum intentions effective discussion-based pedagogy in mathematics classrooms is rare (Lemke, 1990; Cazden, 2001). Classroom analysis reveals even when teachers claim to engage in whole-class discussions many rely on student recitation (Alvermann et al., 1990). When classroom discussion is realised, literature suggests lower attaining students contribute less than their high attaining peers thusly making student experience inconsistent (Lemke, 1990; Cazden, 2001; Applebee et al., 2003; Kelly 2008).

O'Connor et al. (2016) reason there to be four different pressures felt by teachers which minimise time dedicated to collaborative discussions. These reported pressures are: adequate representation of content; the management of student clarity and coherence; equitable participation of students; and time. These pressures mirror those outlined by Reeve (2009) who considers why tightly controlled teaching styles might be used by teachers. Additional ideas from Reeve (2009) include pressures to produce specific student outcomes and equating control with a structured learning environment.

Considering the above, it is unsurprising professional literature exists to assist teachers in their endeavours to better orchestrate effective mathematical discussions. One such piece of literature is 'Classroom Discussions: Using Math Talk to Help Students Learn', by American education researchers Chapin, O'Connor, and Anderson (2009). Chapin et al. (2009) advocate a five-step talk move framework specific to mathematics teaching which guides teachers in their efforts to create effective math-talk communities.

The following literature review intends to explore the aforementioned talk move framework. The individual structure and intention of each talk move, as outlined by Chapin et al. (2009), is described. Potential impacts of each move are then detailed. Additional literature relevant to each talk move is also examined. Following this, important themes arising from the literature are summarised. Finally research questions relevant to my school context are formed.

Literature Review

Introducing Talk Moves

The following section introduces the talk move framework advocated by Chapin et al. (2009). Talk moves are described as tools that teachers can use during whole-class discussion to implement productive classroom talk. There are five talk moves suggested to be most effective in this endeavour. These talk moves are briefly outlined next.

1	Revoicing	Revoicing a student's contribution	"So you're saying… is that right?"
2	Repeating	Asking students to restate another student's reasoning	"Can you repeat what he said just in your own words?"
3	Reasoning	Asking students to apply their own reasoning to someone else's reasoning	"Do you agree or disagree and why?"
4	Adding on	Prompting students for further participation or discussion	"Would someone like to add something more to this?"
5	Waiting	Using wait-time.	"Take your time… we'll wait…"

Table 1: The five talk moves

Before talk moves are implemented Chapin et al. reason: 'the teacher must first establish ground rules for respectful and courteous talk' (2009, p.12). Students should be unafraid to talk freely, without ridicule. The need to co-construct and establish ground rules of this nature is echoed by others (Baines et al. 2009; Webb, 2014). A further recommendation from Chapin et al. (2009) is for teachers to set out conditions for full participation. Specifically, it is reasoned teachers should ensure 'that every student is listening to what others say; every student can hear what others say; and every student may participate by speaking out at some point (Chapin et al., 2009, p.12)'. Whilst these conditions are more easily described than implemented, they perhaps stem from arising problems associated with implementing whole-class discussions in mathematics classrooms. Literature teaches us students often feel more comfortable participating in discourse within small groups settings (Roberts & Billings, 2009). Teachers report experiences where some students choose to remain silent (Inagaki et al., 1998) whilst highly competitive students dominate conversation (Good et al., 1992). Literature explains power, social status and friendship networks can heavily shape

participation norms in classrooms (Fassinger 1995; Chizhik 1998). Perceived social standing is paramount for adolescents; many students fear speaking aloud in front of peers will damage their social reputations (Van Hoose, Strahan, & L'Esperance, 2001). These realisations further emphasise the importance of exploring talk moves.

Talk Move One: Revoicing

This section explores talk move one, revoicing. First the definition of revoicing, according to Chapin et al. (2009), is outlined. Similar definitions to revoicing found within literature are also stated with specific mention being made to formulations (Heritage, 1985) and reformulations (Waring, 2002). Following this, potential impacts of revoicing are explored. Specific discussion is made of the teacher's verification stage, which we will learn forms an integral element of this move.

Description of Revoicing

Revoicing is defined by Chapin et al. (2009) as a teacher repeating some, all or part of a student contribution. Revoicing sequences typically include discourse markers, names or personal pronouns, laminating verbs and content propositions (O'Connor & Michael, 1993). Revoicing, according to Chapin et al. (2009) need not be verbatim but must include a verification stage whereby the teacher confirms with the initial student contributor whether their revoicing is accurate.

Should the verification phrase of this talk move be removed, the definition for revoicing would be noticeably broad. Many other discourse techniques would fall within this definition. Examples of these techniques include but are not limited to: repeating;

recasting; formulation; reformulation; rephrasing; rebroadcasting; and elaborating (Nystrand, 1997; Forman et al., 1998; O'Connor & Michaels, 1993, 1996; Solem & Skovholt, 2017). These forms of talk take on different meanings according to how readily the teacher can alter and redecorate student contributions. Classifying and distinguishing each technique in turn is difficult; terms within literature are often used interchangeably, with overlap and without accompanying definitions.

Two terms worthy of further inspection are 'formulation' and 'reformulation'. Heritage (1985) defines formulations as utterances that summarise or develop the gist of a speaker's earlier statement allowing for preservation, deletion or transformation of ideas (Heritage & Watson, 1979). Waring (2002) later classifies reformulations as a sub-group of formulation. Waring describes reformulations to include phrases such as "you are saying" (Waring, 2002, p.457) which purposefully act to verify the accuracy of teacher repetition. It seems reformulation closely mirrors revoicing. Chapin et al. are not alone in signalling the importance of accuracy checks, the significance of which will be discussed later.

Potential Impacts of Revoicing

We shall next consider potential impacts of revoicing, looking at revoicing verbatim, in-part and with teacher decoration separately. Each form has different impacts; teachers may need to choose carefully which form to use.

First and foremost, revoicing verbatim is explained to be helpful in making quiet student contributions audible (Chapin et al., 2009). This becomes useful when trying to use contributions as a basis for ongoing discussions. Chapin et al. (2009) argue revoicing allows the original speaker, the teacher and other students time for 'thinking space'

which is particularly helpful when student contributions are muddled or incomprehensible. Whilst these impacts are positive some literature cautions over-utilising revoicing. It has been reasoned if teachers habitually revoice all contributions students may habitually stop listening to peers (Herbel-Eisenmann et al., 2008).

Our definition of revoicing allows teachers to repeat student contributions in part. This flexibility allows for retroactive contextualisation (Lemke, 1990). Put simply, teachers may choose only to revoice key elements of contributions. This can help to drive discussions in directions deemed relevant by the class teacher. Hufferd-Ackles et al. remind us 'as teachers open up their classroom for students' ideas, they find it more difficult to manage the mathematical direction that instruction takes' (2004, p.82). Retroactive contextualisation potentially helps manage this difficulty.

The flexibility given for teachers to subtly reform student contributions also has relevance. Firstly, redecoration allows for insertion and modelling of mathematical vocabulary. This helps students develop mathematical language, a skill particularly significant for bilingual students (Moschkovich, 1999). Secondly redecoration allows teachers to lend power and authority to student ideas (O'Connor & Michaels, 1993). Teachers can carefully reformulate student ideas which may otherwise be dismissed. This action can successfully reposition students as competent mathematical thinkers potentially leading to student empowerment. It should be noted some literature warns heavy redecorations of contributions may remove power, authority and control from students subsequently transforming dialogic teaching moves to authoritative teaching moves (Furtak & Shavelson, 2009).

Finally, revoicing with redecoration can set up animation in classrooms (Goffman, 1981). Alongside revoicing teachers can comment 'so you are saying you

disagree with…' or 'is it right to say you agree with …'. Here we observe how a teacher has deliberately positioned a student in relation to a concept. This action helps students create alignments and oppositions to ideas which arguably otherwise may not have been realised (O'Connor & Michaels, 1993). Such realisations are deemed important when endeavouring to mirror classroom discourse practices with those found in scientific and mathematical communities (Forman & Ansell, 2002).

We noted earlier revoicing deliberately includes a verification stage. Most importantly the verification stage indicates to students that their teacher is genuinely wanting to understand their thinking. In essence, the ownership of knowledge remains with the student instead of the teacher. This arguably helps build classroom cultures where teachers and students in that moment share authority, an idea deemed important in supporting the orchestration of engaging and authentic productive mathematical discussion (Engle & Conant, 2002). Additionally, it could be reasoned the verification stage can help alter common social participation structures found in class discussions, specifically acting as an invitation for original contributors to speak again thereby encouraging a turn transition. This moves away from initiation-response-evaluation participation structures commonly used in classrooms (Cazden, 1988; Mehan, 1979). Within the turn transition an opportunity arises for the initial student to clarify, expand, or make changes to original ideas. This shifts the responsibility from the teacher to the student to evaluate correctness of contributions (O'Connor & Michaels, 1993; Waring, 2002). The removal of teacher evaluation is deemed to encourage students to interact without needing right or wrong answers. It is argued this becomes useful in creating low pressured environments, which may encourage reluctant students

to contribute (Forman & Ansell, 2002). These contributions may in turn empower students as they become valued contributors to the classroom community.

Talk Move Two: Repeating

The next section discusses the second talk move, repeating. Firstly, the talk move is described. Next potential impacts assigned to repeating are explored. It will be noticed whilst some purposes liken to those in talk move one others are less similar. Similarly to revoicing specific mention is made of the verification stage, which once again forms an integral element of this move.

Description of Repeating

Talk move two, described by Chapin et al. (2009), is when a teacher asks one student to repeat or rephrase another student's idea. In a similar manner to revoicing once the action has taken place the teacher redirects conversation back to the original speaker to confirm accuracy.

Potential Impacts of Repeating

According to Chapin et al. (2009) some purposes of this talk move are comparable to those discussed in talk move one. As with revoicing, repeating allows contributions to be restated, giving students who did not hear original contributions opportunity to listen again. Additionally original speakers may rehear ideas, potentially resulting in verbal or non-verbal clarification of thought. Furthermore experience teaches us it is usual for student contributions to be muddled when learners are

grappling with new mathematical ideas. Whilst students require time to process meaning of these contributions, teachers may do as well. When teachers utilise the talk move repeating, they are providing themselves this additional time. Unlike talk move one repeating also may aid assessment for learning. Should students be unable to repeat other's contributions it can indicate either the idea was not heard, or not fully understood. This may signal to the teacher that the idea needs reclarifying or further exploration.

Whilst these ideas remain important, we might ask what further advantages are brought by a student repeating over their teacher. Most importantly this talk move can help shift specific classroom norms (Cobb et al., 1993). A 2008 study demonstrated teachers who practised using the talk move for the first-time found students were unable to repeat when asked. Over time these difficulties diminished (Herbel-Eisenmann et al., 2008). Additionally it was reasoned in the short term repeating acted as a mechanism to maintain the focus of 'off-task' students, whilst in the long term it helped establish the expectation listeners need to remain attentive. The expectation for students to remain attentive supports the development of mutual knowledge. Gibbs and Mueller (1990) teach us '…mutual knowledge is a necessary element in what it means to speak in a coordinated, cooperative manner' (p.106). To successfully establish mutual knowledge speakers are required to speak as audibly and comprehensibly as possible whilst listeners must also actively attend to changing classroom ideas. Unfortunately, as reminded by Ollerton and Watson 'many learners will attend closely to what the teacher says but will ignore what fellow learners say' (2001, p.114). Since repeating demands students repeat instead of teachers, it helpfully promotes clear speaking and active listening. This supports the development of mutual knowledge

through improved coordinated speech. Additionally teachers have reported this to be a helpful move when students interrupt, speak over, or ignore each other, all actions suggestive of competing student agendas (Sarangi & Slembrouck, 1992).

Moving beyond shifting classroom norms, literature also demonstrates a difference between repeating yourself and repeating someone else. During a study by Barron (2000), which explored the interactions between primary learners during small group problem solving tasks, it was observed more successful teams repeated one another's ideas more frequently than their own. Repetition of ideas in these groups had the purpose of confirming, questioning, or repeating an idea so it could be recorded. This differed significantly to less successful groups whereby repetition most often made by the team member who originally proposed the idea. It should be noted this research explored a different talk format to our interest. Additionally this study was small-scale and explored just two triads of sixth-grade male students selected purposefully because of their previously observed contrasts in interactional behaviours. It could be questioned whether conclusions from studies examining small group learning should be extended beyond such settings.

Lastly our focus will turn to the confirmation stage in this talk move. Much like talk move one, the talk move ends with the teacher redirecting conversation back to the original student contributor to confirm accuracy of repetition. Teachers have commented this action results in greater student involvement and changes the interactional patterns typically observed in classrooms (Herbel-Eisenmann et al., 2008). O'Connor & Michaels argue it is necessary for a teacher's role in discourse to change from initiator and regulator of discussions to that of discussion orchestrater (1993, 1996). This talk move arguably supports this goal.

Talk Move Three: Reasoning

This section explores the third talk move, reasoning. Initially the talk move is described according to the framework outlined by Chapin et al. (2009). Within this description challenges associated with clearly defining the term 'reasoning' are acknowledged. Following potential impacts of the move for teachers, student speakers and student listeners are discussed. Finally, literature which supports and disputes teachers openly evaluating student reasoning is considered.

Description of Reasoning:

Talk move three encourages students to apply reasoning to each other's ideas. An example of this talk move is to ask a student if they agree or disagree with another student and to then ask for reasoning why. Chapin et al. (2009) comment teachers should refrain from supporting one position or another.

A challenge exists in defining 'reasoning' and more specifically 'mathematical reasoning'. It seems the term mathematical reasoning is not concisely defined within literature and unfortunately Chapin et al. (2009) do not give us their own definition within their talk move framework. It appears the terms 'explanation' and 'mathematical explanation' are more prevalent in literature. For the purposes of our work reasoning will be considered as the content of a mathematical explanation. We should then consider how to identify mathematical explanations, a challenge which goes beyond the one associated with identifying an explanation (Bailey et al., 2015; Pimm, 2014; Resnik & Kushner 1987; Ingram et al., 2019). Some academics consider mathematical explanations to include mathematical definitions or use mathematical properties, others make distinctions between procedural based explanations and those describing

actions on mathematical objects (Levenson et al., 2009; Yackel and Cobb, 1996). Finally, some academics see importance in descriptions which include why to do something over simply how to do something (Perry, 2000). It seems academics utilise definitions differently and a consensus has not been reached.

Potential Impacts of Reasoning

We should ask why verbal articulation of reasoning is helpful and who it is helpful for. Importantly it seems the action of reasoning in a classroom is multifunctional impacting teachers, student speakers and student listeners in different and multiple ways.

For teachers asking students to reason aloud provides an opportunity to hear and understand student thought. In hearing student reasoning teachers can gain information about an individual's mathematical beliefs and understandings (Chapin et al., 2009). Listening to verbal explanations therefore acts as an assessment for learning tool thereby informing teachers how to proceed (Forman et al., 1998).

Turning our mind to student speakers, it is a well-established idea explanation is an important discursive practice. (Erath, 2016; Bargh & Schul, 1980, Webb, 1991). Many studies demonstrate positive correlation between content related explanations and student mathematical achievement (Erath & Prediger 2015; Webb, 2014; Webb 1991). Academics maintain verbal reasoning aids student development and understanding of mathematical ideas (Rogoff, 1991). Additionally oral reasoning supports the acquisition of language skills, the use of mathematical terminology as well as the practice of other communication skills (Ingram et al., 2019). These are important skills in preparing

students to successfully participate in mathematical discourse communities (Leinhardt, 2001)

Delving a little deeper it is reasoned explaining acts as a tool for construction of knowledge (Erath, 2016). More specifically it is suggested verbal explanation demands the reorganisation and clarification of material in the brain, known as cognitive reconstruction (Bargh & Schul, 1980; Webb, 1991). Furthermore, oral reasoning creates opportunities for student speakers to become mindful of gaps in knowledge as well as provide opportunity to identify misunderstandings (Ingram et al., 2019; Webb 1991; Bargh & Schul, 1980). In converse non-explanatory reasoning, in the form of short answers, does little to promote cognitive restructuring. These ideas combined reaffirm the importance of demanding reasoning from all students over just an agreement or disagreement with another.

Verbal reasoning is additionally an important element within mathematical argumentation, for which there is a rich field of research. Argumentation can be considered as:

> … a verbal and social activity of reason aimed at increasing or decreasing the acceptability of a controversial standpoint for the listener or reader, by putting forward a constellation of propositions intended to justify (or refute) the standpoint before a rationale judge (Van Eemeren et al., 1996, p.5).

Argumentation incorporates the process of generating individual or collective argument and involves seeking explanations for claims made. Therefore argumentation encourages self-explanation and reasoning (Chi et al., 1989). It has been claimed, promoting mathematical argumentation in mathematics classrooms can positively affect the development of students' mathematical understanding (Schwarz et al, 2010). Work by Schwarz et al. (2010) specifically demonstrates, through classroom examples,

how argumentation can foster sense-making and conjecturing, can integrate semiotic systems, and can help lead from enquiry to proving. Finally research has shown challenges and contradictions to one's own ideas supports learning gains, conceptual changes and supports the long-term retention of ideas (Howe, 2010; Kruger, 1993).

Having discussed the potential verbal reasoning has for student speakers, it becomes interesting to consider the possible impact on student listeners. Does listening alone lead to learning progression? As phrased by Clarke et al. Is simply 'being there' enough? (2016, p28). Before endeavouring to explore this, it should be recognised a distinction exists between engaged silent students and disengaged silent students (O'Conner et al., 2017). Whilst both groups remain silent, the former may follow attentively to discussions whilst the latter may not. A challenge exists distinguishing the two groups. This challenge perhaps reasons why just a few studies focus on this area of research.

To begin we will consider a study by Schober and Clark (1989). In this study students were split into two groups and asked to complete a mathematical task. The first completed this task with the support of a tutor and their session was recorded. The second group, labelled 'overhearers', watched these recorded sessions and then completed the task. Overhearers performed less well than students who had the opportunity to construct dialogue with a tutor, demonstrating simply 'being there' is not enough. A study by Chi, Roy, and Hausmann (2008) developed this idea further. They set up student groups much like Schober and Clark (1989). This time, as overhearers watched recorded lessons they were requested to self-explain as they worked. In this setting overhearers achieved as well in post-tests as students being tutored directly, reemphasising the power of verbal reasoning.

Another study of interest is by Webb (1991). This study explored students receiving help from peers in the form of content-related explanations during small group work. In Webb's study it was hypothesised that receiving help in this way should be beneficial for learning, however no positive relationship was found between listening to content-related explanations and student achievement (Webb, 1991). It was consequently reasoned for an explanation to be effective 'the receiver has to understand it, internalize it, and use it to correct the area of misunderstanding or lack of understanding' (p 373). The idea that specific conditions must be met before a heard explanation can be helpful is echoed by others (Vedder, 1985; Webb & Mastergeorge, 2003; Webb, Troper, & Fall, 1995).

A final study of note is by Stahl and Clark (1987) which explored students learning in science classrooms. Prior to whole-class discussions, learners were placed in three groups. The first group were advised they would be called upon to speak during the discussion. The second group were also advised they would be called upon to speak during the discussion but were then ignored. The third group were told they would not be required to speak. From pre-tests and post-tests it was recognised whilst all students showed progression, students who anticipated they would be asked to speak significantly out-performed students who knew they would not need to. It seems it is possible for silent learners to make gains in learning if they anticipate they might be asked to contribute.

In conclusion, whilst we have confidence verbal reasoning is beneficial for student speakers, the impact on student listeners is less clear. It has been suggested before students can learn from listening alone other conditions must first be met. Specifically students who use explanations in some form after hearing them are more

likely to make learning gains. Additionally silent learners, who anticipate they might be called upon to speak, are more likely to make gains than those who do not anticipate they will be asked to speak. Such learnings further emphasise the discussed ground rules outlined by Chapin et al. (2009) alongside the requirement for teachers to focus on developing equitable participation in classrooms.

This talk move encourages teachers to refrain from evaluating student reasoning. It would appear Chapin et al. are not alone supporting this restraint (Forman et al., 1998). Engle and Conant (2002) teach us such efforts help nurture students' mathematical authority. It is specifically reasoned students should be able to judge the validity and efficacy of their own approaches instead of simply reiterating the views of their teachers. It is important here to recognise whilst a teacher may not explicitly evaluate a student explanation teachers can inadvertently reveal a inferred acceptance or denial of an explanation through differences in facial expressions, pauses, overlapping speech, vocal stress, or repetition (Forman et al., 1998; Stein et al., 2008). Although teachers may verbally follow the guidance by Chapin et al. (2009) unintended practices may directly oppose their intentions and signal unforeseen statuses of authority. We are reminded by Stein et al., (2008) in these cases students may stop reporting their honest thoughts to a mathematical problem and instead communicate what they believe their teacher wants to hear.

Talk Move Four: Adding On

The fourth talk move described by Chapin et al. (2009) is adding on. Firstly, we will understand the structure of the talk move. We will then learn the possible impacts of this talk move, first through the eyes of Chapin et al., and then in accordance with other academics.

Structure of the talk move:

Adding on is described by Chapin et al. (2009) as the moment when teachers prompt students for further participation. Phrases such as "Would someone like add something more to this?" and "Who would like to add onto this discussion?" illustrate this talk move.

Potential Impacts of the talk move:

Chapin et al. (2009) claim this talk move helps invite students to enter a discussion, thereby increasing participating numbers in conversations. Additionally they comment this talk move encourages students to engage in one another's ideas. Unfortunately, Chapin et al. give no further detail regarding this move and we must turn towards the work of others to gain further understanding.

Engagement with others' ideas is identified by Webb (2014) to positively relate to student achievement. Webb categorises the engagement with others' ideas in three ways; high-level, medium-level, and low-level. High-level engagement involves students adding to another student's strategy by either disagreeing, suggesting alternatives, or adding further detail. Medium-level engagement involves students referencing explicit details of another approach but not adding further detail. Low-level engagement

involves students referencing others' ideas loosely with no details. Webb's study found the level of engagement with each other's ideas was the greatest predictor of achievement. Notably Webb's study recognised moments when building and adding on to ideas was not always helpful. In moments where students have difficulty understanding initial concepts asking others to add on seemingly overcomplicated ideas proving counterproductive.

The importance of building on another's ideas is also referenced in the work of Barron (2003). Barron's work thoroughly analysed collaborative interactions between students during group problem solving tasks. She found when groups proposed ideas coordinated with the content of preceding discussions, the groups were more likely to be successful. Barron argued such behaviour indicates the cohesive nature of a group. As in Barron's previously referenced study this research explored triads of learners in a primary setting. Unlike previously a larger sample size was gathered by Barron thereby making generalised conclusions more appropriate.

Finally, the work of Mercer is of interest. Mercer's (1995) research categorises three types of talk: exploratory, disputational and cumulative talk. Exploratory talk is characterised by participants critically but constructively engaging in others' ideas. Ideas are negotiated and various perspectives are considered. Reasoning is prevalent amongst talk leading to longer individual utterances and sequences of linked clauses. Knowledge is made jointly and is made publicly accountable. Whilst exploratory talk involves joint thinking disputational talk is associated with competitive working and individual decision making. Participants may be unwilling to take on another view and frequently reassert their own instead. Other researchers name this process as 'skip connecting' (Barron, 2003). Characteristics of this talk move include short exchanges of assertions

without reasoning. Disagreements are frequent and constructive criticism is lacking (Webb et al., 2014). Cumulative talk involves sharing and building ideas collectively in a positive but crucially uncritical manner. Talk is characterised by repetitions, elaborations, and confirmation of ideas. Whilst cumulative talk and exploratory talk both include adding on, Mercer reasons exploratory talk is preferable for problem solving scenarios. It seems students building on ideas passively is not always effective.

Talk Move Five: Waiting

This section explores talk more five, waiting. Firstly, the talk move is outlined according to the suggested framework. Then some important related terminology from literature is reviewed. Following this, potential impacts of this talk move for teachers and students are considered.

Description of Waiting:

Chapin et al. (2009) refer to waiting as either the silence immediately following a teacher's question or the silence immediately following nomination for a student to speak following a whole-class question. Chapin et al. (2009) also categorise comments from teachers towards nominated students such as "It's ok, we will wait" prior to speaking as waiting. The inclusion of speech as oppose to silence in this categorisation of waiting is unusual in comparison to related literature.

Waiting is not the only word utilised by academics to describe this talk move. Terminology such as 'wait time', 'think time', 'thinking time' and 'response time' are also prevalent in literature (Rowe, 1974; Stahl, 1990; Alexander, 2004; Kirton et al.,

2007). Some academics also give names to silences depending on placement within interactions (Sacks et al., 1974; Maroni, 2011). Silences during a speaker's turn have been considered as a 'pause' whilst silences following a change of speaker as a 'gap'. An extension of a gap has been considered as a 'lapse' with speech being discontinued (Sacks et al., 1974).

Ingram and Elliott (2016) teach us that most academics categorise waiting in accordance to the work of Rowe (1972) and Tobin (1986) using the categories wait time I and wait time II. Wait time I categorises the silence between a teacher speaking and their continued speech, whilst wait time II categorises the silence between a student speaking and their teacher speaking. Notably both silences are ended by the teacher. Ingram and Elliott (2016) categorise wait time further. They consider wait time I(i) as the silence between a teacher finishing speech and a student beginning, wait time I(ii) as the silence between a teacher's speech and that teacher's continued speech. They then consider wait time II(i) as the silence between a student's finishing speech and the teachers next turn and finally wait time II(ii) as the silence following a student's finishing speech and their continuing speech. Notably these categories are inclusive of silences discontinued by students and teachers. Waiting, in our framework seems to be considering wait time I(i) and I(ii).

<u>The potential impacts of talk move five:</u>

Chapin et al. (2009) make some suggestions to why extending wait time is beneficial. They firstly claim waiting allows students' time to process and think. They argue, alongside others, students require thinking time, time to construct response and time to deeply reflect on posed questions (Mercer & Dawes, 2008). Chapin et al. (2009)

also reason waiting extends participation rates beyond the select few students who are quickest to form thought. This agrees with similar suggestions that if teachers wait before nominating students to speak more students will attempt to process and be ready to be called upon (Duell, 1994) as well as the work by Stahl and Clark (1987) which we previously explored. Chapin et al. (2009) also comment extended wait time is particularly useful for second language learners. Whilst Chapin et al. (2009) give some idea of appropriate wait time lengths they remain vague. Other academics reason wait time lengths must link to the cognitive demand of questions (Riley, 1986; Brophy & Good, 1986) with closed, factual recall questions requiring different wait length to questions demanding in-depth reasoning, and retrieval of information from long term memory (Tobin, 1987).

Whilst the above information regarding impacts of wait time from Chapin et al. is helpful, it remains limited. It has been argued there are consequences to teachers attending to lengths of silence without deeper thought regarding the purposes, consequences, and placements of these increased silences (Ingram and Elliott, 2016). We need to delve a little deeper into literature to gain a more complete understanding of the complexities of wait time. We will first consider the impact of extending wait time on student behaviour considering wait time I and wait time II in turn. We will then consider impacts on teachers.

Research demonstrates when wait time is repeatedly limited students may establish the belief 'that every problem should be solvable with little or no thinking' (Lesh and Zawojewski, 2007, p.784) and may habitually stop attempting to answer questions. Conversely, extending wait time I to more than three seconds has been linked to fewer non-responses from students as well as fewer "I don't know" contributions

(Rowe, 1972). Ingram and Elliott (2016) explain silences within conversations are often interpreted by participants as 'trouble'. Desired reactions would be to speak and initiate a repair. Should teachers refrain from repairing, students are likely to feel compelled to speak instead.

Extending wait time II has been shown to lead to longer student responses containing explanation and reasoning (Rowe, 1972). Additionally, students may ask more questions and speculate. Ingram and Elliott (2016) explain, much like previously, when students hear silence after contributing, they may feel need to correct themselves, complete answers or further explain. In addition, extended silence may prompt other learners to self-select and speak. This can increase the number of student-to student interactions taking place in a classroom and help the building of ideas as observed in talk move four (Rowe, 1972). It has been reported by Tobin (1987) extended wait time can be associated with increased student achievement. Others warn this is not true for all groups of students (Duell, 1994).

Whilst the literature discussed so far remains positive some studies warn otherwise. Some research demonstrates the extension of wait time I may result in boredom for some students (Kirton et al., 2007). In addition, although some academics report extended wait time results in motivated learners, others suggest prolonged extension of wait time II may cause students to lose confidence in contributions (Rowe, 1986). Additionally, Duell (1994) suggests over extended wait times may cause student to think about irrelevant content or even to turn their minds to figuring out why the teacher is waiting. Notably Duell's research is focused on University learning, a different age group to our interests.

Whilst alterations to student behaviours are an interest, the impact waiting has for teachers remains significant. It has been suggested teachers in some settings ask an average of one hundred and fifty questions an hour (Gall, 1970) leaving pauses lengths of less than a second (Rowe, 1972), although some academics have reported a longer (Heinze & Erhard, 2006). Teachers habitually repeat, rephrase or answer questions themselves should students be unresponsive (Rowe, 1972; Liebscher & Dailey-O'Cain, 2003; Seedhouse, 2004). Extended wait time seems to correlate with a reduced frequency of questions from teachers, as well as changes to types of questions asked. With extended wait time questions tend to invite student elaboration, explanation, and alternative viewpoints (Rowe, 1986). Teachers also interrupt students less (Tobin, 1986). Furthermore, teachers utilising extended wait time report changed perspectives of students. Where teachers previously thought student silence was indicative of reduced ability, after extending wait time teachers reported a recognition that some students simply require more time to respond (Kirton et al., 2007; Michaels et al., 2008). Silence may also be resultant of cultural and social differences rather than lack of knowledge (Bernstein, 2000; Heider, 1968).

The above research may suggest teachers should blanketly extend wait time. Ingram and Elliott (2016) however suggest it is important for teachers to think clearly to which interactional changes they hope to achieve before doing so. Furthermore, they carefully explain how deliberately extending wait time leads to new co-constructed norms of interaction (Yackel & Cobb, 1996). Once new socio-mathematical norms are established it may be detrimental to continue extending wait time. Doing so may results in students moving away from new, preferential ways of working. It therefore would

seem asking teachers to mechanically extend wait time remains simplistic; deeper considerations are essential.

Summarising Themes

The previous literature has helped us understand the structure, intentions, and potential impacts of each talk move. If we consider the five talk moves in their entirety some overlapping themes are revealed. To summarise our learning these themes are acknowledged next.

Firstly, many of these talk moves seemingly encourage changing interactional behaviours between members of the classroom. Examples include turn transitions in talk move one, increased student to student interactions in talk move two, the invitation of more students into conversation in talk move four and a different use of the initiation-response-evaluation feedback pattern in talk move five. All these interactional changes provide greater opportunity for student speech.

Whilst perhaps obvious, the increased levels of student speech provide teachers valuable assessment for learning opportunities. Revoicing accurately requires teachers to actively listen, repeating provides opportunities to listen again. Talk move five encourages longer student explanation and elaboration of thoughts. Furthermore, a student's inability to participate when asked in talk move three or four is information itself. Such moments may not have been created without the use of the talk move framework. The increased level of speech also provides students opportunity to grapple with mathematical ideas and mathematical language themselves.

Another change these talk moves collectively encourage is a shift in ownership of mathematical of ideas. An interesting question to consider is who is responsible and accountable for the mathematics created in a classroom? These talk moves seemingly shift the power away from teachers towards students. This was observed through the verification stage in talk move one, the created opportunities for reasoning in talk move three and potentially the increased waiting in talk move five. The increased responsibility could empower and motivate students whilst also helping them to identify as active members of the mathematics community.

Development of Research Questions:

It now becomes important to combine the learnings from literature with the practice in my department. I have interest in understanding my teachers current use of talk moves in their classrooms and current dialogic reactions to these moves. I also have interest in guiding the teachers of my department through a period of professional development and understanding how their use of talk moves, and the reactions to these talk moves, change over time. I am specifically interested in whole-class discussions. Guided by literature, the following four research questions have been developed.

RQ1: What talk moves do teachers in my department currently use during whole-class discussions?

RQ2: Are there any observable discourse patterns, for students or teachers, in response to individual talk moves?

RQ3: Does teachers utilisation of talk moves change following a period of focused professional development?

RQ4: Are there any notable differences to the discourse patterns previously observed after a period of focused professional development?

Methodology

The following section guides us through the design of this investigation. First is an overview of the general structure of the methodology, described in five stages. Following this is a detailed explanation of each stage. Within each stage rationale for choices made and ethical considerations are discussed. Ethical considerations are then summarised for clarity. Finally limitations of this research are noted.

Structure of Project

Stage 1: Information sharing and recruitment of teachers.

Stage 2 Initial data collection; using video to capture teachers' current classroom practice.

Stage 3: Collaboration with mathematics department; six weekly development sessions centred on the use of talk moves within mathematics classrooms.

Stage 4: Further data collection; tracking teachers use of talk moves over six-week period following development.

Stage 5: Analysis of data.

Due to the outbreak of Covid-19 this methodology was not fully completed. For clarity, stages 1 and 2 were completed. School closures disrupted stage 3 in its final weeks. Stage 4 was prevented entirely. Consequently, analysis of data in stage 5 could only be completed with data gathered from stage 2.

Stage 1: Information sharing and recruitment of teachers.

After the project gained ethical approval to go ahead (see Appendix 1, 2 & 5) this research project was formally introduced to the school's mathematics department during a timetabled curriculum meeting. Teachers were guided through the general structure, purpose, and intentions of the project. Teachers were advised of intended data collection methods and ethical considerations relevant to their own and their students' involvement with opportunity to ask questions as appropriate.

Staff were explained research intended to explore teacher and student discourse during whole-class mathematics discussions. Teachers were advised, after an initial video recording of a lesson, a series of six pre-planned collaborative development sessions would commence. It was explained, should they wish to join the project, video-recording would be used to capture classroom practice with or without researcher presence. This choice was given in consideration of potentially existing power dynamics between researcher and teacher. It was also deemed important to minimise external pressure on staff; removing an additional observer supported this goal. Teachers were explained moments of interest from video-recordings would be transcribed for analysis, more detail of which is discussed in stage five. Teachers were advised all data would be

anonymised with pseudonyms as appropriate. Teachers were informed of the ethical considerations made for their students. These are described in stage two. Teachers learnt this was an opt-in project with no pressure to be involved. Additionally it was advised they could remove themselves from the project any time without justification. Teachers were provided with a written account of information after this meeting (see Appendix 3).

After this sharing of information four volunteers gave signed consent to join the project (see Appendix 4). Each teacher's profile is described next. Participant one gained qualified teacher status in 2018 and has been teaching in our school community for two years. Aside from teacher training this school provides the only context for which they have taught. Participant two has a similar profile to participant one having gained qualified teacher status in the same year. This participant also trained within our school community and has therefore worked in our school the same length of time. Prior to commencing teacher training this participant worked as a teaching assistant for one year. Participant three gained qualified teacher status in 2014. Apart from teacher training their experience is isolated to this school setting. They hold a multitude of teaching and learning roles and have completed a MSc in education. Participant four is the most experienced teacher of our volunteers. This teacher has taught in various educational settings spanning a decade. All participants have degrees relevant to teaching mathematics.

Stage 2: Initial data collection

This section describes initial data collection. First the process of class selection is explained and rationalised. Following this is an explanation of the data collection methods alongside ethical considerations. Finally a brief overview of each class is made.

Prior to development the project intended to capture teachers existing use of talk moves. The four teachers were asked to choose a Key Stage 3 class to work with. This project had genuine intentions of aiding teachers develop whole-class dialogue. It therefore felt important not to impose class selection but instead give teachers professional freedom to choose. Data collection was restricted to Key Stage 3 to constrict analysis to students of comparable age. It was also deemed important, by senior leadership, exam classes were not disturbed thereby removing the possibility of using older year groups. Teachers were asked to choose suitable times for filming. This freedom aimed to minimise pressure on participants' workload. Teachers were asked to plan what they considered a typical mathematics lesson, following usual schemes of work. Whilst by no means guaranteed, participants were asked to follow their usual practice.

Once classes were selected students were guided through the project. Although our school is a teaching school, and thusly video and audio recording of classes is common practice, it felt important students were fully informed and able to ask questions before filming commenced. This was not just ethically important but also intended to limit potential behavioural changes the presence of an unfamiliar camera might bring. Students were informed filming would take place from the back of classrooms centred on teachers. They were informed audio transcripts of their mathematical discussions would be made. Student anonymity was assured. Students

were advised this was an opt-in project. They were asked to inform their classroom teacher or myself in person or by email should they wish not to be involved, otherwise they were advised assent would be assumed. Only a handful of students, across all four classes, chose to not participate.

Once data collection began students not participating in the project were moved to the side of classrooms. This ensured these students were not captured on video whilst guaranteeing no disruption to educational experiences. Any audible contributions made by these students were ignored in audio-transcription. The audio transcription process is described fully in stage five.

Next is an account of each teacher's class and a very brief account of mathematical content explored during initial data collection. Teacher one chose to work with a year seven group. Students were of mixed gender and not grouped by attainment. Participant one opted for my presence during data collection. The lesson observed focused on proportional reasoning. This was students first introduction to proportional reasoning according the school's scheme of work. Participant two opted to work with a year nine class and asked for my presence during recording. This class were a setted class; set four of four. The initial lesson focused on an introduction to ratio. Whilst this was the first lesson on ratio this academic year students had some experience with the concepts from earlier school years. Participant three chose to work with a year eight class, again of mixed gender and prior attainment. This participant also opted for my presence during data collection. The lesson recorded was the second of a series of lessons focusing on sequences. Students initially generated next terms of sequences. Students then generated sequences given nth terms and some generated nth term formulas themselves. The final participant chose to work with a year seven

class and asked for my presence for filming. Students were mixed gender and not setted by attainment. The lesson focused on introducing algebra. This was the first time students were exposed to algebra according to our scheme of work.

Stage 3: Collaborative department development sessions.

This section describes the collaborative department development sessions. First is a general overview of the timetabling of the sessions. Following this, the intentions and philosophy behind the sessions are outlined. This section ends with an account of each session.

Collaborative development sessions began after February half-term, following initial data collection. Sessions deliberately occurred over Thursday lunchtimes; a time usually dedicated to curriculum development. Sessions were timetabled accordingly so not to infringe existing workloads.

The initial session was dedicated to giving department members a platform to discuss, explore and listen to each-other's currently formed ideas about whole-class discussions. Crespo (2006) teaches us the importance of developing mutual trust when using study groups as a tool for teacher development. Therefore, the group was encouraged to speak in open and non-judgemental ways. This is not dissimilar to my impression of our usual ways of working. Recognising the potential impact 'a more knowledgeable other' can have on group conversational practices (Barnes, 1976) it was important I placed myself as a facilitator of conversation, thereby helping to promote and sustain the group's discussions rather than intentionally impose any unhelpful power dynamic.

Each remaining session was designed to understand and explore the five talk moves described by Chapin et al. (2009). Whilst sessions were purposefully planned and structured the intention was to minimise expository talk in these sessions. Once teachers were introduced the format of each talk move the mindset was to allow teachers to authentically explore and share ideas collaboratively. Where appropriate staff were guided to relevant academic literature. Ten out of eleven department members attended the sessions actively collaborating in the project.

Session 1: Session explored the department's current views on whole-class discussion. Staff were asked to imagine facilitating a whole-class discussion and consider which features they ideally would and would not like to observe and hear from themselves or their students, considering first-hand examples where appropriate. After a sharing of ideas, the department were given an extract of whole-class discussion taken from work by Chapin et al. (2009, p.3). Staff were asked to highlight features in the extract they considered valuable and discuss why. Many features they highlighted were talk moves, although the group were not explicitly told this.

Session 2: This session was dedicated to revoicing. The department were given examples of revoicing within text (Chapin et al., 2009, p14). The verification stage was explicitly noted. We shared ideas regarding when this talk move might be considered helpful, giving first-hand examples when available. At the end of the session staff were directed to literature by Herbel-Eisenmann et al., (2008) to explore independently should they wish.

Session 3: Session three was dedicated to repeating. The session began with dialogue extracts demonstrating this talk move (Chapin et al., 2009, p15) with specific

acknowledgement of the verification stage. Teachers raised ideas surrounding the ownership of ideas in maths classrooms and considered whether this move helps invite greater student participation. Teachers considered this a move they were unfamiliar with.

Session 4: Session four was dedicated to reasoning. Dialogue extracts from Chapin et al. (2009, p.23) demonstrated this move. Teachers considered the extracts analysing the displayed student reactions. Most teachers considered this a move they were familiar with. Teachers agreed they would rather hear students' reasoning over reasoning themselves. One teacher spoke thoughtfully about what constitutes mathematical reasoning surmising they would accept different reasoning according to the mathematics being explored.

Session 5 & 6: Session five and six would have been dedicated to adding on and waiting retrospectively. Unfortunately, these sessions were prevented by school closures.

Stage 4: Further Data Collection

The following section describes the intended plan for stage 4. This stage was prevented due to Covid-19.

This stage would have consisted of further data collection. Data collection would have been completed in a consistent manner to stage two. The intention was for each teacher to be video recorded with their original classes immediately after professional development and twice more at two-week intervals. The intention was to track talk moves over time.

Stage 5: Analysis of Data.

It was acknowledged whilst video-recordings would capture classroom conversation it also would produce vast amounts of footage. Guided by Ingram and Elliott (2019) it became important to narrow data. Two approaches were decided helpful; the first was the computer software NVivo which allowed for organisation and subsequent reduction of data; the second tool was transcription.

Using NVivo lessons were scanned for whole-class discussion. Moments of instruction relating to organisation, behaviour management and task explanation were ignored. Any moment where a teacher was heard using a verbal talk move was coded. Coded data was then transcribed and inspected further. Since the interest was what participants were saying over how they spoke, transcription was simple verbatim with the focus being accuracy of content over speaker intonation and other discursive properties. Facial expressions, eye contact, body gestures and other non-verbal forms of communication were not pursued. Although it is understood this represents a select part of the data (Ingram and Elliott, 2019) this decision was deemed necessary to help narrow the complexity of the data.

The original intention was for transcription to begin on hearing a talk move and to stop when a mathematical idea changed. Early on however it became necessary to change this process. It was recognised transcribing in this manner led to extremely disjointed text. Often speech immediately before a teacher's talk move helped bring clarity. Thusly, when relevant, slightly longer passages were transcribed.

Talk move five, waiting, had to be captured differently to the remaining talk moves since it relies on silence not speech. It was decided unwise to measure all silences during discussion, consequently waiting was measured according to specific student

behaviours. If, during whole-class discussion, a student displayed an unusually long student response containing mathematical explanation or if a student asked a question these moments were coded, measured, and analysed. These behaviours were chosen due to their recognised importance but rareness in classroom dialogue (Rowe, 1986). Initially difficulty arose in defining 'an unusually long student response', it was realised during initial analysis responses longer than two sentences was rare for these students thusly focus remained here. Silence was measured with the help of NVivo. Sound waves corresponding to moments of interest were inspected to find lengths of silences between speech. Although Chapin et al. only consider silences following teachers' speech in their framework this research measures all silences surrounding moments of interest. This decision was made due to a developing interest in the ideas raised within previous literature.

Guided by the readings of Elliott, (2018) it was decided whilst the coding through NVivo was a priori, the coding of transcribed data needed to be responsive. It was unknown what themes would unfold from transcription and analysis, by necessity, was flexible and reactive. Emerging trends were noted and considered, sometimes shifting as an authentic response to the unfolding data. This helped to develop a 'professional vision' of the data (Goodwin, 1994). It sometimes became helpful to return to original video-footage. As guided by Ingram and Elliott (2019) returning to visual data helps researchers remain familiar with data. This choice also allowed for better identification of communicating students. Furthermore, video footage was a helpful reminder of mathematical content. Specifically, students' frequently referenced content visible on school whiteboards. Returning to still images helped bring meaning to mathematics referenced by students.

Before moving onwards some detail regarding transcripts should be made clear. During transcription, each teacher was given a corresponding code T1, T2, T3 & T4. Students were given the code S followed by a number. The number is indicative of the order of speech during the extract. Consider the following:

> T2: Okay, would anyone like to share a fraction that cannot be simplified anymore and also why?
>
> S1: 10 over 21.
>
> T2: Okay, why can't I simplify that anymore? Or why is it already simplified?
>
> S1: I'm not sure. 'Cos you can't half 21.
>
> T2: Okay, you can divide it by some other stuff though. **So what might be a reason you can give? Alicia, what might be a reason you can give as to why 10 over 21 can't be simplified any further?**
>
> S2 (Alicia): Because you can, like you can divide it by 3.

This extract demonstrates a conversation with teacher two and some students. The student S1 speaks twice followed by a second student, S2. Since the teacher has named the second student speaker during the passage, she is labelled S2 alongside her name. All names in the text are pseudonyms. Talk moves relevant to the analysis are highlighted in bold.

Consider the next transcription which demonstrates wait time:

> T1: So, you're saying if you've got some money and you are splitting it between people it's so they've got the same amount each. Okay that's another suggestion. **(0.1)** Katy? **(<0.1s)**
>
> S3 (Katy): Is it like a part of something?
>
> T1: **[Overlapping]** A part of something?
>
> S3 (Katy): **[Overlapping]** So like a third, one third is a portion of the whole thing. I dunno.

Lengths of silences relevant to discussions are displayed in brackets, emphasised in bold. All silences are measured in seconds. Silences of less than 0.1 seconds were considered too brief to measure reliably and are therefore indicated by (<0.1). Overlapping speech is indicated at the beginning of speaker turns.

Summary of Ethical Considerations:

During the design, implementation, analysis, and reporting phases of this research project every attempt was made to follow the British Educational Research Association ethical guidelines (BERA, 2011). Throughout this methodology more specific ethical considerations have been clearly outlined. Considerations have included; the opt-in nature of the project with rights for teachers or students to withdraw without reason at any time; the assured confidentiality and anonymity of participants throughout; the multiple considerations given to minimise pressure on teacher workload; and the care taken to consider risks associated with the responsibilities of being a dual researcher and teacher. Furthermore, the responsibilities to our community of educational research have been considered. All research findings are reported honestly, without falsehood, exaggeration, or distortion. My school, who partially funded this study, have been kept fully informed of research purposes and findings will be shared in an appropriate and professional manner.

Limitations

Whilst some limitations are mentioned in previous passages this section aims to more fully acknowledge limitations which should be noted in the review of this study.

First and foremost the outbreak of Covid-19 and closure of schools heavily disrupted this project. School closures commenced during stage 3 of this project, halting the final weeks of collaborative development. Additionally, since learning was moved online, aside from initial data collected no further data collection could occur. Subsequently only analysis of initial classroom recordings could occur. Thusly only research questions one and two could be explored. By necessity research questions three and four, which endeavoured to track teachers beyond development, were discontinued. This remains the largest limitation of this research.

Aside from the disruption brought by Covid-19 additional limitations are important to acknowledge. The first of which is the professional power dynamics existing between myself and participants. The dynamic between myself and teachers one and three are particularly interesting. I have supported both teachers during training at the school. Therefore, although these participants asked for my presence during data collection, there existed a risk that they might feel pressure to conform or impress during data collection and thusly not follow their usual practice. Notably teacher one commented she felt nervous prior to my observation. It is possible this nervous energy impacted teaching mannerisms and subsequent student responses during any observed talk moves. For teacher two these concerns are diminished. We have a close working relationship and are frequent observers in each other's classrooms. Finally, teacher four is considered. This teacher emailed prior to data collection and asked what to include in her lesson. Whilst she was advised to teach in her normal manner there is potential practice was altered.

The next limitation relates to researcher and camera presence in the classroom and the resultant impact on student behaviour. Whilst effort was made to prepare students

for filming for many this was a new experience. It is unknown whether researcher and camera presence led to behaviours less indicative of usual working. It should perhaps be noted at the start of each class students commented and referred to the camera. Whilst this settled as lessons commenced it does remain possible their learning behaviours may have changed. Additionally, we know some students were moved out of camera shot. This change from normality potentially could have disrupted usual conversational patterns and norms of working.

A further limitation relates to analysis of data. This analysis was completed by a sole researcher. The risk existed that my own pre-existing experiences, norms, and personal values influenced interpretation. As commented by Cohen, Manion & Morrison (p.687, 2018) 'the researcher's analysis may say as much about the researcher as about the text being analysed'. Unfortunately, aside from my supervisor, no other researchers were available to objectively assess the credibility and dependability of my coding categories at transcription stage. Despite efforts to remain unbiased analysis could have unknowingly been driven by personal agenda and experiences. Other potential interpretations additional researchers may have brought during analysis are missing.

Finally, it should be noted this is a small-scale case study isolated to teachers in one unique school context. Data collected is therefore situational thusly making generalisation and statistical analysis beyond this sample inappropriate.

Findings and discussion

Before discussion commences it is important to acknowledge the duration individual teachers spent using whole-class discussion. This will aid proportional

understanding of talk move usage. Times dedicated to whole-class discussion are displayed below. All lessons were one hour.

Teacher	Total duration of whole-class discussion (Minutes)
1	29
2	16
3	31
4	42

Table 2: Teaching time dedicated to whole-class discussion.

This table demonstrates participant two dedicated approximately a quarter of her lesson to whole-class discussion, the least of all teachers. Teacher one and three dedicated approximately half their lessons to whole-class discussion. Teacher four dedicated approximately three quarters of their lesson to whole-class discussion, the most of all teachers. Let us now consider research question one.

RQ1: What talk moves do teachers in my department currently use during whole-class discussions?

The table below shows how frequently verbal talk moves were used by teachers in lessons. Talk move five is considered separately.

Teacher	Revoicing	Repeating	Reasoning	Adding on
1	17	0	1	1
2	0	0	2	0
3	0	0	0	0
4	7	0	16	7

Table 3: Frequency of talk moves.

The table demonstrates teacher one utilised revoicing more heavily than any other moves. Remaining talk moves were rare in her classroom or not used at all. Notably this teacher revoiced more than any other teacher. Participant two only employed reasoning twice and used no other moves. Participant three used no talk moves and was the only teacher not to do so. Teacher four used reasoning most heavily but also applied revoicing and adding on. She used the highest frequency of talk moves compared to the other teachers, although she spent the largest proportion of her lesson utilising whole-class discussion. No teacher used repeating.

Next is an overview of talk move five which is considered according to two student outcomes. The table below summarises the frequency of these student outcomes.

Teacher	Longer student response containing reasoning.	Student Question
1	2	0
2	0	0
3	0	2
4	4	1

Table 4: Identified moments of interest relevant to waiting.

This table demonstrates six longer student responses present in the lessons of teacher one and four. These were responses which contained reasoning greater than two sentences in length. Of these six moments just two contained silences longer than one second. One moment was in the lesson of teacher one, where a silence was 2.5 seconds. The second was in the lesson of teacher four, where silences of 3.5 seconds and 3.4 seconds existed. This table also identifies three questions posed by students in lessons.

For the questions in teacher three's lesson there are silences of 2.5 seconds and 6.4 seconds. The silences surrounding the question posed in our fourth teachers lessons are minimal. Detailed analysis of all these silences, alongside accompanying transcripts, are considered within research question two.

RQ2: Are there any observable discourse patterns, for students or teachers, in response to individual talk moves?

To address research question two each talk move will be analysed individually. Talk moves relevant to discussions are emphasised in bold for the duration of analysis.

Revoicing:

The table below shows the number of times each teacher utilised revoicing in their lesson. Revoicing was only counted if the teacher verified accuracy. Mild redecorations of ideas were included if integrity of student contributions were maintained.

Teacher	Talk Move Frequency
1	17
2	0
3	0
4	7

Table 5: Frequency of revoicing.

Participant 1:

Our first teacher revoiced seventeen times. Notably there were many examples not included in the count where this teacher repeated students verbatim without verification of correctness.

A consistent feature observed in this teacher's implementation of revoicing is her appeared refrain to evaluate student ideas. Consider the following:

T1: Right, who has heard of proportion before? What do you think it means? Er, John?

S1 (John): Isn't it like the err, is it like the length or the length or the height or the width of a shape is bigger than normal?

T1: **Okay, so John is saying it's when the length or the width or the height of a shape is bigger than normal.** Ok, what do other people think? Do you think you could either build on John's suggestion or say something else? Umm, Amy?

S2 (Amy) : I think proportion is when you have, when you say you have a pile of money and you want to split it, so certain people have the exact amount of (*inaudible*). That's what I think proportion might be.

T1: **So, you're saying if you've got some money and you are splitting it between people so they've got the same amount each. Okay that's another suggestion**. Katy?

S3 (Katy): Is it like a part of something?

T1: A part of something?

S3 (Katy): So like a third, one third is a portion of the whole thing. I dunno.

T1: Are you talking about portion or proportion?

S3 (Katy): Oh err, portion yer.

T1: Ok maybe, so thinking about, so do we think that Katy is maybe talking about portion there?

Multiple Voices: Yer

T1: Rather than proportion there. Similar words though. Robbie?

S4 (Robbie): Isn't proportion like kind of like the size, kind of like a bit like comparing the size of something, or like something in proportion to something else.

T1: **Okay, so Robbie's saying that something could be in proportion to something else. And you are talking about size here are you?**

S4 (Robbie): Yes

T1: Yer. Any other thoughts? Okay well I'll leave you to think about so hopefully by the end of the lesson we are going to do a few different things and hopefully you will have a better idea of what proportion might mean at the end of the lesson.

This extract demonstrates the teacher revoicing three successive times. Each time she appears to neither support or disagree with the ideas raised. This is particularly noteworthy in the first revoicing where the student presents their idea in the form of a question, requesting clarification. Whilst it is tempting to conclude this teacher is consistently holding back her evaluation of ideas it is first worth considering the student input "Is it like a part of something?" made by student three. Notice the student has inputted an incorrect suggestion and the teacher has not revoiced. Instead the teacher repeats the incorrect suggestion verbatim as a question. This led me to wonder whether this teacher ever revoiced when presented with incorrect suggestions. Data revealed she did not. The consequences of this teacher choice for students are worth reflecting upon.

Whilst this behaviour remains consistent there are variations in how this teacher verifies the accuracy of her revoicing. At times verification is made exceptionally clear through use of direct questioning, other times verification is implied. The following extract demonstrates both examples.

> S1 (Jamie): So I divided, I divided 3 by 7 [inaudible] because 3 goes into 7 two times [inaudible] makes 6 and then with the 1 remainder I put it with the 5 to make 15. I then divided 3 by 15 to make 5 because that's how many times it goes in and then [inaudible]
>
> **T1: Okay, I'm going to repeat what you said so everyone can hear. Correct me if I'm wrong about anything. So, what Jamie did was he worked out how many threes go into seven which is two whole ones with a remainder of 1.5 isn't it? And then, were you working with 15 then? So you decided to make it 10 times bigger in order to make the answer 10 times smaller. So 3's into 15 goes 5 times, so 3's into 1.5 must go 0.5 times. Okay. So that means we must have in total 2.5. Okay.** You could use the bus stop method to do that as a good way. Nick?
>
> S2 (Nick): Umm, from like fractions and stuff I know that 25 percent is a quarter and 75 percent is three quarters, so it's got to be three times that.

T1: Okay, so Nick is saying another good way to do it is just using your general knowledge of maths and knowing that if 75 percent is the same as three quarters then, then, one, and one quarter is 25 percent you know that a third of 75 is 25, okay? So you could then use that here to know that a third of 7.5 is 2.5.

In the first talk move highlighted the teacher comments "correct me if I'm wrong" clearly verifying her revoicing. In the second talk move she utilises the inference marker 'so' which literature teaches us implies an accuracy check (Schiffrin, 1987). Throughout this lesson accuracy checks via direct questioning occurred only three times, the remaining examples utilised implied verification. In all but one cases of revoicing original speakers remained silence following revoicing. This contradicts suggested intentions of the verification stage outlined previously.

<u>Participant 2 & 3:</u>

Both participant two and three behaved differently to our other teachers by never utilising the talk move revoicing. Analysis shows these participants typically either repeated contributions without verifying accuracy or heavily elaborated contributions, actions which fall outside our conditions for revoicing.

The following two cases demonstrate this

T2: So what does prime mean Sam?

S1 (Sam): Its can't be, it's only times by it and itself.

T2: It can only be divided by itself and 1, right? So itself and 1, it's a prime number. Yep. Do you have another one Emma?

Here the teacher has redecorated the student's response by correcting their definition of a prime number.

T3: Now lets do, 5, 10, 15, 20, I want a formula for that. Okay, I did not ask you to speak, people should be looking at the board at this point. Jack?

S1 (Jack): 5n.

T3: 5n. Okay.

Here the teacher asks a question, the student gives a solution and the teacher repeats it to the class. The lesson then continues and this suggestion is not discussed.

Participant 4:

Our fourth teacher revoiced seven times. She always refrained from verbally supporting or disagreeing with suggestions made. Unlike teacher one she revoiced following incorrect student suggestions. She also always revoiced verbatim, never redecorating contributions. Unlike teacher one she always implied an accuracy check utilising the word 'so' at the start of her revoicing but never more clearly confirmed accuracy.

Analysis reveals six out of seven revoicings by this teacher took an almost identical structure, typically beginning with the words "so you think…", "so you're saying" or "so you're thinking". The words 'you' and 'your' are of note. See below for an example:

T4: Who can tell me any other questions or things the discovered from theirs? Emilie?

S1 (Emilie): Um c and c are, wait, is this in a maths way?

S2: Oh god.

T4: Any way you want.

S1 (Emilie): Oh, c and c are the same number.

T4: So you think c and c are the same number?

S1 (Emilie): Yes they are the same number

S3: They're not numbers.

S1 (Emilie): Yer I know, but they represent the same number.

Our alternative seventh case did not follow this format. The teacher instead named the student contributor, no longer using the possessive pronoun ‘you’ or ‘your’.

T4: 4, 8, 4. Okay. Abbie does it meet the requirements? You don’t have to answer it all, what can you answer though?

S1 (Abbie): Um, the numbers across are I think they are all square numbers.

T4: **So the numbers across are all square numbers says Abbie**. Are they? No? How are you going to check?

S2: By dividing it by a number

In our first case we speech return to the original student speaker after revoicing. This was true in all but one examples. In the second case another student speaks. This leads us to question the impact of using ‘you’ and ‘your’ versus naming students during revoicing. Arguably the revoicing in the first case directly speaks to the original student, potentially leading them to speak again. Possibly naming the student’s idea opens conversation to the remainder of the class, making it more likely for another student to speak. This behaviour brings to mind research by Sacks et al. (1974) which explored turn taking behaviours in ordinary conversation. Their analysis demonstrated naturally occurring participation ‘rules’ within conversation. They found when one speaker nominates another participant to speak the nominated participant has the obligation to take the turn. When no person is nominated a different participant can self-select to speak. An argument stands, strengthened by the work of Sacks et al. (1974), that the choice this teacher made to use or not use personal pronouns during revoicing, influenced the participation structures during these conversations.

It is now worth analysing the counterexample where the teacher revoiced with the use of a personal pronoun but the original speaker did not speak. This example is below.

> T4: I'd like some comments about, what did you find out? What did you discover? What did you think? You were all handed out slightly different worksheets. Please listen to each other because you had different things you don't know what they've got. Hamish?
>
> S1 (Hamish): What is c?
>
> **T4: So that was one of your questions, what is c?**
>
> S2: A number!
>
> S3: Anything
>
> T4: Can we make sure we are not just calling out. We are instead thinking about each other's questions.
>
> S2: Sorry, Okay.
>
> T4: Because that was a good question to start with. What is c? Okay, anyone else?

In this extract students are generating questions they could ask given the information on their worksheets. We observe the teacher revoicing a student's question, utilising the word 'your'. Rather than speech returning to the original contributor another classroom member speaks instead, answering her question "what is c?". We observe the teacher reprimand the student for doing so. I wonder whether the second student speaker believed the teacher was asking "what is c?" to the class which potentially led them to speak.

A comparison of these patterns of interaction is next made with teacher one. On review it appears teacher one fluctuated evenly between naming students and using you/your during revoicing. In eight cases this teacher named the student in the remainder she did not. Examples of both are visible in earlier extracts. Analysis shows, regardless of this choice, the next person to speak typically was a different student to

the original. This response differs to the students of teacher four. The two extracts below demonstrate this.

> S1 (Hattie): Err, you can, but it is just a bit harder to divide decimals by integers.
>
> T1: **Okay, so Hattie is saying you can but it's a bit harder again, okay because dividing decimals by integers is a bit tricky. So, with D then, how did people work out D? Does anyone want to talk us through it? Alice?**
>
> S2 (Alice): I did 3 divided by 7.5.
>
> ……
>
> S1: Cos 5 x 4 is 20 and then 4 times 4 is 16.
>
> T2: **Okay so you've worked out what we times 5 by to get to 20 and then you've done the same thing with 4 to get to 16. Do other people think that is the right thing to do?**
>
> Multiple Voices: Yes
>
> T2: Yep that sounds about right. So, we have worked out what we are timesing one side by to get the other side. Fantastic.

In both cases the teacher follows her revoicing with a further question. This is typical in almost all revoicing cases for this teacher, a behaviour which differs to teacher four. Arguably this additional question, directed away from the original speaker, would impact participation behaviours in the classroom.

One final consideration worth exploring is the type of question asked preceding a revoicing. Transcripts reveal both teachers, prior to revoicing, typically asked genuine enquiry and meta questions (Mason, 2002) open to a variety of possible solutions or opinions. Questions included "Right, who has heard of proportion before? What do you think it means?", "Okay, so has anyone got a good method for dividing 7.5 by 3?" and "Why are decimal ones harder?" for teacher one and "What did you discover?", "Who can tell me any other questions or things the discovered from theirs?" and "What did you find out?" for teacher four. In contrast the transcripts reveal our remaining teachers

typically asked focusing or cloze form questions (Mason, 2002) demanding fact recall or numerical solutions. Whilst this pattern of questioning itself is revealing it also makes me consider whether the type of question a teacher asks influences their likeliness to revoice. While to my knowledge no research currently yet exists exploring this relationship we do know focusing and cloze form questions are typically used by teachers to exert social control and authority (Ainley, 1987; Love and Mason 1992). Notably this supports a different classroom culture than that encouraged by this framework.

Repeating:

The table below shows the total number of times each teacher utilised the talk move repeating in their lesson.

Teacher	Talk Move Frequency
1	0
2	0
3	0
4	0

Table 6: Frequency of repeating.

Careful analysis demonstrates no usage of the talk move repeating. It would be interesting to explore teachers' perspectives on why this might be.

Reasoning:

The table below shows the total number of times each teacher utilised the talk move reasoning in their lessons.

Teacher	Talk Move Frequency
1	1
2	2
3	0
4	16

Table 5: Frequency of reasoning.

Participant 1

Our first teacher utilised the talk move reasoning just once during her lesson as demonstrated by the following extract.

> T1: Any others? Are there any other possible ones?
>
> S1: Well there's an infinite number.
>
> T1: Okay? **Are there an infinite number do you think?**
>
> Class. Yes
>
> T1: Yer? **Why?**
>
> Multiple Voice: (*inaudible*)
>
> S2: 'Cos there is an infinite number.
>
> T1: Okay, so just saying because there is an infinite number isn't telling me why. Nikki?
>
> S3 (Nikki): Because there are infinite numbers that you can times by.
>
> T1: Okay, so there are an infinite number of things I can times the sides by. So long as I'm timesing both sides by the same amount or dividing them both by the same amount it will stay in proportion. Okay so there are an infinite number of possibilities. Right.

In this extract the teacher is asking if there are any further shapes proportional to an original. A student suggests there are an infinite number of possibilities. The teacher chooses to ask the class if they agree and once agreement is shown she asks why they agree, completing the talk move. We observe two students further contribute towards the idea, the second of which gives some precise mathematical reasoning to the question.

Analysis revealed far more incomplete examples of this teacher utilising the talk move reasoning. Often the teacher asked students if they agreed or disagreed with suggestions but failed to ask for reasoning. The following extract demonstrates an example of this.

> S1: 16.
>
> T1: 16 okay 16. How did you work that out? Let's wait until it comes back up so everyone knows what we are talking about. Okay, how did you decide that you think it is 16?
>
> S1: 'Cos 5 times 4 is 20 and then 4 times 4 is 16.
>
> T1: Okay so you've worked out what we times 5 by to get to 20 and then you've done the same thing with 4 to get to 16. **Do other people think that is the right thing to do?**
>
> Multiple Voices: Yes
>
> T1: Yep that sounds about right. So, we have worked out what we are timesing one side by to get the other side. Fantastic.

Comparing this extract to the previous something quite different has occurred. Rather than students reasoning with their peer's contribution, as observed in the first extract, reasoning is completed by the teacher. Although we are mindful not to make generalisations on just two examples one might ask if the partial use of this talk move influenced the limited reasoning displayed by students in this extract.

<u>Participant 2</u>

Participant two used reasoning just twice in her classroom. Much like teacher one many incomplete examples of the talk move exist. An example of the talk move being used in full is below.

> T2: Okay, would anyone like to share a fraction that cannot be simplified anymore and also why? Ben?
>
> S1 (Ben): 10 over 21.

T2: Okay, why can't I simplify that anymore? Or why is it already simplified?

S1 (Ben): I'm not sure. 'Cos you can't half 21.

T2: Okay, you can divide it by some other stuff though. **So what might be a reason you can give, Ryan, what might be a reason you can give as to why 10 over 21 can't be simplified any further?**

S2 (Ryan): because you can like you can divide it by 3.

T2: You can divide what by 3? 21 by 3?

S2 (Ryan): 21

T2: Okay can you divide it by anything else?

Multiple Voices: Seven

T2: Okay it can be divided by seven. What else?

Multiple Voices (*inaudible*)

T2: Yer it can be divided by 1 and 21 and 3 and 7. Do any of those numbers go into 10? Other than… one? Ok so, what might be another way of saying, that, like that the same numbers don't go into 10 and 21? What do I call numbers that go into numbers?

S3: Factors

T2: Factors. Okay so they don't share any common factors other than 1. Okay, so that might be an explanation we could give.

In this extract a student has correctly identified, as requested, a fraction from the board in its simplest form. This student struggles to identify why this is the case. The teacher uses the talk move reasoning, which brings another student into the conversation to help. In this scenario this nominated student also struggles to apply correct reasoning. What follows is a short conversation where the teacher appears to be focusing talk towards common factors. Unlike our first teacher, even though the talk move was used in full, it is the teacher who articulates the final reasoning needed in this problem. This reasoning arguably is a leap from the students displayed understanding in this extract.

The second example if this talk move from this teacher is below.

> T2: What is the last one up there that can't be simplified? It is already as simplified as it can be. Can anybody spot it. Megan?
>
> S1 (Megan): Is it 15 over 24?
>
> T2: Okay. Why would it be 15 over 24. Is there any number that goes into 15 and 24?
>
> S1 (Megan): No
>
> T2: Do people agree?
>
> Multiple Voices: Three
>
> T2: Three yer. Both numbers are in the three times table so that one's not going to work.
>
> S2 (Tim): Is it 11 over 16?
>
> **T2: Why would it be 11 over 16?**
>
> S2 (Tim): I haven't got any logical thing to back it up I just think it is.
>
> T2: **Okay, Mark can you help Tim?**
>
> S3 (Mark): I don't know, there's like there's no number that, either, theres er eleven.
>
> T2: Okay, so what type of number is eleven?
>
> S3 (Mark): Prime
>
> T2: Prime number. Okay we've got two types of explanations there, either they, like 10 and 21, neither of those numbers are prime, but they don't share any other factors or the explanation can be like oh it's prime so I can't simplify it any further. So we have got a few different explanations there. Okay?

Notably this teacher has chosen to use this talk move like before; when one student is struggling to apply reasoning to their own idea, she invites another student in to help apply reasoning instead. As before, this invited student struggles to provide sufficient reasoning to the problem. The teacher subsequently funnels her questions towards the concept of prime numbers, before providing reasoning for the class. I wonder, had the

talk move been utilised again whether an alternative student would have articulated correct reasoning or whether this still would have fallen towards the teacher.

Participant 3

In contrast to all other teachers, participant three made no used of the talk move reasoning during his initial observation. Whilst it is tempting to presume students did not reason during the lesson this is not necessarily the case. For clarity, they simply did not reason each other's ideas.

Participant 4

The fourth teacher used this talk to a greater extent than her colleagues using it sixteen times during her lesson. The following extracts demonstrate a handful of successive examples. Students are exploring a numerical three-by-three grid with different conditions for rows and columns. Numbers reading horizontally are required to be square and digits need to be placed accordingly.

T4: I'm happy to start again

S1: Okay, on the top row going horizontally you could have 144 because that's 12 squared.

T4: **144. What do we think? Does that work so far? Finn does it work so far?**

S2 (Finn): Um yer,

T4: **Ciara, 144. Do you know that is a square number?**

S3 (Ciara): Yer.

T4: **How did we get 144 Molly?**

S4 (Molly): That's a square, I've got 144.

T4: **Danny why is it a square number?**

S5 (Danny): Well because, well 12 times 12 is 144.

T4: **Jess does that make it square?**

S6 (Jess): Yes.

T4: **Why does it make it square Richard?**

S7 (Richard): Um.

T4: Why is it a square number? What is a square number? Well done to those people who are listening to each other and not calling out. What is a square number Kevin?

S8 (Kevin): Basically, so a square number is a number times-ed by itself.

T4: **What do we think, is that what you would say Marie?**

S9 (Marie): Yep

T4: A square number is a number times-ed by itself. Dave?

S10 (Dave): Well it's the result of a number times-ed by itself.

S8 (Kevin): Oh yer

T4: Is that what you think Kevin?

S8 (Kevin): That is what I meant.

T4: That is what you meant. The result of a number times-ed by itself. Okay, so 144 is the result of 12 times 12. Okay.

In this extract the teacher asks the class if they agree with a suggestion to use 144 in the top row. On agreement reasoning is demanded completing the talk move. Interestingly reasoning is requested from multiple students who are named each time. Reasoning is requested even when correct reasoning is heard beforehand. This results in ten student contributors and the development of an increasingly sound definition of a square number. Successive use of this talk move is common in this teacher's lesson, thereby displaying a contrasting usage in comparison to our other teachers.

Next consider a further reasoning example displayed in this lesson. Following on from the previous puzzle a student is attempting to fill a vertical row that requires a three-digit odd number. The student incorrectly has added the three digits and

concluded since the addition of the digits is odd, the number is also odd. Notice how one student corrects another.

T4: Okay. What number isn't even then?

S1 (Lindsey): 9

T4: 9 okay. **How did Lindsey get 9 do you think? Do you agree with Lindsey. Why? Alan?**

S2 (Alan): She added them all together. You don't.

T4: Okay, Alan. Lindsey did you hear that?

S1 (Lindsey): Oh yer.

T4: You added them. You actually don't need to.

In this extract rather than express agreement or disagreement with the incorrect suggestion the teacher has asked another student if they agree and why. This leads to one student correcting another. The original student expresses "Oh yer" and the teacher summarises the mistake.

Whilst there are many more examples of this talk move the final extract beneficial to share is as follows. Rather than one student correcting another this extract demonstrates the talk move followed by a student self-correcting.

T4: Did anyone manage to fill in this last one then? Danielle did you manage that one?

S1 (Danielle): Yes, I had 7a, 4b and 4f.

T4: Okay. **Do we agree? Did you get the same? Joe you got the same, did you Amie?**

S2 (Amie): Yep

T4: **Yep? How do we know Becca? How do we know that? Where are these numbers from?**

S3 (Becca): Because you can look at 2a.

T4: 2a okay.

S3 (Becca): Oh no, and its seven, no and you've got 5 apples plus 2 apples and that's seven apples.

T4: Two apples and five apples is seven apples.

This extract demonstrates our teacher utilising the talk move. As per the talk move format she asks if students agree with a suggestion and then asks for reasoning. As we know is familiar to this teacher, she asks multiple students to join the conversation. In this scenario students are collecting the like terms 2a and 5a. This extract is of interest because we observe student three incorrectly suggesting 2a as a solution. The student then corrects herself and accurately collects the terms. It will never be known if this student would have made this correction without use of this talk move, however this student does self-correct through verbal reasoning made available by this talk move. In my mind this is noteworthy.

Adding On

The table below shows the total number of times each teacher utilised adding on in their lessons.

Teacher	Talk Move Frequency
1	1
2	0
3	0
4	7

Table 5: Frequency of adding on.

Participant 1

Our first teacher showed just one example of adding on during her lesson. This is displayed below.

T1: Right, who has heard of proportion before? What do you think it means? Er, Edward?

S1 (Edward): Isn't it like the err, like the length or the length or the height or the width of a shape is bigger than normal.

T1: Okay, so Edward is saying it's when the length or the width or the height of a shape is bigger than normal. Ok, what do other people think? **Do you think you could either build on Edward's suggestion or say something else?** Umm, Connie?

S2 (Connie): I think proportion is when you have, when you say you have a pile of money and you want to split it, so certain people have the exact amount of *(inaudible)*. That's what I think proportion might be.

T1: So, you're saying if you've got some money and you are splitting it between people it's so they've got the same amount each. Okay that's another suggestion.

In this extract the teacher clearly asks the class to try and build onto another named student's previous suggestion. What follows is a further student contributing to the idea of what proportion might be. The contribution is connected to the general theme of the conversation but arguably disconnected to the previous student's idea. Our earlier literature signalled this disconnect to be unhelpful for student progression (Barron, 2003).

During the remainder of the lesson the talk move was never used as fully and clearly as observed above. Instead phrases such as "Any other thoughts?" and "Anything else?" were common. It is debatable whether these phrases fall into the category adding on. Whilst such phrases do prompt for further participation, which is an important element of the talk move, they fail to signal a request to try and link contributions to those previously heard. More so, such phrases fall far short of promoting the higher-level engagement behaviours deemed significant by Webb (2014). Interestingly analysis of reactions to these phrases demonstrate no verbal responses from students.

Participants 2 & 3

During the initial observations neither teacher two nor teacher three displayed use of the talk move adding on. Rather than ask students to connect ideas to those gone beforehand both teachers typically posed new mathematical questions.

Participant 4

Our fourth teacher utilised adding more frequently than any other teacher, applying it seven times. The following extracts demonstrates an example. It begins in response to a student not understanding a task displayed on the board.

> S1 (Jim): What do you have to do?
>
> T4: Jenny can you explain what you have to do?
>
> S2 (Jenny): Yes I can. So basically, you have to, the numbers, you have to put them in the, what do you call it, the boxes. Um, and like, well um, say you put 1 in there in the top and then you put 8 next to it and like 5 next to that one. Doesn't it have to like add up to a two digit number, like that way, that way, and that way.
>
> T4: **Can anyone add onto to what Jenny just said then? So Jim said he wasn't sure what to do, Jenny has tried to explain it there. Can someone else explain what the task is. Aurelia?**
>
> S3 (Aurelia): So it, um, all the numbers that go horizontally have to be square numbers and um all the boxes, all the numbers in the boxes that go vertically have to be even.
>
> S4: Which way is horizontal?
>
> T4: Okay, Jim, is that the task you were doing?
>
> S1 (Jim): No
>
> T4: Can you try doing that task then?

In response to the student being confused the teacher appears to use this talk move to assist. Much like in our extract from teacher one a new student responds verbally to the move.

Now consider another conversational extract.

> T4: Why Ellen?
>
> S1 (Ellen): because if it is going to be, if it's going downwards and it has to be an even number. And if you go downward a five will be the left-hand side of the 7. If you go ups it's in the middle but if you go down it would be in the wrong column so it would be an odd number
>
> T4: Okay, is that what you say Laurence?
>
> S2 (Laurence): Er, well it doesn't matter because it's not possible to do it from there because you have only even, so 1 add 2 is 3, and 4 add 5 is 9, and you only have even numbers left and you need another odd, two other odd numbers below the four and five and 1 and the 2 to make those two even.
>
> T4: **Can anyone add onto what Laurence has said there? Add on to what Laurence has said. Laurence has said it can't be done from here, and his reason was because you've got 1 and 2, they make 3 and if you add on even number it's going to be odd.** Do you agree with Laurence there? Daniel?
>
> S3 (Daniel): I don't think it would be *[inaudible]* an even number in line 124, 458, like a number ends in another even number.
>
> T4: What do you think Laurence?
>
> S2 (Laurence): What did he say?
>
> T4: Daniel was following along from what you said, so it would have been polite to listen. Daniel said it's not about adding them together. 124 is the number that would be even.
>
> S2 (Laurence): Oh, I thought it was adding them. I didn't know that.

Although this conversation is a little confusing to follow it displays the talk move adding on alongside a student successfully joining the conversation. This consistently occurred each time this talk move was implemented by the teacher. Notice in both extracts the teacher provides a summation of key conversational moments gone before. It is plausible the teacher is aiding her students to follow conversations therefore easing the request to add on. It would be interesting to know over time whether this teacher continues making this choice and whether this choice is always necessary. One might

question whether students would be able to successfully summarise key moments independently in the future.

Unlike teacher one, who utilised this talk move whilst introducing a new concept, this teacher utilised the talk move to assist struggling students. Rather than correcting through adding on, this teacher brings other student into the conversation instead. In the example above this results in a student referencing the previous idea and then stating his own correct thinking. Whilst there is some promise in this response, with regards to one student mildly engaging with another's idea, in most adding on cases with this teacher students simply stated their own thinking. The important higher-level engagement behaviours, described in our earlier literature review, were uncommon.

Waiting

Research question one highlighted a handful of student responses and student questions worthy of detailed analysis. These moments are considered next with wait time in mind.

Longer student responses containing reasoning.

We learnt earlier across all lessons there were just six student responses which contained mathematical reasoning and were greater than two sentences in length. Two of these moments contained silences longer than one second. The first moment was in teacher one's lesson.

> T1: Yes. Okay, so has anyone got a good method for dividing 7.5 by 3? **(0.2)** Yep Jamie. **(2.5)**
>
> S1 (Jamie): Err so what I did, I looked at the, I looked at the stuff and I saw that it was [inaudible] then I knew it was times 3, divided by 3 so I did 7.5 divided by 3 [inaudible] goes into 7 two times

to make it 6, so it will be one remainder which makes 5 into 15 and then I times, I divided 3 by 15 [inaudible] **(0.6)**

T1: Sorry Jamie, there were a few people talking. Okay. Could you repeat what you said again about the working out the 7.5 divided by 3 but louder so everyone can hear. **(0.2)**

S1 (Jamie): So I divided, I divided 3 by 7 [inaudible] because 3 goes into 7 two times [inaudible] makes 6 and then with the 1 remainder I put it with the 5 to make 15. I then divided 3 by 15 to make 5 because that's how many times it goes in and then [inaudible] **(0.9)**

T1: Okay, I'm going to repeat what you said so everyone can hear…

Whilst this student's response is only a few sentences it stands out as the lengthiest response in this lesson. Whilst most silences in this extract are less than one second a lengthier silence of 2.5 seconds exists. This silence follows the teacher's nomination for the student to speak. Ingram and Elliott (2014) reason silences of this nature are usual in formal classrooms settings. It is reasoned since the student has been nominated by the teacher, they alone have the right to speak next. The turn is secured, and the student therefore has the option to take time before responding. It is plausible this lengthier silence allowed the student additional thinking time to construct a response.

The second moment of interest is displayed next. It existed in our fourth teacher's lesson.

T4: Okay, so there are a few different things going on there. What do we think? Does L stand for lemonade? **(0.2)**

Multiple Voices: Yes **(0.9)**

T4: A lot of people are saying yes to that. **(3.5)**

S1: Algebra **(3.4)**

T4: You called it algebra.**(0.1)**

S2: It doesn't matter what L stands for. Lemonade, L stands for lemonade, which is like could be a certain price. So, each letter stands for a number so two c's mean the same number. Um

and B, so like B is the same number and L is the same number and if it says 2L or c or something, then it means 2 of them. **(<0.1)**

T4: So, 2 L's stand for two of those things

In this extract there exist two lengthier silences, the first silence of 3.5 seconds falls into the category of wait time I(i) and the second silence of 3.4 seconds falls into the category of wait time II(i). Neither silence directly surrounds our specific moment of interest. It may be worth noticing students in this extract students are self-selecting to speak, never being directly nominated by their teacher. Our silence of 3.5 seconds is immediately prior to one of these self-selections. I wonder whether this might be an example of an extended silence compelling the student to speak and 'repair' the conversation as described by Ingram and Elliott (2016).

Student Questions

When analysis of student questions began, it became clear that a distinction existed between genuine student enquiry and hesitant student responses. Hesitant student responses were visible across all lessons with examples including "Is it like a part of something?", "Isn't it three?", "Would it be 7n?" and "Um c and c are, wait, is this in a maths way?" Whilst these student inputs appear to take the form of questions, they were felt not to represent genuine enquiry and were removed from analysis. After removal of these moments three questions remained, two of which contained silences longer than a second. Both moments were in our third teacher's lesson.

The first lengthy silence is displayed below.

T3: We are quickly going to one more.

S1 (Sebastian): **[Overlapping]** Sir?

T3: Sebastian? **(0.2)**

S1:Is it probably the answer for the first one is just there in the bottom half? With 6n it was 6, so that's why it was 6n. So if you put a 6, so basically 2, wait. **(2.5)**

T3: Are you saying it is six n because there is a six here? **(<0.1)**

S1 (Sebastian): Yer **(<0.1)**

T3: Yer. Okay Sebastian, that is a thing we are going to explore later in the lesson okay? **(<0.1)**

S1 Sebastian: Sure.

In this extract the class are inspecting the sequence 6, 12, 18, 24, 30. Earlier in conversation 6n has been identified to represent the sequence. Sebastian has had his hand raised during the conversation but has not been called to speak. He interrupts the teacher to conjecture if the sequence is labelled 6n because the first number in the sequence is a 6 risking over-generalisation. The lengthier silence follows this student question. Without talking to teacher it is unknown whether this silence was purposefully inputted. Perhaps the teacher required time to form thought himself or perhaps he was hoping the lengthier silence might result in continued student speech.

The second silence of length was present in the same lesson. Students have previously inspected the sequence 6, 13, 20, 27, 34 and the formula 7n-1 has been determined.

T3: Okay we can see guys every time it is one less, one less, one less, its one less. Now if this one is 7n and this one is one less that 7n every time. We would say this is 7n take away 1. Okay? **(6.4)**

S1 (Frank): Sir? Can't it also be also 6n + 1? **(0.3)**

T3: Could it be 6n + 1? Lets check. Let's check. Now if we do 6n + 1, in the first term Frank what is n?

S1 (Frank): [**Overlapping]** Oh yer, no.

T3: [**Overlapping]** Well Frank, let's explore. In the first term what would n be? **(<0.1)**

S1 (Frank): 1 **(<0.1)**

T3: 1. So 6 lots of 1 plus 1 gives us 7 so it's not going to be that. Okay, I'm going to write another sequence on the board and we are going to think what it might be.

A lengthier silence of 6.4 seconds exists between the teacher's speech and the student's question. It is intriguing this silence is once more placed prior to the student self-selecting to speak. Mirroring our earlier thoughts it again might be questioned whether this student would have interjected had the silence been shorter. Without further examples to explore it is inappropriate to make large generalisations but potentially this forms another example of student 'repair' as specified by Ingram and Elliott (2016).

We will now move onto the question posed in our fourth teacher's lesson. Consider the transcript below.

T4: Okay, it does work. Um how do you check if something is a square number. Can you do it by dividing it by something? That was Jakes ideas. **(<0.1)** Keiron? **(<0.1)**

S1 (Kieron): Well, you can do it like that, but it would be a bit, yer, you can, you'd have to guess. There is a way to find the square root of something, but it is quite long.

T4**: [Overlapping]** Okay, okay so Jake you could do it like that, or you could use the square-root couldn't you?

S2 Jake: **[Overlapping]** Oh yer.

T4: **[Overlapping]** Because if you are not sure what you are dividing it by. **(0.9)**

S3: How do you do the square root?

T4: **[Overlapping]** How do you know the square root?

S3: **[Overlapping]** No, how do you use the method. **(0.4)**

T4: As Kieron said, a method for square rooting something is quite complicated, and you don't need to know it. Um, so the way we would generally square root things. How do we generally square root things? Malcolm?

Prior to this extract students are exploring a puzzle and need to determine whether 256 is square. A student Jake has suggested dividing the number. The extract begins with the teaching asking how to find the square root of a number. Kieron appears to demonstrate some awareness of a method but does not fully communicate it. Student S3 asks for clarification asking "How do you do the square root?". Unlike our two previously analysed questions no lengthy silences are visible surrounding this moment. This extract has instead been included in analysis due to interest in the high proportion of overlapping speech. Whilst overlapping speech was visible in other extracts notably more is visible in this one. Forman, McCormick and Donato (1998) reason this behaviour to be indicative of classrooms where shared authority and responsibility for explanations is not evenly distributed between teachers and pupils.

Conclusions and Implications

This project investigated the use of talk moves in Key Stage 3 mathematics classrooms. It explored which talk moves teachers in my department currently use during whole-class discussions and then investigated discourse surrounding these moves. Originally the objective was to also track talk moves following a period of staff development, due to unforeseen circumstances this was prevented. Conclusions are therefore made only with research questions one and two in mind. Following this, overriding themes relevant to analysis are discussed alongside considerations of the implications for wider research. This research is then concluded with implications for my professional practice, my departments practice, and implications for the wider school community.

The exploration of research question one demonstrated just three out of four teachers used the talk moves one to four in their observed lessons. Teacher one used revoicing, reasoning and adding on, teacher two used reasoning and teacher four used revoicing, reasoning and adding on. Teacher three used no verbal talk moves. Most talk moves were utilised rarely except for revoicing with teacher one and reasoning with teacher four. It is interesting to consider why no teachers utilised repeating during lessons, without teacher perspectives this remains difficult to understand.

Talk move five was explored differently to the other talk moves with analysis focusing on student responses and student questioning. Silences surrounding these moments were then analysed. Analysis revealed longer student responses with reasoning were only visible in the lessons of teachers one and four. Student questions were only visible in the lessons of teachers three and four. These moments were rare for both categories. In such moments most silences were less than one second and overlapping speech was common. There existed just a few lengthier silences between two and seven seconds. It remains unknown if our teachers utilised lengthy silences elsewhere in lessons, this remains a limitation of this study.

Research question two allowed for a more detailed exploration of our teachers talk moves. Each talk move is discussed next.

Analysis revealed teachers one and four were the only teachers to utilise the talk move revoicing. Teachers two and three failed to apply verification or heavily redecorated student ideas instead. For teachers one and four inconsistencies were observed within their verification stages of revoicing. Whilst teacher one checked

accuracy with the use of direct questioning teacher more weakly checked accuracy. Additionally, whilst it appeared both teachers consistently restrained from verbally supporting or disagreeing student suggestions during revoicing it was later recognised no examples existed of teacher one revoicing in response to incorrect suggestions. One might ask what consequences exist for students if revoicing is only used for correct responses. It could be suggested should students recognise this habitual teacher behaviour the inclination to evaluate the ideas of peers might diminish. Returning to our analysis, social participation structures were also reflected upon. Whilst literature suggests the verification stage of revoicing encourages original speakers to recontribute this was not always observed. Students typically remained silent after revoicing from teacher one. It was suggested her questions whilst followed revoicing impacted this change. Furthermore some significance seemed to lie with our teachers use of the possessive pronouns 'you' and 'your' as opposed to the reference of a student's name. These subtle differences may potentially alter the turn-taking behaviours of students. Such subtleties were not considered in our earlier literature review. Finally it was recognised our teachers' typically revoiced following genuine enquiry and meta question types. It was queried whether a relationship exists between the types of questions teachers ask and their likelihood to revoice. Whilst no literature exists to specifically answer this query there is literature which reasons some question types better support the development of conjecturing mathematical environments (Mason, 2002). Considering our framework also supports this atmosphere it is likely these actions will interlink.

Turning to talk move two analysis revealed no uses of repeating during our teachers' lessons. Not once did a teacher ask a student to repeat another's idea. It would

have been interesting to observe if after professional development whether this would have changed for teachers. Sadly for reasons explained previously this could not be explored.

Moving onto reasoning our analysis demonstrated variations in teacher implementation. Whilst teacher one demonstrated a complete form of the talk move it was more common for her to use it in part. We noticed limited reasoning from students in these moments. Teacher two applied the talk move reasoning when students were struggling with an idea, using it as a vehicle to invite others into the conversation to help. Whilst it was positive to see additional students attempting to provide reasoning in these moments in all cases it was the teacher who displayed final reasoning. It is worth questioning why, despite full use of the move, the desired effects outlined by Chapin et al. (2009) were not reached in these moments. Much like teacher two our fourth teacher also used the talk move when students were struggling. Unlike our other teachers she habitually demonstrated successive uses of the move, even after correct reasoning was given from students. Interestingly in one such an example the result was an increasingly sound definition of a mathematical term, developed from the contributions of many students. Other promising behaviours from students included self-correcting or students correcting each other. It is worth considering if these student behaviours would have existed without use of this move.

Analysis revealed just two of our teachers implemented adding on during their lessons. For one teacher this was used just once and for the other more consistently. In all cases where adding on was used fully students successfully entered conversations. This was not true when diminished attempts of the talk move were observed. Analysis also revealed how teacher four, who used the move multiple times, summarised key

conversational moments alongside the move. It was questioned whether this action assisted students in their responses. It was questioned in time whether this summation of information would still be deemed necessary by the teacher. Finally teacher four appeared to use this talk move as a strategy when students were struggling, an action reminiscent of our teachers' use of the talk move reasoning. Although one example existed showing a student correcting another after the move most students rarely engaged very highly with one another. Most students merely stated their own ideas instead. It would be interesting to understand this teacher's perspectives of this move. If intentions were for struggling students to simply hear correct suggestions, then perhaps the outcome from the move would be identified to be successful. If intentions were for students to authentically build and develop mathematical ideas, engaging and responding to each other then it appears some development is needed. I question whether this talk move alone is enough, do students need more guidance from teachers as to how to engage with each other's ideas more thoroughly?

Wait time was explored with just a handful of extracts. Whilst most extracts revealed minimal silences between speakers a few moments with lengthier silences existed. In two such moments lengthy silences preceded students' self-selection to speak. The significance of these longer silences was brought into question. It was considered if these moments provided an example of conversational 'repair' as outlined by Ingram and Elliott (2016). A further moment of interest occurred when analysis revealed a lengthy silence between a student's nomination to speak and their prolonged response. Whilst literature revealed this silence to be common in formal classroom settings it was questioned whether this silence length impacted the student's verbal response. The final silence of interest followed student speech. The silence was ended

by the teacher. Without the perspective of the teacher it is difficult to know if this silence length was intended. The impact of extending this silence further would be interesting to explore. One final consideration worthy of mention relates to the types of questions asked by students in these lessons. Our questions in the lessons of teacher three were both conjectures. Research evidences these types of questions to be rare from students in this setting (Rowe, 1986). In our fourth teachers lesson the questions demanded clarification of procedure which Rowe (1986) would reason to be more common. It would be interesting to understand whether a relationship exists between wait time and the types of questions asked by students in lessons. Due to the original sample size and the small nature of this study we should be hesitant to make any general claims about these findings. There is potential for this to be studied on a wider scale.

Having concluded each talk move in turn there are some overriding themes worthy of discussion. Themes include teacher's verbal assistance when students make mistakes, participations structures of classroom members and student interactions with other's ideas. Each theme is discussed next alongside considerations for wider research.

Analysis revealed multiple moments where students struggled. At times students openly exclaimed confusion and at other times misunderstandings were exposed through classroom contributions. At times, our teachers responded to such moments with talk moves, at other times they did not. It could be suggested some teachers in my department see talk moves as a mechanism for indirectly aiding struggling students. Moving forward this makes me consider how teachers typically respond when presented with incorrect student suggestions. It makes me consider potential other verbal options available to teachers in these moments. This becomes an area of interest for further research.

Looking broadly at our analysis we noticed times where students successfully engaged with the ideas of peers and times where they did not. Broadly speaking students more readily engaged with each other following the talk move reasoning. This engagement was revealed through their disagreement, correction and building of one another's ideas. Less success was observed following the talk move adding on. Transcripts revealed it more usual for students to simply state their own reasoning following a teacher's use of this move. If we are to be guided by literature and are to consider engagement with ideas important for the development of mathematical understanding, it is worth considering what further strategies teachers can employ to help students to engage more successfully with the ideas of their peers.

Finally each talk move revealed varying participation behaviours of classroom members. During revoicing we noticed when teachers used diminished forms of the moves originally speakers mostly remained silent, an action contradicting the intentions of this move. It was also noticed using the pronouns you/your rather than naming students typically resulted in a change of student speaker rather than a return to the original. During the talk move reasoning we noticed when our fourth teacher used the move in succession many students were able to contribute to the conversation, making participation more equitable. We also noticed how additional students were invited into conversation through the talk move reasoning and adding on in moments when others were stuck. This action influenced the balance of teacher and student speak in the classrooms. Finally although there were just a few moments to analyse we did pick up on moments of self-selection in our analysis of wait time. We questioned whether extended silences during these moments were examples of students 'repairing' conversation as described by Ingram and Elliott (2016).

Moving forward there are some implications worth considering in relation to my own professional practice and my school's practice. On a personal note the ideas raised in this project have given me much to consider as I return to the classroom. I've a awareness of some important themes relevant to generating effective whole-class discussion, an awareness that has been heightened by this research. As I generate discussion with my own students, I am now able to consider deeply how particular actions may impact the power, authority and control of ideas raised. I've a greater sensitivity to social participation patterns during classroom conversation and a building awareness of available strategies that have potential to influence change. I have developed a sounder understanding of the discursive behaviours worth encouraging from students alongside understanding to why such behaviours might be important. Whilst I do not consider talk moves to be a 'quick-fix' for generating effective classroom discussion I can use my awareness of them as a lens to understand my own practice, this has potential to evoke professional change.

Turning towards my departments development it was with sadness this project was halted mid-way through completion. Unfortunately, I did not gain an understanding of how teachers' talk moves might change over time. Additionally school closures prevented the ongoing professional conversation amongst staff. I believe this limited the departmental-wide developmental endeavours this project originally held. Fortunately there remains the possibility for this project to continue informally next academic year. Classroom discussions remains on the agenda for our departments collaborative development sessions thereby ensuring the professional conversation will continue. Additionally development sessions centred on classroom discussion have been added to our newly qualified teachers professional learning calendar next year. I

am responsible for leading these sessions and am endeavouring to share my developing knowledge with colleagues.

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Appendices

Appendix 1: Letter to the Headteacher

Dear [redacted]

I am writing to enquire about conducting research in school this academic year. As you know, I am studying for the Master's in Learning and Teaching at Oxford University, supervised by [redacted]. In my final research project I will explore the dialogic outcomes for learners in the moments preceding a teacher's use of a specific talk move.

The research will take place within key stage three mathematics classes. I am aiming to explore and develop colleague's use of talk moves over the January to April Term. This project falls within part of the larger conversation regarding promoting effective classroom dialogue currently being explored by the maths department as read in our department improvement plan.

By participating in the research, the school would be contributing to a project that will deepen our understanding of mathematics learning for students and so contribute towards developing ways of improving attainment for students in the school in the future. It will also contribute to Mathematics education more widely.

I hope to conduct this research with three volunteer colleagues in the mathematics department. Towards the start of the project I will lead a series of development sessions aimed to introduce and explore five different talk moves available for mathematics teachers. As a department we will explore surrounding literature aimed in understanding the purpose of each of talk move. Volunteers will then be video recorded implementing these talk moves in their classrooms and the effects on classroom dialogue will be analysed. More specifically each colleague will be recorded four times over a term with the hope of capturing change over time. Video recordings will be subsequently coded and analysed for discussion. Pupils will also be explained the project and asked for verbal assent to be involved. Any students not wishing to be involved will be removed from video capture and no audio will be transcribed, thereby removing their data from the analysis.

Oxford University has strict ethical procedures on conducting ethical research, consistent with current British Educational Research Association guidelines. The University also recognises, however, that my study is a piece of practitioner research, and that schools already operate with the highest ethical standards. Therefore only <u>your</u> formal consent as headteacher is necessary, and not that of individual parents or staff. However, throughout the research, students and other teachers will be able to refuse to participate in any research activities at any time.

All participants, including students, teacher and the school, would be made anonymous in all research reports. The data collected would be kept strictly confidential, available only to my supervisor [redacted] and me, and only used for academic purposes. It will be kept for as long as it has academic value.

If you are happy for me to proceed with this study, please confirm that using the attached reply form. If you have any concerns or need more information about what is involved, please contact me or my supervisor. Further, if you have any questions about this ethics process at any time, please contact the chair of the department's research ethics committee, though: [redacted]

I look forward to hearing from you.

Yours sincerely,

[redacted]

Appendix 2: Headteacher Approval



We do not wish to participate in this project.

We would like to find out more about this project.

We would like to take part in this project.



Head teacher's signature

Please return this form to me.

Thank you for your help.

Appendix 3: Information for Participants

Research Project – Information for Participants.

This research project aims to explore the effect teacher talks moves have on classroom dialogue.

The project is divided into three stages.

Stage 1: Pre development video recording.

Stage 2: Curriculum development sessions.

Stage 3: Further video recording.

Should you wish to participate in this project stage one asks you to be video recorded whilst teaching a key stage three lesson of your choice with content following our usual scheme of work. Video recording can be done with or without the presence of myself, as you wish.

Preceding this you will be invited to participate in a series of curriculum development sessions aimed at exploring the introduction, use and purpose of five different talk moves in the classroom. We will explore some literature surrounding each talk move and aim to understand how to use the talk moves in our classroom practice.

Should you wish to continue in the project you will be asked to be video recorded a further three times with the key stage three mathematics class previously chosen. These video recordings will be spaced out between February half term and Easter holidays 2020. The first video recording aims to capture the moments when a teacher is first introducing talk moves, the second aims to capture talk moves once imbedded into practice and the final video follows progress beyond this.

Video recordings will be audio transcribed retrospectively and then subsequently coded and analysed for discussion.

All data collected will be anonymised and used solely for this research project. You are entitled to withdraw yourself from the project at any time, without giving reason.

Appendix 4: Participants Consent Forms

PARTICIPANT CONSENT FORM

Purpose of Study: This study investigates the effect of talk moves on classroom dialogue in key stage 3 mathematics classrooms.

		Please initial e box
1	I confirm that I have read and understand the information given regarding the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.	☐
2	I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, and without any adverse consequences or penalty.	☐
3	I understand that research data collected during the study may be looked at by authorised people outside the research team. I give permission for these individuals to access my data.	☐
4	I understand that this project has been reviewed by, and received ethics clearance through, the University of Oxford Central University Research Ethics Committee.	☐
5	I understand who will have access to personal data provided, how the data will be stored and what will happen to the data at the end of the project.	☐
6	I understand how this research will be written up and published.	☐
7	I understand how to raise a concern or make a complaint.	☐
8	I consent to being video recorded.	☐
9	I understand how video recordings will be used in research outputs.	☐
10	I agree to the use of pseudonymised quotes in research outputs.	☐
11	I agree to take part in the study	☐

[redacted]

Name of person taking consent Date Signature

Appendix 5: Curec

The University of Oxford places a high value on the knowledge, expertise, and integrity of its members and their ability to conduct research to high standards of scholarship and ethics. The research ethics clearance procedures have been established to ensure the University is meeting its obligations as a responsible institution. They start from the presumption that all members of the University take their responsibilities and obligations seriously and will ensure that their research involving human participants is conducted according to the established principles and good practice in their fields and in accordance, where appropriate, with legal requirements. Since the requirements of research ethics review will vary from field to field and from project to project, the University accepts that different guidelines and procedures will be appropriate.

- Please check **"Where and how to apply for ethical review"** and the **CUREC flowchart** first to see if you need ethics approval.
- Please complete this form using a word processor and email it, together with your supporting documents, to your **Departmental Research Ethics Committee (DREC)** (**if applicable**). If you don't have a DREC please email this form to **ethics@socsci.ox.ac.uk** using your official **ox.ac.uk email** address. **Only type-written, emailed applications will be accepted.**

SECTION A: Filter for CUREC 2 application This section determines whether your study raises more complex issues requiring the completion of a full application for ethical review, known as the CUREC 2 application. **(Please mark 'X' in the Yes/No column.)**		
1. Are research participants classed as **people whose ability to give free and informed consent is in question**? (This may include under 18s (although see "competent youths"), prisoners, or adults "at risk".) Your attention is drawn to the University's **Safeguarding Code of Practice** and its implications for researchers involving children or adults at risk. This includes the need for the work to be risk assessed and for researchers to undertake related training. (**Note**: If any of your participants are aged 16 or under, answer 'Yes' here **and** also answer question 5 below.)	Yes ☒	No ☐
2. By taking part in the research, will participants be at risk of criminal prosecution (e.g. by providing information on drug abuse or child abuse)?	Yes ☐	No ☒
3. Does the research involve the **deception** of participants?	Yes ☐	No ☒
4. Does your research raise issues relevant to the **Counter-Terrorism and Security Act (the Prevent duty)**, which seeks to prevent people from being drawn into terrorism? Please see advice on this on our **Best Practice Guidance web page**.	Yes ☐	No ☒
If you answered 'No' to all the questions above, go to **Section B**. If you answered 'Yes' to any question above, continue to question 5 below.		
5. Is your project covered by a CUREC **Approved Procedure** (formerly known as "CUREC Protocols")?	Yes ☒	No ☐
If yes, give the specific Approved Procedure number(s): MSc Modus Operandi		
If you answered '**Yes'** to **ANY** of questions **1-4**, **and** answered '**No'** to question **5**, **stop completing this checklist and do not submit it for ethical review**. Instead, complete the CUREC 2 application form from the CUREC website, then submit that for ethical review. If you answered '**Yes'** to ANY of questions 1-3, **and** answered '**Yes'** to question 5, go on to **Section B**.		

SECTION B: Contact details and project description	
Contact details:	
1. **Principal investigator** OR supervisor (if student research) (give title and full name)	[redacted]
2. Name of student (if student research)	
3. Degree programme (if student research), e.g. BA, BSc, MSc, MPhil, DPhil	
4. Department or Institute name	
5. Address for correspondence (if different from above)	
6. University (**not** private) e-mail address and telephone number	
7. Name and status of others taking part in the project (e.g. third year undergraduate; postdoctoral research assistant)	

Project description:	
8. Title of research project	[redacted]
9. List of location(s) where project will be conducted	[redacted]
10. If your research involves overseas fieldwork or travel and your department requires a travel risk assessment, will you have completed and returned a risk assessment form beforehand? (This must be approved by your department before you travel. If you are travelling overseas, you are strongly advised to take out University travel insurance.) Please also address any physical or psychological risks for Oxford researchers and local fieldworkers in Section 16 below and discuss with your safety officer.	Yes ☐ No ☐ Not required in this instance ☒
11. Anticipated duration of overall research project	9 months or years (maximum 5)
12.a) Anticipated start and end dates of the part of the research project involving human participants and/or personal data	From: (13/01/2020) To: (18/09/2020) **Note**: You will need ethics approval **before** you start your research. CUREC 1As may take up to 30 days to process. **Retrospective ethics approval cannot be granted.**
12. b) In the case of international or collaborative research, will you submit or have you submitted	Yes ☐

this project for ethical review or consideration elsewhere (e.g. collaborator's/local ethics committee, or other local approval)?	No ☐ If 'Yes', please attach ethics or other approvals and give more details below. If 'No', please explain your reasons below. Please also refer to the Best Practice Guidance on Ethical Review of social-sciences based research conducted outside the UK (BPG 16), which includes an Ethics Issues Checklist for International Research (Appendix A)
13. **External** organisation funding the research (if applicable)	N/A

14. a) Title and brief description of **research** (about 150 words) in lay language.
When describing the research, include your methodology, how you are applying professional guidelines, and the use to which results/data will be put. **Please also declare any conflicts of interest here.**

I am am MLT student and this is a small scale research and development project. This research aims to analyse discourse outcomes when mathematics teachers utilise different talk moves in classrooms. This research is to take place in key stage 3 mathematics classrooms within the school I currently work and I will be getting written consent from my head teacher before proceeding.

The project will be introduced to math staff during a curriculum meeting. Teachers will be made aware of the nature and purpose of research. Teachers will be asked to volunteer to be video recorded once with a current key stage 3 mathematics class of their choice with or without my presence.

Following this a series of departmental development sessions will occur. It is normal practice in my department for mathematics teachers to partipate voluntarily in lunchtime development sessions. It is usual for different team members to run these sessions. I will be running five opt-in lunchtime development sessions for maths teacuers aimed to introduce five different talk moves.

Teachers will then be able to volunteer to be part of a longer project. They will be explained that the purpose of the project is to analyse classroom dialogue resulting from use of a talk move. They will be offered the opportunity to be video-recorded four separate times over a 6 week period with a key stage 3 maths class of their choice. Any whole class discussion within the videod material will then be audio transcribed. Any moments during and immediately after a teacher uses a talk move will be coded and analysed. Teachers will have the option to have the video-recording completed with or without myself present, thereby allowing them to be as comfortable with the reseach process as possible.Teachers will be advised that they are able to withdraw from the research process at any time. Any video material will be deleted and removed after completion of the project.

My school is a teaching school and therefore it is usual practice for video to be used in classrooms. Regardless, students in classrooms will be explained the purpose of the project and then asked for verbal assent to be involved in the project. Any students who do not wish to be involved in the project will be positioned outside of camara placement and any of their audio will not be included.

No data collected will be used outside of this research project and will not be discussed beyond the analysis of the project. Any transciption of data will be anonymised so participants cannot be identified.

14.b) Description of participants and how you will **obtain informed consent** to take part in the research (about 200 words in total)

1. Description of participants **and** your criteria for inclusion/exclusion

Teachers in mathematics department & students within their classes. Teachers must be currently teaching key stage three mathematics in the school I work.

2. Your method(s) of recruitment

All teachers will be advised of project during a curriculum meeting. All teachers meeting criteria for inclusion will be offered the opportunity to be involved in project. They will be fully explained the aims of the project and the methodology to be utilised. They will be informed that they can remove themselves from the project at any point. A subsequent email will be sent to all teachers meeting criteria asking for an individual response to volunteering.

3. Your processes for obtaining consent from participants

Email to be sent to department teachers asking for consent to volunteering to project.

Assent will asked of students in classes of volunteered teachers prior to project commencement.

A letter to head teacher and head of department will be sent prior to project commencement asking for permission to go ahead.

Please **attach separate supporting documents (in Word)** if appropriate for your research (English language versions only). Tick those you are submitting below. If appropriate supporting documents are not submitted, you will be asked to provide these separately, which may delay the ethical review process.

- ☐ Recruitment and advertisement material (e.g. a poster, social media recruitment text, or brief invitation letter/ email)
- ☒ Information for participants to read (or hear) before they agree to take part (e.g. written information or, if applicable, an outline oral information script).
- ☒ A document to record informed consent. Templates for written consent forms and/or oral information scripts (in case of an oral consent process) are available from the CUREC website
- ☐ Questions to be asked of participants (e.g. interview questions, or a preliminary scope of questions, or a sample questionnaire)
- ☐ (If relevant) debriefing document after participants have taken part
- ☐ If you feel the above approaches are not appropriate for your study, provide details on how you will obtain consent from participants
- ☐ Please complete section 15 if you cannot obtain informed consent

Please add any further details here.

15. If you cannot obtain informed consent from participants according to CUREC guidelines and good practice in your discipline, please give a brief explanation and justification of this decision below.

16. What are the ethical issues connected with your research and what steps have you taken to address them? **Please do not answer 'none'.** We need to see evidence that you have identified potential ethical issues with respect to your research and have taken steps to address them. If applicable, please address:

- Participant burdens and/or risks

  Teacher workload – all participants will be able choose the class they wish to be video-recorded and will be given flexibility of when this might occur so not to apply additional workload or pressure. All lunchtime development sessions are optional. These fall within normal practice in the department.

  Power dynamics – teachers will be given the option to have their lesson video-recorded without my presence should they feel more comfortable working in this manner

  To avoid misuse of data only anonymised data will be used for dissemination.

- Your own physical and psychological safety as a researcher or of fieldworkers you may employ (see the University's and Social Science Division's Safety in Fieldwork guidance)

  This research project falls within usual professional practice. I do not expect any physical or psychological risks to be associated with the project beyond those that fall within my usual professional practice.

- Data protection/ confidentiality (also see Section 18).

  All data is to be anonymised and safely stored on password protected software.

For more guidance on ethical issues, please see
http://researchsupport.admin.ox.ac.uk/governance/ethics/resources

Discuss other ethical issues here

17. Will your research involve discussing sensitive issues? This could be information relating to race or ethnic origin, political opinions, religious beliefs, physical/mental health, trade union membership, sexual life or criminal activities.	Yes ☐	No ☒

If you answered 'Yes', make sure you include some supporting information (as directed in Section 14 b.) above, showing the range of questions covering these issues.

18. Management and handling of personal and other research data	
For the purpose of completing this section, all information provided by participants is considered **research data**. Any research data from which participants can be identified is known as *personal data*; any personal data which is sensitive is considered *special category data*. Management of **personal data** and **special category data** of human participants, either directly or via a third party, must comply with the requirements of the General Data Protection Regulation (GDPR) and the Data Protection Act 2018, as set out in the University's Guidance on Data Protection and Research. In answering the questions below, please also consider the points raised in the Data Protection Checklist. For advice on research data management and security, please consult with the University's Research Data Team (researchdata@ox.ac.uk) and/or your local IT department, and the University's web pages on research data management. a.) **Please mark 'X' against the data you will collect for your research**	
Consent records (written consent forms, audio-recorded consent, assent forms (for research involving minors) including participant name	☒
Online consent (may be anonymous)	☐
Opt-out forms	☐
Contact details for research purposes only (destroyed when no longer needed for this research)	☐
Contact details kept for future studies	☐
Audio recordings (preferably using PIN-protected audio recorder and stored on device's hard drive)	☐
Video recordings	☒
Transcript of audio/video recordings	☒
Photographs	☐
Task results (e.g. paper/online tasks, diary completion)	☐
Questionnaire answers	☐
Field notes	☐

Other (please specify below) ☐
b.) For **each** of the types of data selected above, state how this will be physically transferred from where it is collected to a local secure storage site (and backed up as necessary). This includes paper records and data captured electronically.
The video recorded material will be removed from the camera and onto my workspace for my use only. This workspace will be password protected and not shared beyond my own use for analysis. From the video I will audio transcribe the data (keeping it anonymous and using pseudonyms where needed). This will be stored on my workspace only, again password protected, solely for analysis for this research project. Consent forms from teachers will be digitalised and stored on my workspace as described above.
c.) How and where will **each type of data** be stored during the research (until the end of all participant involvement)? Describe the arrangements for ensuring confidentiality, i.e. location of storage (e.g. Nexus 365 OneDrive for Business, SharePoint), security arrangements and de-identification of such data. Do not store unencrypted data in freely available cloud services or unprotected USB drives.
Storing of data will adhere to our schools' data protection policy and will be stored on the school's password protected system.
d.) Will you use a unique participant number on research data instead of a participant name? If **yes,** state whether or not you will retain a list of participant names against numbers (i.e. pseudonymisation via a linkage list). Where will the list be stored, and when will it be destroyed?
No participant names will be used on research data. Pseudonyms will be used instead for each participant. No original student names will be retained. Teachers original names will be retained against pseudonyms which will be stored in password protected document on the schools system.
e.) Who will have access to the research data?
Myself only
f.) If research data is to be shared with another organisation, how will it be transferred / disclosed securely?
N/A
g.) When and how will identifiable data (including audio/video recordings & photos) be destroyed or deleted? **Note:** Records of consent should be retained for a **minimum of three years after publication or public release**. Some funders may require longer periods (see http://www.dcc.ac.uk/resources/policy-and-legal/overview-funders-data-policies). If you wish to retain contact details in order to re-approach participants about future studies, you must detail this in information provided to them and obtain specific consent for this.
Consent records will be retained for three years. Audio and video recordings will be deleted and destroyed after completion of the project.

h.) Please confirm that you will store **other research data** safely for at least 3 years after final publication or public release and adhere to any additional research funder policies. For more information about the University policies, please see the University's web pages on research data management.	Yes ☒	No ☐
If '**Yes'**, please give details of who will store the data and on storage format, location and security. Note that open science is encouraged. If **'No',** please provide further details below.		
On password protected school system.		
i.) Does your research involve the use of secondary (i.e. previously collected) data? Common sources of secondary data include censuses, information collected by government departments, organisational records and data that was originally collected for other research purposes (If "**No**", please go to section **19**.)	Yes ☐	No ☒
j.) Do you have data access agreements for the use of this secondary data? (If so, please attach these.)	Yes ☐	No ☐
k.) Is your use of this secondary data compatible with what data subjects/participants agreed that their data should be used for?	Yes ☐	No ☐
l.) Could this data be linked back to an individual or individuals? If yes, address how securely any personally identifiable data will be transferred to you, and where and for how long it will be stored during or after the research. Who will have access to it?	Yes ☐	No ☐

19. Publication and dissemination of research data	
How will you disseminate and feedback project outcomes at the end of the research?	Project feedback outcomes will be discussed with participants during curriculum meeting. All participants will have access to final project write up should they wish The project will also be disseminated more widely at school level during a research themed school inset. The work will then be disseminated at a research meet for the [redacted]

SECTION C: Methods and procedures to be used	
Method used: Please ensure you have addressed any potential ethical issues related to these methods in Section 14 and in your Participant Information Sheet	**Please mark 'X'**
1. Analysis of existing records	☐
2. Snowball sampling (recruiting through contacts of existing participants)	☐
3. Use of casual or local workers e.g. interpreters	☐
4. Participant observation	☐
5. Covert observation	☐
6. Observation of specific organisational practices	☐
7. Participant completes questionnaire in hard copy	☐
8. Participant completes online questionnaire or other online task	☐
9. Using social media	☐
10. Participant performs paper and pencil task	☐
11. Participant performs verbal or aural task (e.g. for linguistic study)	☐
12. Focus group	☐
13. Interview	☐
14. Audio recording of participant (you will generally need specific consent from participants for this)	☐
15. Video recording of participant (you will generally need specific consent from participants for this)	☒
16. Photography of participant (you will generally need specific consent from participants for this)	☐
17. Others (please specify below)	☐

SECTION D: Professional guidelines and training		
1. In this section, please mark 'X' against at least one of the following professional guidelines you aim to adhere to. You should use the principles listed in your chosen guideline(s) in conducting your own research. **Note**: this is not an exhaustive list.		**Please mark 'X'**
Research specialism/ methodology	**Association and guidance document**	
Anthropology	Association of Social Anthropologists of the UK and Commonwealth	☐
Computer Sciences	ACM Code of Ethics and Professional Conduct	☐
Criminology	http://www.britsoccrim.org/ethics/	☐
Education	British Educational Research Association Ethical Guidelines for Educational Research	☒
Geography	Association of American Geographers Statement on Professional Ethics	☐
History	Oral History Society of the UK Ethical Guidelines	☐
Internet-based Research	British Psychological Society: Conducting Research on the Internet Association of Internet Researchers Ethics Guide ACM Code of Ethics and Professional Conduct Also see our Best Practice Guidance on internet-based research	☐
Law (Socio-Legal)	Socio-Legal Studies Association: Statement of Principles of Ethical Research	☐
Management	Academy of Management's Professional Code of Ethics	☐
Political Science	American Political Science Association (APSA) Guide to Professional Ethics in Political Science	☐
Politics	Political Studies Association. Guidelines for Good Professional Conduct	☐
Psychology	British Psychological Society Code of Ethics and Conduct	☐
Social Research	Social Research Association: Ethical Guidelines	☐
Sociology	The British Sociological Association: Statement of Ethical Practice	☐
Visual Research	ESRC National Centre for Research Methods Review Paper: Visual Ethics: Ethical Issues in Visual Research	☐
Other professional guidelines. Please specify the other guidelines used here*:*		☐
2. Please indicate what training in research ethics (or research methodology) the researchers involved with this study have received, e.g. the title of the course and date completed (online training available at http://researchsupport.admin.ox.ac.uk/support/training/ethics), or discussions between researchers and supervisors, if applicable.		
I have participated in lecture provided by the University regarding research ethics.		

SECTION E: Signatures or email endorsements (The SSH IDREC Secretariat accepts either option below. If you have a DREC, check which signature option it prefers.)

- **Option 1:** Email confirmations from a University of Oxford email address can be accepted. Separate emails should come from each of the relevant signatories as outlined below, indicating acceptance of the relevant responsibilities. **Pasted images of signatures cannot be accepted.**
- **Option 2:** Handwritten (wet-ink) signatures. Please scan them and the rest of the checklist pages to create a single PDF document and email to us.

Please ensure this checklist is signed by:

For staff research:	**For student research**:
1. Principal investigator	1. Principal investigator **(project supervisor)**
2. **Head of Department (or nominee)**	2. **Head of Department (or nominee)**
	3. **Student researcher**

1. **Principal Investigator signature/supervisor signature (if student research)**

[redacted] principal investigator [redacted]

[redacted]

[redacted]

[redacted]

2. **Departmental endorsement signature**

I have read the research project application named above. On the basis of the information available to me, I:

(i) consider the principal investigator to be aware of her/his ethical responsibilities in regard to this research;
(ii) consider that any ethical issues raised have been satisfactorily resolved or are covered by relevant professional guidelines and/or CUREC approved procedures, and that it is appropriate for the research to proceed (noting the principal investigator's obligation to report should the design of the research change in a way which would alter any of the above responses so as to require completion of a CUREC 2 full application);
(iii) am satisfied that: the proposed project design and scientific methodology is sound; the project has been/will be subject to appropriate **peer review**; and is likely to contribute to existing knowledge and/or to the education and training of the researcher(s) and that it is in the **public interest**.

[redacted]

[redacted]

[redacted]

3. **Student signature (if student research)**

I understand the questions and answers that have been entered above describing the research, and I will ensure that my practice in this research complies with these answers, subject to any modifications made by the principal investigator properly authorised by the CUREC system.

[redacted]