A Comparative Study of the Beliefs about and Practices of Secondary School Mathematics in England and China concerning Teacher Questioning

By

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Declaration

I hereby declare that this thesis is my own work and has not been published before. This thesis has not been submitted for a degree at another university.

Abstract

Teacher questioning as a fundamental element of pedagogy has been long recognised, but has been under-researched inter-culturally especially in the context of England and China. The literature suggests that a teacher asks a significant amount of questions every day in lessons, although it does not say why a teacher asks questions. Teachers could see questioning as a pedagogic tool to facilitate their teaching, or they could ask questions just out of habit. By making a comparison between two countries, this exploratory study aims to examine the cultural differences and similarities underpinning the use of teacher questioning. The participants in the study were 11 mathematics teachers in two lower secondary schools in England and 12 mathematics teachers in two lower secondary schools in China and data collection took place during the year 2015-2016.

A qualitative research approach was adopted to include both classroom observations of teaching and follow-up semi-structured interviews with the teachers. All observations and interviews were audiotaped. The follow-up interviews with the teachers also sought to get some clarifications of and justifications for the teacher questioning behaviours observed in order to verify possible interpretations of classroom practices by reference to the teachers' perspectives.

The findings suggest significant differences and similarities between the English and Chinese mathematics teachers' questioning use. Teacher questioning was pervasive in both classrooms, and the questions asked were predominantly managerial and 'information-seeking'. Teachers in England valued questioning highly, were also more aware of and reflective about their questioning behaviours, and seemed to possess more profound pedagogical competence than their Chinese counterparts. In general, the English mathematics teachers displayed a student-centred/inquiry-based questioning that adjusted questions to accommodate students with diversity of learning abilities. The Chinese teachers, meanwhile, were less positive about questioning, placing a great deal of weight on the importance of having profound mathematical content knowledge, and presented a relatively traditional teacher-centred/content-based approach to questioning. The findings bring some insights into the nature of questioning from social and cultural perspectives. The investigation of the relationship between teacher beliefs and practices has the potential to provide some suggestions for policy makers and educators for future

teacher training in improving teachers' self-awareness and reflectiveness of their repertoire of questioning skills.

Chapter One Introduction

1.1 Introduction

This chapter explains the background and rationale of this study. After giving the rationale and explaining the motives behind this study, the significance and aims of this study are also presented, together with the structure of the thesis.

1.2 Rationale of the Study

There are many reasons that motivated the research to explore and examine the differences and similarities of teachers' beliefs about and practices in questioning between England and China in the mathematics context, and to investigate the relationship between these beliefs and practices. I would like to give the context and rationale of this study using four lines of enquiry: the role of teacher questioning; the culture; the political status of mathematics; and my personal experiences.

1.2.1 The Role of Questioning

Teacher questioning has always been at the heart of teaching and learning practice. When students learn, they construct meanings and develop understanding in a social context. The process of meaning-making mostly happens through classroom interactions including both teacher talk and teacher-learner talk. Teacher questioning as one frequent component of classroom talk thus plays an important role in determining the nature of learning in classroom instruction. The types of questions that teachers ask and the way they ask these questions can potentially have an impact upon the types of cognitive processes that students engage in while constructing their knowledge. Thus the role of teacher questioning is a fruitful area to investigate, in searching for a better understanding of how students can be helped to make sense of and develop their learning in classroom settings.

1.2.2 'Culture Does Matter'

Teaching is a cultural activity (Stigler and Hiebert 1999), and therefore so is questioning as the predominant activity of teaching. Alexander (2000: 266) stated clearly, *'the national culture in which all the schools in a country are embedded, and which all teachers and pupils in that country share, is as powerful a determinant of its character as are the unique institutional dynamics and circumstances…, culture both drives and is everywhere manifested in what goes on in classrooms, from what you see on the walls to what you cannot see going on inside children's heads.'*

Questioning, as a cultural product, in one culture might not be highly valued in the teaching process where teachers are expected to hold profound subject-matter knowledge; but in another culture, may be valued highly as an effective teaching pedagogy if teachers are expected to possess profound pedagogical knowledge. The study of questioning from its cultural perspective can offer some valuable information about how culture itself could affect teachers' beliefs and teaching practice, and to what extent it may affect the use of questioning as a teaching tool.

1.2.3 The Political Status of Mathematics Education

With the growing obsession with international large-scale assessment (ILSA) such as Programme for International Students Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS), many countries are being challenged to reform mathematics education (Baird et al. 2013; Tan 2013; Wiseman 2014; Greany et al. 2016; Jerrim and Shure 2016; You and Morris 2016; Nortvedt 2018; Pons 2017). The international league tables have revealed that East Asian students consistently outperform their western counterparts (Mullis et al. 2015; OECD 2015a, 2018). A report from the Organisation for Economic Cooperation and Development (OECD) (2018) comparing the mathematical achievements of 15-year-olds suggested that East Asian countries such as China, Japan, Korea, Hong Kong, and Singapore, dominated these top-achieving groups. Most importantly, Shanghai students, who ranked at the top in 2012 in mathematics (OECD 2012), continued to significantly outperform England again in 2015 (OECD 2015a; Jerrim and Shure 2016). Issues have been raised with these large-scale international studies concerning the validity and reliability inherent in their nature and methodology and their limitations including sampling (Dohn 2007; Baird et al. 2011; Freitas et al. 2016), the selection of tasks in terms of difficulty (Meyer and Benavot 2013; Hopfenbeck 2016), and the relevance of the tasks themselves with relevance to the total curriculum (Clarke 2003; English 2008). Nevertheless, the political influence of the studies (Hopfenbeck and Gorgen 2017) have triggered the UK government to initiate a project called 'The Mathematics Teacher Exchange' which has involved the direct employment of a group of mathematics teachers from Shanghai to teach in UK secondary schools (Boylan et al. 2017). This action was intended to improve students' achievement by copying the Chinese education model (Ibid). However, this approach has been criticized (Lindblad et al. 2015; Baird et al. 2016) since the achievement of Shanghai students could be explained by many reasons, not just teaching pedagogy. Some studies have suggested that it could be students' reproductions of teachers' knowledge rather than the creation of their own ideas and critical thinking skills in mathematics (Zhou and Wang 2016). For example, the OECD reported that Shanghai students spent an average of 13.8 hours on homework, which was the highest in any jurisdiction and almost three times the international average of 4.9 hours (OECD 2014a, 2014b). It may also be due to the Confucian-based cultural values placed upon mathematics education, which underpins the high achievement of Chinese students in these international league tables (Biggs 1996; Kim 2009; Sellar and Lingard 2013; Leung 2006, 2014; Jerrim 2015; Tan 2017b). Askew et al. (2010: 12) wrote that:

> *'One of the striking things the review has shown is that high attainment may be much more closely linked to cultural values than to specific mathematics teaching practices. This may be a bitter pill for those of us in mathematics education who like to think that how the subject is taught is the key to high attainment […] being born into a culture that highly values success in mathematics established a virtuous cycle of continuing success.'*

Zhang et al. (2016) carried out a study with Chinese students which supported the above claim that students in lower secondary school in China valued 'achievement' more than anything else, which should be understood to be a result of Confucius heritage culture (CHC) and the superior status of Chinese examination history. The political status of mathematics education has subsequently encouraged many researchers to carry out cross-nation comparative studies to look at other countries' educational systems.

This study is therefore also prompted by the superior performance of Chinese students over their British counterparts previously mentioned in international studies on mathematical achievement: it seeks to examine whether the differences in teacher questioning may play a role as one of the cultural differences between the pedagogies of the two nations.

1.2.4 Personal Experiences as Insider and Outsider in Teaching Mathematics in China and England

Finally, as a student in China for so many years, I have personally experienced the teaching of mathematics in lower secondary schools, and then as a postgraduate student in England studying mathematics education, I have closely observed some teaching of mathematics to Year 7 students in England. My experience as a student in both places has offered me a close insight into the similarities and differences of questioning in teaching mathematics between the teachers in England and China, in terms of how they pose their questions to students, and the questioning techniques used. It has also motivated me to carry out a comparative study of teacher questioning in the two nations.

1.3 Aims of the Study

The major aim of this study is to explore and examine the similarities and differences in both teachers' beliefs about questioning and in their questioning practices in England and China; and to investigate the relationship between the two to see if teachers' beliefs are correspondent with their practices. It aims to explore the social-cultural significances underlying teachers' questioning practices and their personal beliefs, values and attitudes towards questioning.

Through comparing teachers' beliefs and practices in the two nations, this research aims to provide some original insights into the perceived cultural differences and similarities underpinning the use of teacher questioning. It is hoped that the outcomes of this research will be of use to policy makers, teacher educators and practising teachers who are interested in cross-country examinations of culture and teaching pedagogy.

1.4 Structure of Thesis

This thesis consists of six chapters.

Chapter Two illustrates the review of current literature related to the research topic. It starts with a general description of teacher questioning including its definition, its current practices and its key features. Then it narrows teacher questioning into its specific context: mathematics classrooms. In this mathematics context, it explores the significant role of teacher questioning in mathematics and suggests that teacher questioning in mathematics is unique and different from that in other curriculum areas such as Literacy. Following this, it focuses its attention on the distinct educational systems and curricula in England and in China, and the comparison between England and China with an emphasis upon teacher questioning. As well as comparing teacher questioning in mathematics in the two countries, it also sets out to examine the relationship between beliefs and practices in questioning, through using literature relating to the importance of teacher beliefs, and the influence of this upon classroom practices, as well as the variations between beliefs and practices. In the end, the research questions derived from the aims of the study are presented.

Chapter Three describes the methodology of the study, including the theoretical underpinnings informing the use of methods, the design of methods, sampling, data collection, and ethical considerations. This study employed a qualitative approach combining classroom observations and semi-structured individual interviews. Before the main study, a trial study was piloted. The data collection procedures are also illustrated. Issues related to the validity and reliability; positionality and ethics are also discussed in this chapter. Finally, data analysis is presented, which includes data transcription and the analytical frameworks for observations and interviews.

Chapter Four presents the findings from observations and interviews. The observational data describes the similarities and differences between a group of mathematics teachers in China and England focusing upon the types and frequency of questions asked and the patterns and strategies of questioning including wait time, questioning distribution methods and other questioning patterns identified in the data. The interview data is also presented concerning the similarities and differences of the two groups according to the values and attitudes held concerning questioning, its frequency and purposes; the types of questions posed; the preparation and sourcing of questions; the patterns and strategies of questioning explained and justified by the teachers; and the teacher training underpinning teacher practices in questioning. The variations between beliefs and practices in questioning is illustrated firstly at an intra-country level; then is examined at a cross-country level.

Chapter Five discusses the findings in the light of the existing literature, following the three research questions which guided this study. It firstly discusses the similarities and differences between the teachers' practices in questioning in England and in China, including the types and levels of the questions they posed and the strategies they used in asking these questions. In this respect, the clarifications and justifications of the teachers from their follow-up individual interviews were also integrated into the discussion of each of the identified questioning strategies and patterns. Then, it discusses the similarities and differences between the beliefs about questioning held by these teachers in England and in China, following their purposes for using questioning in their teaching, the types and levels of the questions they posed, the sourcing and preparation of questions, the strategies they used in asking these questions, and the training for questioning they had experienced. Following this, the emerging contextual and social-cultural factors including class size, and the notion of Collectivism-Individualism are explored. The variations between beliefs and practices in questioning are also discussed in both at an intra-country level and at a cross-country level.

Chapter Six concludes this study by presenting its contribution and implications, together with the limitations and recommendations of this study.

1.5 Summary

This chapter has offered the rationale of this study including the reasons that motivated me to conduct such research. The aims of the study and the organisation of the thesis has also been presented. The next chapter (Chapter 2) will present the theoretical background to this study.

Chapter Two Literature Review

2.1 Introduction

Reviewing the background for the chosen topic is always important in order to understand the ways in which existing studies relate to the proposed study. This chapter will review the literature to explain a series of reasons behind the choice of study. It mainly consists of four sections: teacher questioning and its current practice according to relevant research; questioning in mathematics education; the cross-cultural comparison between England and China; and the relationship between teacher beliefs and practices in questioning. Firstly, it sets its starting point at exploring the key issues within teacher questioning, in terms of its importance and pervasive use in classroom teaching, its current situation in educational research and some key features of teacher questioning. Secondly, it reviews the literature related to teacher questioning in the context of mathematics education. Thirdly, it focuses on the cross-culture comparative perspective of teacher questioning in England and China, highlighting the significant role of culture in teacher questioning. Finally, it seeks to investigate the relationship between teacher beliefs and practices regarding their questioning. After reviewing the literature, a summary is presented in order to establish the research gap; derived from this, the research questions are also presented at the end of this chapter.

The literature is mostly retrieved based on the journals and books accessed through Google Scholar, British Library (Ethos.bl.uk), University of Warwick library (e.g. Warwick wrap), and other online resources (e.g. Copas, Google Books). I have also taken some workshops about where to find resources through the research student skills programme (RSSP) provided by the University of Warwick. More precisely, I adopted reverse snowballing and forward snowballing when searching for literature in the databases. I began to look for articles by searching keywords (e.g. teacher questioning, teacher questioning in mathematics, teacher questioning beliefs etc.) in Google Scholar or Warwick Library Search, sometimes used different wording in the keywords. Alternatively, I already knew a few articles that currently exist in my research topic of interest (e.g. Mercer's work). So the first thing was to find out what articles those papers cited (reverse snowballing), the second was to find out what articles cited those papers (forward snowballing), and then retrieve them. In the process, I also checked if those articles cited any other relevant articles, and retrieved those, and continued this process until I could not find any more relevant articles.

Many journals (such as Sage, Jstor, and Google Scholar) would have ‘citation tracking’ function, displaying which articles are referenced in this article, together with more recent articles that cited your article. The next thing is to see if these articles were peer-reviewed before I read them. The dates of publication of most of the literature I retrieved were after 2000, but there were exceptions, for example, the seminal work in my research field (e.g. Dillion’s work on teacher questioning in the 1980s). This demonstrates that I have gone through the literature in a systematic and rigorous way.

When reading the literature, I categorised it and developed themes, using a combination of deductive and inductive approach. It began with a deductive approach knowing that I was doing something within the field of ‘teacher questioning’, along with the reading, new themes and categories started to emerge in the reviewing process (e.g. the relationship between teacher beliefs and practice).

2.2 Teacher Questioning from a General Perspective

This chapter will begin with a review of teacher questioning in its current practice and research, then following this, it will illustrate some key features of teacher questioning, so as to help with the understanding of aspects of teacher questioning, including questioning purposes, types of questions, wait time, questioning distributions and strategies of questions. According to Alexander (2017: 9), ‘*talk has always been one of the essential tools of teaching’*, which is more than just an aid to effective teaching. Most importantly, it lays at the heart of learning. That is, through talk, students make sense of their thinking and experiences. Thus arguably, classroom talk is the ‘true foundation’ of learning in terms of cognitive development and discursive competence (Mercer 2012). Teacher questioning as one of the key components of classroom talk inevitably plays a fundamental role in education.

History reveals that purposeful questioning and discussion began approximately 2000 years ago with Socrates, who strove to engage the intellectuals in rhetorical analysis that required critical thinking to solve the political, medical, religious, and philosophical problems of the day (Gross 2002). The literature has suggested that teacher questioning is a ‘*frequent, pervasive and universal phenomena’* (Roth 1996: 710). Apart from lecturing, teacher questioning is by far the most popular instructional technique in classroom settings (Sullivan and Lilburn 2002; Mohr and Mohr 2007; Albergaria-Almeida 2010; Ernst-slavit and Pratt 2017; Fitriati et al.

2017; Dohrn and Dohn 2018). Teachers constantly ask questions, and in some lessons, there is nothing but questions (Cotton 1988). Teachers typically use 80% of their school time to ask questions, which works out to around 300-400 questions each day (Levin and Long 1981). Sullivan and Lilburn (2002) reported that most mathematics teachers spent 60% of their lessons asking questions. Mohr and Mohr (2007) reported that elementary classrooms contained 100 teacher questions an hour. In an average career of 40 years, they are likely to ask about five million questions. With such prevalence of teacher questioning, comes a question: what is a teacher's question?

2.2.1 Definition of Questioning

The literature reveals that a question can be defined in many ways. Functionally, a question can be both seen as an utterance that requests information, confirmation or agreement (Searle 1969; Stivers and Enfield 2010) and an utterance that requests social actions (Jefferson 1984; Bartels 2014). Teacher questions can also be defined as '*instructional cues or stimuli'*, which convey to learners the content knowledge to be learned and '*directions for what they are to do and how they are to do it'* (Cotton 1988: 2). Some studies have attempted to define teacher questions from their linguistic and grammatical form, in that questions can be expressed in three syntactic structures (Wu 1993: 51) including interrogative form (e.g. 'who can give an answer?'), imperative form (e.g. 'tell me why.') and declarative form (e.g. T: 'that means your brother is 11 years younger than you.' S: 'yes.'). But Wu's definition does not include the question that is syntactically an interrogative but functionally considered as a command such as '*would you speak louder*?' The interrogative form is the most typical form of a question: this includes yes/no questions, wh- questions and rhetorical questions. The imperative form is grammatically imperative with a falling intonation, but functionally used to seek information from learners, which is then interpreted as a question. The declarative form, often appearing to be a statement in Wu's (1993) definition, is also considered as a question, a non-interrogative question. However, as Bartels (2014), and Halliday and Greaves (2008) argued that some declarative utterances alone with a rising intonation could also be considered as a question, since functionally their role was to express uncertainty or to seek confirmation or denial.

Therefore, the research focus is on those statements that have the grammatical and intonation form of questions (Wu 1993; Bartels 2014), whether they are functionally for the purpose of eliciting information or for social acts. Some of these questions in this study are incomplete sentences that ended with a rising intonation followed by a pause (Chin 2007). They are indicated by '[…]?' in the excerpts of classroom questions.

2.2.2 Teacher Questioning in Current Practice and Research

Given the technological and sociocultural environment of the twenty-first century and the increasing demand for creative and inquiry based learning in education, teacher questioning is at a rather complex stage of development (Ingram 2012; Mercer and Dawes 2014; Patahuddin et al. 2018). Discourse in traditional classes often takes the form of the recitation or IRF (Initiation, Response, Evaluation/Feedback) pattern of discourse (Mehan 1979; Cazden 2001) or authoritative discourse (Mortimer and Scott 2003; Scott et al. 2006) or the triadic dialogue (Dillon 1988; Lemke 1990), where teachers ask too many questions, most of which are to evaluate what students know and have learnt, in which a teacher typically initiates an interaction with a question, a student response and the teacher evaluates or gives feedback (what we call 'IRF/E'). This suggests one distinct feature of teacher questioning, which is 'authoritative', meaning that only teachers are the ones with the authority to ask questions, and students can only respond to teachers' questions, never comment or ask questions to teachers and others, with such behaviour being perceived as a threat (Baird and Northfield 1992; van Zee et al. 2001). As a result of this, students' responses often tend to be short with few words. Most of teacher questions asked are aimed at assessing and modifying student learning and understanding. Dillon (1984, 1990) has criticised such an approach to teacher questioning as it draws upon behaviourism, which suggests that learning happens because of passively transferring knowledge from one to another (Bates 2016; Cooper 2018). In other words, learners construct their knowledge through receiving it from teachers. Therefore, such traditional or conventional classrooms often are teacher-centred, giving teachers' full control and power over the students. Based on this, teachers can declare the knowledge and students are expected to accept it without debate (van Zee and Minstrell 1997). In this case, teachers are the source of knowledge, are described as knowledgeable and are interpreted as 'knower' and 'doers' (Nassaji and Wells 2000; Cundale 2001), whereas students are perceived as passive learners and merely receive the transmission of knowledge from the teachers. Therefore, the nature of teacher questions in traditional classes is basically information seeking, that requires a series of pre-determined answers that the teachers already know and expect to hear from students, which may reflect out as playing '*guess the answer in my head game'* between teachers and students (Edward and Mercer 2013). These questions often are pitched at merely recall of facts and concepts or comprehension of tasks. After having collected or accepted students' 'right' answers, the teacher moves on with the lesson in accordance with a planned agenda (Lemke 1990), which appears to discourage students from actively participating in the process of teacher questioning.

However, since the early 1960s, under the influence of socio-cultural theory, there has been a shift in conceptions and theories of learning towards a view in which learning is believed to occur only when learners actively engage in the process of knowledge construction (Constructivism, Social Constructivism) (Piaget 1962; Vygotsky 1978). The idea is that conceptual knowledge first appears between people on an inter-psychological plane and then inside the learner's mind on the intra-psychological plane (Vygotsky 1978). In such constructivist classroom settings, the role of teachers is highlighted as a facilitator or scaffolder, guiding students towards conceptual understanding using language through the 'zone of proximal development' (Ibid), where '*the limits of a person's learning or problem solving ability can be expanded if another person provides the right kind of cognitive support'* (Mercer 1995: 72). This implies that with the support of a teacher, learners can achieve levels of understanding they would never achieve alone. Teacher questions are thus to elicit what students know, to encourage them to elaborate on their previous answers and ideas, and to help students construct their own conceptual knowledge. Teacher questioning then is to diagnose and extend students' ideas and to scaffold students' thinking (Mercer and Littleton 2007; Oliveira 2010; Almeida 2012; Engin 2013; Philpott 2014; Chen et al. 2017; Patahuddin et al. 2018). In this case, teachers focus on adopting student-centred explorative questioning instead of teacher-centred evaluative questioning. Through this approach, teachers have more flexibility in adjusting their questions to accommodate their students' contributions and responding to students' thinking in a respectful manner (Phillips 2013). Hence, teacher questions are no longer to evaluate student understanding but to serve as communicative device for true dialogue between teachers and students (Lemke 1990; Patahuddin et al. 2018) or exploratory talk (Mercer et al. 1999). Such questions tend to be genuine, and longer with one or two-sentence answers from students. Kawalkar and Vijapurkar (2013) noted that in inquiry classrooms, teachers, through asking reactive and thought provoking questions which followed up on exploring and extending students' previous responses, and encouraged students to articulate their own ideas, could scaffold students' thinking. van Zee and Minstell (1997) in their examination of teacher questioning to guide student thinking with one experienced physics teacher in an inquiry based discussion, saw a shift in authority for evaluating answers from the teacher themselves to all students who tried to make sense of what their classmates were saying. The students and teachers in inquiry oriented classroom setting seem to reassemble an equal form of social relationship in that students become 'an active inquirer', whereas teachers start to play a role of 'co-inquirer' (Martin 2006).

Meanwhile, the education research field has also witnessed a shift from investigating the cognitive aspects of teacher questioning which tends to emphasise on the importance of wait time (Rowe 1969, 1986) and the relationship between teacher questioning and student attainment (Gall 1984) based on a process-product paradigm (Winne 1979; Redfield and Rousseau 1981; Dantonio and Paradise 1988) in earlier research, towards contributing to an understanding of what constitutes 'effective' teacher questioning practice in constructivist or inquiry based learning environments in recent studies (Chin 2007; Heritage and Heritage 2013; Kawalkar and Vijapurkar 2013; Chen et al. 2017). These studies have potentially provided some practical advice and guidelines for teachers to enhance their repertoire of teacher questioning skills, to '*serve as a heuristic for them to shift their classroom discourse towards more constructivist based practices'* (Chin 2007: 840). In Chin's (2007) study, she focused on identifying how individual specific questioning strategies interwove together to form different approaches to questioning in scaffolding students' thinking and helping students to construct science knowledge, through analysing 36 lessons of six individual science teachers teaching grade 7 in four schools covering a range of topics through whole-class discussion in Singapore. Chin (Ibid) proposed four types of productive questioning approaches including socratic questioning, verbal jigsaw, semantic tapestry and framing. The existing literature, as reviewed above, has revealed that teacher questioning is associated with productive classroom discourse includes eliciting, challenging and extending students' ideas, and the use of peer assessment through asking the entire class to evaluate individual students' answers. However, the literature focusing on existing practice has also revealed that teachers are currently encountering difficulties in the process of employing inquiry based teacher questioning (Kim and Tan 2011; Chichekian et al. 2016). Some have claimed that teachers struggle to balance the power dynamics between them and their students, and are concerned about losing control over the management of classrooms (Hayes 2002; Lotter 2004; Cheung 2008), preventing them from adopting a new structure of classroom relationship within inquiry setting. Others have reported that teachers are constrained by the fact that students usually expect them to provide corrected answers (Keys and Kennedy 1999; Friedrichsen et al. 2006; Furtak 2006). For example, Keys and Kennedy (1999) in their study with one experienced science teacher teaching fourth grade, identified one major challenge for the teacher in inquiry-oriented teaching was stopping herself from answering students' questions directly, rather turning the question back to the students and encouraging themselves to answer their own questions. Similarly, Friedrichsen et al. (2006) illustrated a prospective secondary science teacher found it hard not to provide the right answers but to allow his students to explore their own alternative explanations. Such 'interactional inability' (Oliveira 2010) and lack of pedagogical content knowledge (Gillies and Nichols 2014; Allus et al. 2016) may lead to many teachers unprepared for effectively coping with the social and cognitive demands of inquiry teaching. Some other studies have also indicated that there seems to be 'a lack of sincerity' in teacher questions (Oliveira 2010: 424). Wellington and Osborne (2001) argued that many teachers' questions in discussion appeared to be open-ended in their format but were actually closed in that they were still asked to invite students to guess the specific answers that the teacher was thinking about (e.g. why did you get 2 + 5 = 7? The teacher might expect the students to reproduce the steps to this answer). Similarly, in another study, Blanton et al. (2005) analysed three secondary mathematics and Science teachers' classroom practices, and found that although the teachers encouraged students to take part in whole-class discussions, they constantly posed simple, short-answer, leading questions that filtered their students' contributions towards their own problem-solving strategies. All these studies have suggested that dilemmas continue to present obstacles to inquiry-based teaching. Therefore, studies have urged for developmental research as a paradigm of teacher education requiring new inquiry oriented identities for students and teachers (Oliveira 2010); or requiring professional development in specific content and pedagogical strategies (Brand and Moore 2011; Gillies and Nichols 2014).

What is more, with the prevalence of constructivist teaching and learning, a review of literature (Almeida and Neri de Souza 2010; Robitaille and Maldonado 2015; Bigger 2017; Chen et al. 2017; Eliasson et al. 2017; Dohrn and Dohn 2018) has revealed that teacher questions even in today's classrooms are still continuously dominated by a large number of short answers that require students to recall facts, rules and procedures, portraying the traditional teacher-centred IRF pattern of teacher questioning in secondary classrooms. Shahrill and Clarke (2014) analysed teacher questioning with four teachers teaching Year 8 mathematics in Brunei Darussalam using video observation and individual teacher interviews, demonstrated that teacher talk still dominated classroom discourse, and teachers' questions appeared to be asked at fast-fire pace, restricting students into single word (yes or no) or short choral responses. Roth (1996: 711) has criticised the nature of teacher questioning in a classroom setting, and claims that teacher questions violate the fundamental assumption of genuine questioning behaviour in everyday life outside of schools, namely '*the person asking the question 1) does not know the requested information, 2) believes that counterpart can provide the information 3) is genuinely interested in the requested information, and 4) believes the answerer will provide the answer.'* Similarly, as Rowland (2001: 65) in his book *'The Pragmatics of Mathematics Education: Vagueness in Mathematical Discourse'* illustrated:

> '*Classroom questions are not a genuine request for information, but public requests for display… [when] enquirer A [the teacher] already has the information sought in the question, and the request is for B [the student] to display whether or not s/he already has the information.'*

Teacher questioning has been extensively examined during 1980s. This recognition of the role of language (Vygotsky 1978) in guiding and shaping the definitions of learning and pedagogy has encouraged research focusing more onto student-centred teaching rather than teacher-centred teaching. Research into teacher questioning has been woven into research into student-centred research such as student-student interaction or cooperative learning.

2.2.3 Features of Teacher Questioning

Purpose of Teacher Questioning

Teacher questioning plays a significant role in structuring the classroom environment for teachers, organising the content of the lesson, and also has deep implications for student assimilation of prior knowledge in class. The purposes of questioning can be considered from three perspectives: cognitive, social and managerial needs (Walsh and Sattes 2016). Cognitively, questions can be used to organise the content of lessons, to initiate discussions, to introduce new topics of lesson, to review what has been taught previously (Sahin 2007). Teacher questioning can also be helpful to respond to different students' personalities and experiences, to make students listen carefully and in moderating student behaviours (Wragg and

Brown 2001). In some way, questions are as a mean to fulfil cognitive demands and build social relationship with other people. There are many purposes and reasons for teacher questions. The most common purpose of teacher questioning is to check student comprehension and prior knowledge (Fisher and Frey 2015; Andersson-Bakken and Klette 2016). This is the primary and key purpose of why a teacher asks questions in a class. As Wragg and Brown (2001: 6) stated, '*we often ask questions of children, not to obtain new knowledge for ourselves but to find out what children already know*'. Questioning serves as an informal formative assessment tool (Black and Harrison 2001; Ruiz-Primo and Furtak 2007; Ginsburg 2009; Ruiz-Primo 2011; Heritage and Heritage 2013; Jiang 2014; Afflerbach 2017; Muijs and Reynolds 2017; Patahuddin et al. 2018) to help teachers to monitor and evaluate students' current and previous understanding of knowledge, to expose and diagnose students' mistakes and misconceptions (Mercer and Littleton 2007), and to develop and consolidate students' learning (Jacobs et al. 2011; Smart and Marshall 2013). In essence, teachers' questions help to scaffold student thinking and nudge students towards conceptual development instead of just assessing the correction of their response (van den Bergh and Beijaard 2013). Meanwhile, based on the immediate responses from students, teachers can ascertain how well students have grasped the concepts and then '*decide if some certain topics are necessary to be retaught or at what level to pitch the lesson*' (Muijs and Reynolds 2017: 19). In other words, teachers' questions enable teacher to plan and pace the lesson at an appropriate rate according to students' responses (Kawalkar and Vijapurkar 2013). Apart from testing students' understanding, teachers' questions are also widely used for the purpose of classroom management in maintaining control over social and verbal behaviours of students including personal, procedural or discipline matter matters (Gayle and Preiss 2008) and keep all students alert during the lesson and subsequently keep the flow of the lesson (Cotton 2001) in order to create an inclusive and supportive classroom climate for all students conducive to the transfer of knowledge in class (Kawalkar and Vijapurkar 2013). Studies have revealed that teachers spent a large part of their questioning time on classroom management (Kerry 2002; Compell and Erdogan 2008). Review of one study, teachers still spent 36% of their lesson time on monitoring students' progress and plans asking questions such as '*have you all finished*?'(Campbell and Erdogan 2008). Albergaria-Almeida (2010) criticised teachers spending too much on managerial questions, that left no space for investing and asking questions for students to think deeply about their learning.

Teachers' questions are also used as a communication device between teachers and students. This is understandable, in that a question, once asked, always expects a response from students, and serves the function of interaction between teachers and students, which then encourages students' participation in a lesson. What is more, in a lesson, when a teacher asks questions, students have to consider how to respond, so that teacher questioning is used to encourage students to think (Chin 2004; Chin and Osborne 2008; Kawalkar and Vijapurkar 2013; Walsh and Sattes 2016).

Types of Teacher Questioning

The literature has indicated that teachers use all kinds of questions to test student understanding, to elicit student ideas, and to facilitate student critical thinking. Questions can be differentiated according to their forms; their functions; or the levels of cognitive performance demanded from the respondents. The earliest classification system was devised by Bloom (Bloom et al. 1956), though it was not originally used to be a classification for teacher questions but for types of cognition as discussed below. It is widely accepted as the optimal classification (Gall 1970). Since then, many more classification systems have appeared, most of which are based on Bloom's taxonomy. This section aims to justify the framework or typology of teacher questions used in this study and also to explain some other common classifications being rejected.

Bloom's taxonomy, is arguably one of the most recognised educational references published in the twentieth century (Ahtee et al. 2011; Webb 2014). It was taken from Bloom's taxonomy of Learning Objectives (Bloom et al. 1956), in an attempt to provide a hierarchy of complexity of cognitive thinking skills. They identified a triangle with six categories following a hierarchy of cognitive thinking: knowledge, comprehension, application, analysis, synthesis, and evaluation (see Figure 2.1). As noted in a 40-year retrospective by Bloom (1994: 1), '*it has been used by curriculum planners, administrators, researchers and classroom teachers at all levels of education.*' It has also been applied and adapted by mathematics educators, mostly in the design and interpretation of achievement tests (Webb 1996; Mullis and Martin 2013; OECD 2015b), curriculum development and classroom assessments in mathematics (Webb 2012; Mason 2014). Based on Bloom's taxonomy, Anderson et al. (2001) revised and considered remembering (knowledge) and understanding (comprehension) to be lower order thinking skills, and the rest to be higher order thinking skills. Thus, some studies have classified teacher questions into lower cognitive and higher cognitive level of questions, or lower-order and higher-order questions. This has also been used in guidance for teachers by the Department of Education in England (DfES 2004). Another example is the international achievement test. The Trends in Mathematics and Science Study's (TIMSS) framework for Mathematics (Mullis and Martin 2013) was also evidently influenced by Bloom's taxonomy: the study adopted it for its organisation and subcategories.

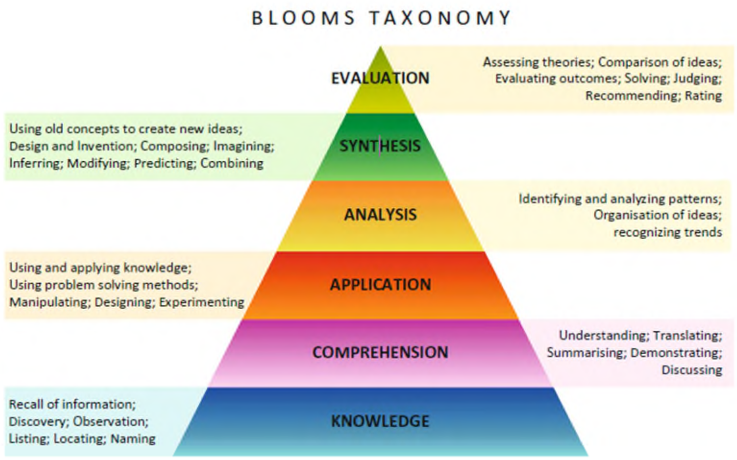


Figure 2.1 Bloom's taxonomy (Office of Community Engagement and Service 2012)

But this genetic taxonomy was never intended to be used to classify questions and its application to mathematics is still questionable, particularly when examined within the context of the literature on mathematics thinking. Firstly, such hierarchy of cognitive thinking does not seem to fit with mathematical thinking, since mathematics understanding is not necessarily a linear progression (Sfard 1991; Gray and Tall 1994; Watson 2007; Denton 2017). Watson (2007: 115) in her ongoing work '*The Nature of Participation Afforded by Tasks, Prompts in Mathematics Classrooms'*, reviewed and criticised Bloom's taxonomy when applying it to mathematics, commenting that:

> *'It underplays knowledge and comprehension in mathematics, both of which are multi-layered and require successive experiences in different mathematics contexts, comprehension can mean anything from understands how to do it' to 'understands its place in some overarching unifying theory'. 'Knowledge' can refer to results, techniques, concepts or behaviours, for example, what does it mean to have knowledge of equations? Knowing what an equation is, knowing how to work out*

what it represents, recognising on in unfamiliar texts and knowing how to solve it are very different kinds of knowledge.'

In other words, mathematical thinking does not follow the hierarchy of Bloom's taxonomy, and some mathematical thinking, as mentioned above, can be interpreted at different levels of mathematical thought. For example, a question involving multiplication, such as '7 times 8?' might be a lower cognitive question to older students who have already memorised the tables well, but a higher cognitive question for those who do not know the tables and have to manipulate pieces of information (Harrop and Swinson 2003).

As mentioned above, the classification of cognitive levels of questions in terms of lower and higher order thinking based on Bloom's taxonomy and another classification of open and closed questioning, is often found in the literature of teacher questioning. This common distinction between open and closed questions (Hargreaves 1984; de Rivera et al. 2005; Wasik et al. 2006) is defined in terms of students' answers: i.e. whether it requires one single answer (closed) or whether it allows for a multitude of responses. A number of studies have classified their questions using the above taxonomies, but have then come to conflicting findings about effective questioning in terms of, whether closed/ lower order thinking of questions or open/higher order thinking of questions constitute the most effective questioning (Hargreaves 1984; Phillips 2013). For example, there is an assumption that open instead of closed questions develop higher comprehension (McComas and Abraham 2004; Mercer and Littleton 2007; McNeill and Pimentel 2010; Lee et al. 2012), but studies have suggested that even open questions can limit students' comprehension to literal recall as they tend to follow the IRF cycle with no follow up after that (Christoph and Nystrand 2001). Based on the discrepancies within the literature about open/closed and lower/higher order thinking of questions, the research has suggested that such classifications of teacher questions is too vague and ambiguous (Galton et al. 1999) and too simplistic (Watson 2003) for differentiating teacher questions, and that teacher questioning appears to be more complex than that (Smith and Higgins 2006; Parker and Hurry 2007; Ingram 2008; Denton 2013a; Alexander 2017). Additionally, the lower/higher order thinking of questions often cannot be observed directly (Gall 1984), and does not take the context into consideration, including the social, the situated and collaborative nature of classroom questioning (Nassaji and Wells 2000; Harrop and Swinson 2003; Smith et al. 2004; Smith and Higgins 2006; Phillips 2013). Smith and Higgins (2006) argued that it was hard to know about a teacher's intent in asking a question, which made it difficult to identify the question types. An example was, in a classroom observation, a teacher started asking a question *'what happens when we eat food?'* (examples taken from Harrop and Swinson 2003). This question can be interpreted as requiring reflection from students, but if a student responded to it with 'it goes from our mouths to our stomachs', the teacher might answer 'yes that is right' and moves on to the next question. Therefore, this makes it hard for researcher to tell whether the teacher intends it to be open or closed.

All the above classifications of teacher questions seem to be challenged with a matter of whose views the research is taking. As Watson (2007) noted, what a teacher intended may not necessarily agree with what a learner perceived. Such disagreement between teachers' intentions and learners' perceptions may then confound any classifications that attempt to use 'learning outcome' as their taxonomies to categorise teacher questioning, and '*yet without complex articulation of learning, teachers cannot sensibly create or select tasks*' (Ibid: 114).

This also leads me to consider classifying teachers' questions from the teaching intention perspective regarding the nature of mathematical activities. The following three classifications of teacher questions are specified into the context of mathematics, and are non-hierarchical (Smith et al. 1996; Andrew et al. 2005; Denton 2017).

The first one, an alternative taxonomy came from the analytical framework derived from video analysis of mathematical focus of project lessons in the mathematics education traditions of Europe (METE) international reports (Andrew et al. 2005) of comparative studies of mathematics teaching in Flemish Belgium, England, Finland, Hungary and Spain. The advantage of this classification tool is that it adheres to '*the intentions of teaching through classifying features of mathematical meaning and structure without assuming learners necessarily do what is intended'* (Watson 2007: 116). It categorises what might be afforded and constrained in the public mathematical discourse, without worrying about the central problem: the disagreement between teachers' intention and students' interpretations. The tool categorises seven mathematical foci to analyse teachers' behaviour (Table 2.1).

Conceptual	The teacher emphasises or encourages the conceptual development of his or her students.
Derivational	The teacher emphasises or encourages the process of development of new mathematical entities from existing knowledge.
Structural	The teacher emphasises or encourages the links or connection between different mathematical entities, concepts and properties.
Procedural	The teacher emphasises or encourages the acquisition of skills; procedures, techniques or algorithms.
Efficiency	The teacher emphasises or encourages learners' understanding of acquisition of processes or techniques that develop flexibility, elegance or critical comparison of working.
Problem solving	The teacher emphasises or encourages learners' engagement with the solution of non-trivial or non-routine tasks.
Reasoning	The teacher emphasises or encourages learners' development or articulation of justification and argumentation.

Table 2.1 Mathematical Foci (Andrews et al. 2005: 11)

A second distinction of teacher questioning was proposed by Smith et al. (1996) who recognised the limitations of Bloom's taxonomy, and proposed a modification of Bloom's taxonomy called the MATH Taxonomy (Mathematics Assessment Task Hierarchy). It is originally designed for constructing examination questions and the structuring of assessment tasks in order of the nature of the activity required to complete each task successfully, rather than the hierarchy of difficulty. The nature of the activities might only need an either surface approach or a deeper approach following the below from group A to group C (Figure 2.3).

Group A	Group B	Group C
Factual knowledge	Information transfer	Justifying and interpreting
Comprehension	Application in new situations	Implications, conjectures and comparisons
Routine use of procedures		Evaluation

Table 2.2 MATH Taxonomy (Smith et al. 1996: 67)

A third one, based on the two above taxonomies, Denton (2013a) proposed a new taxonomy for classifying verbal teacher questioning in mathematics (Table 2.3 below). This classification of teachers' questions is a combination of the Mathematical Assessment Task Hierarchy taxonomy framework (MATH taxonomy framework) (Smith et al. 1996) and Andrews et al.'s (2005) mathematical foci, supported by mathematical prompts proposed by Watson (2007) and Hodgen and Wiliam (2006).

Categories of questions Adapted from Smith et al.(1996) and Andrews et al. (2005)	**Prompts** adapted from Watson's analytical instrument (2007:119)	**Formative question** stems from Hodgen and Wiliam (2006)	**Surface approach question coding**	**Deeper approach question coding**
Factual	• Name • Recall facts • Give definitions • Define terms		FS	FD
Procedural	• Imitate Method • Copy object • Follow routine procedures • Find answer using procedures • Give answers		PS	PD
Structural	• Show me… • Analyse • Compare • Classify • Conjecture • Generalise • Identify variables • Explore variation • Look for patterns • Identify relationships	Tell me about the problem. What do you know about the problem? Can you describe the problem to someone else? What is similar…? What is different …? Do you have a hunch? …a conjecture? What would happen if…? Is it always true that…? Have you found all the solutions?	SS	SD
Reasoning	• Justify • Interpret • Visualise • Explain • Exemplify • Information induction • Information deduction	Can you explain/improve/add to that explanation? How do you know that…? Can you justify…?	RS	RD
Reflective	• Summarise • Express in own words • Evaluate • Consider advantages/disadvantages	What was easy/difficult about this problem…this mathematics? What have you found out? What advice would you give to someone else about…?	VS	VD
Derivational	• Prove • Create • Design • Associate Ideas • Apply prior knowledge(in new situations)	Have you seen a problem like this before? What mathematics do you think you will use? Can you find a different method? Can you prove that…?	DS	DD

Table 2.3 Categories of teacher questioning in mathematics from Denton (2013a)

One advantage of this combined taxonomy is that it does not follow a hierarchy of difficulty in teacher questions, since as mentioned above, mathematical thinking and understanding is not necessarily a linear progression. Secondly, it is not focusing on classifying students' learning outcomes in response to a teacher's question, because it is hard for teachers to create or select tasks which will successfully fit into students' complex articulation of learning. The purpose of this taxonomy is for classifying the teaching intention of teachers' questioning. However, this is different from the frameworks that describe teachers' intentions as often teachers tend to use general terms to describe their intentions, such as '*get them to think*' or '*I want them to get a feel for graphics*' (examples from Watson 2007). According to Watson (Ibid), the intention of teaching appeared to be more constrained in the public mathematics discourse. Lastly, this taxonomy also seems to focus on a finer grain of detail than many other classifications, such as the ambiguity of distinguishing between lower and higher order thinking of questions. But there are also some limitations. It focuses only on the cognitive perspective of teacher questioning without taking into account the social-cultural dimension of teacher questioning. As mentioned previously, teacher questions are sometimes asked in order to build a rapport between teachers and students and for classroom management in class. Another limitation is associated with observation difficulties. Though the intention of teaching can be measured and observable, there might be still a level of ambiguity existing in the observation.

There are also other structures of classifying teacher questions. For example, Muijs and Reynolds (2017) classified questioning into two types of product and process, where the former was designed to find the result whilst the latter was focused on the procedure. However, in mathematics, process that copying and reproducing the solution steps is not necessarily considered as higher order thinking (Dubinsky and McDonald 2002). Another classification was from Morgan and Saxton (2006). They classified questioning into three categories: probing what is already known; building a context for shared understanding; and challenging students to think critically and creatively. But the second category might contain a large array of question types and levels of complexity.

Sourcing and Preparation of Teacher Questioning

The sourcing and preparation of teacher questioning also have a significant impact on the quality of teacher questions. Some studies have suggested the importance of lesson planning (Cai 2005; Cai et al. 2014) and the preparation of questions could have the potential to affect the level of their questions asked in a lesson; in particular, it appears that teachers need to prepare their higher cognitive questions in order to ask them in practice (Tienken et al. 2010; Denton 2017). But how teachers prepare their questions varies significantly from one to another: often this is affected by many factors, such as school environment or national policy (Alexander 2000). Regarding the sourcing of teacher questions, teachers can either create their own questions or use questions arising from teaching materials such as textbooks or other online resources. However, very little research has been focused on the sourcing of teacher questions (Hussin 2006). Hussin (Ibid) using a qualitative approach, examined current teacher questioning practice with 7 teachers of English and two intact classes of Form 5 science students from a secondary school in Malaysia, and found that these Malaysian teachers mostly followed their textbooks to source their questions.

Distribution of Teacher Questioning

Directing and distributing questions is an important feature of teacher questioning (Alexander 2017; Rahmah and Adnan 2017). The existing literature has indicated that the distribution of teacher questioning is closely related to classroom management (Kerry 2002; McDonald 2013). There are so many ways of directing and distributing teacher questions. Typically, a teacher question can be distributed either by hand-bidding or nomination. Hand-bidding often involves mostly students who may know the correct answer. This often raises the question of whether teachers should only call on pupils whose hands are up. Some studies (Black et al. 2004; DfES 2004; Leahy et al. 2005; Hodgen and Webb 2008) have appeared to suggest teachers to use ‘no-hands’ strategy, which is nomination. Correspondent with the research, teachers in practice are also found to preferably nominate at those who do not put their hands up (Leahy et al. 2005). As McDonald (2013: 170) proposed, this often helped to ensure ‘equitable distribution’ and establish a classroom culture inclusive to all. Regardless of whether the question is directed to students with hands up or not, this strategy of distributing questions often refers to directed questions (Wragg and Brown 2001). On the other hand, there are also questions that are posed without direction to the entire class. The advantage of such undirected questioning could potentially involve all students, which then could prevent the unequal distribution of focusing on a small number of students, which is caused by teachers who favour asking questions to more able students rather than lower achievers (Hodgen and Webb 2008; McDonald 2013). The reason why teachers subconsciously prefer asking more able students questions is that their answers come out more quickly and seem more rewarding (Chang 2009). Besides, the research seems to reveal conflicting attitudes towards this ‘undirected questioning’ distribution strategy. Some have claimed that it can increase students' participation in responding to questions, since everyone has to contribute to the question rather than one or two volunteers (Nunan 1991; Hodgen and Wiliam 2006). On the other hand, others have argued that it often leads to a chaos of answers (Wragg and Brown 2001; Tan 2007).

Sequences and Strategies of Teacher Questioning

The existing literature has suggested that examining individual questions of teachers alone can only reveal part of the story: of equal importance is the ways in which these teachers structure and sequence their questions (Wood 1998; Chin 2007; Chang 2009; Molinari and Mameili 2010; Boyd and Markarian 2015; Boyd 2016; Dong 2017). How questions are ordered and sequenced by a teacher can be of importance to the learning outcomes of students (Watson and Mason 2005; Watson 2007; Ingram et al. 2015). As Watson (2007: 123) noted,

> '*A lesson which finishes with definition of new terms would be very different from one that starts with definition of such terms. In the first, definition is part of the affirmation of new ideas, in the second, definition is an authoritative starting point.'*

Teacher questioning in the first would be more likely to be explorative as it requires the students to trust their initial factual knowledge and give definitions of their own, whereas in the second, teacher questioning might be authoritative since the definition is given at the start: students may be expected to use their prior knowledge to generate examples of such new term. Evidence for valuing one over another is beyond the scope of this study. This is just to suggest that instead of focusing on isolated questions, it is worth to analyse the whole sequences and patterns of teacher questioning.

The most common pattern is no doubt the IRF/E pattern (Sinclair and Couthard 1975; Mehan 1979), which consists of teacher 'test' questions, student response, and teacher feedback or evaluation of the student's response. As mentioned previously, the IRF/E pattern is still the most dominant pattern of classroom discourse. Despite the dominance of the IRF/E pattern, there are other common questioning patterns identified by the existing literature (van Zee and Minstell 1997; Wood 1998; Chin 2007).

The two common pattern of questioning in mathematics mentioned by Wood (1998) are ‘funnelling and focusing’, which have been examined by later studies (Herbel-Eisenmann and Breyfogle 2005; Wood et al. 2006; Aizikovitch-Udi et al. 2013; Mason 2000, 2014). Davis (1996) distinguished the two patterns between listening for an expected response, and listening to what students were saying. The two patterns differ significantly from each other. Funnelling happens when the teacher asks a series of questions that guide the students through a procedure or to a desired end. In an example below, the teacher has just asked a student to give the answer to 9 + 7.

> S: 14.
> T: Ok, *7 plus 7 equals 14. 8 plus 7 is just adding one more to 14, which makes []?* (Voice slightly rising)
> S: 15.
> T: And 9 is one more than 8. *So 15 plus one more is []?*
> *S: 16.*

(Example taken from Wood 1998: 171)

In the excerpt above, when the student gave a wrong answer above, instead of telling the student the answer directly, the teacher attempted to resolve this situation in a different way. Starting from the incorrect answer, the teacher led the student through a series of explicit questions until the student was able to provide the correct answer in the end.

Some researchers have claimed that it is important to teachers for students to develop these thinking strategies to learn the basic facts, and some studies have shown that students are better able to derive unknown facts following these thinking strategies (Treffers 1991). However, upon closer examination of these question-answer sequences in the excerpt above, it becomes clear that the student does not need to think about the connection between these numbers to arrive at the correct answer to fill in the blank in teacher’s question. Though their intention may be to allow students to be able to see the answer for themselves, this questioning pattern asked by the teacher is still intended to direct and focus students’ thinking towards a limited response. Therefore, studies have criticised this questioning pattern due to the fact that the teacher is the only one who is engaged in the process of cognitive activity and the student is merely answering each question to arrive at an expected answer, without seeing the connections among the questions (Herbel-Eisenmann and Breyfogle 2005; Mason 2014). This questioning pattern is illustrated as '*asking as telling'* (Davis 1996; Mason 2014; Lee 2017). In other words, this questioning is actually '*telling*' masquerading as '*asking*', in which the teacher intends to interrupt and structure students' thinking and expects students to be '*attending the way the teacher is attending: the students have no access to that thinking, and no learning has taken place in the process*' (Mason 2014: 515). The purpose of this questioning pattern is to guide students in their mathematical understanding, however, it often ends in constraining students' thinking (Herbel-Eisenmann and Breyfogle 2005; Wood et al. 2006).

Instead of expecting students to follow a teacher's way of thinking to solve a problem, the focusing pattern requires teachers to listen to students' responses, accepting their thinking and respecting their ideas by expecting students to give some explanations and reasoning for their answers. Through a sequence of teacher questions, the students are expected to provide justifications and clarifications for their mathematical ideas. In this respect, the questioning pattern puts students' mathematical thinking and meanings at the centre of emphasis. This then creates a high level of interactivity between teachers and students, reflecting out the nature of communication as '*asking as enquiring'* (Davis 1996). In one example, the students are in the process of discussing their self-generated methods for solving two-digit subtraction problems with regrouping. The teacher has asked a student to tell the class the solution to the problem: 66 – 28 =.

> S: We put the 66 under the 28. Then we took off the 6 and the 8 and, if you take away 20 plus 60, it is 40. And if you put the 6 back on and the 8, we have 46. Then we take away… we still have to take away that 8. Then you take away that 6, now you have 40 back and you still have to take away 2.
>
> S2: *But, but why did you take the 6 and the 8 off?*
>
> S: It was easier.
>
> T: (Looking around at the class and deciding that the ones still may not understand what he did) Ok, *could you write down beside it what you did?* Maybe that would help us to see it. *Instead of 66 minus 28, what did you do?*
>
> S: 60 take away 20 equals (He writes 60 - 20 vertically, and looks at the teacher.).

T: *Would you write what you get?* (He writes 40 under 60 - 20.) *Ok, what did you do next?*

(Parts took from Wood 1998: 172).

In this conversation above, the teacher asked a series of follow-up questions focusing on the students' mathematical thinking, in the expectation that he/she would make it clear what has been said to the rest of the class. In the process of questioning, students are responsible for offering solutions for mathematical problems to the class and the students themselves are also able to reflect on their mathematical thinking. This is similar to a particular sequence of teacher question called 'the reflective toss[1],' found in van Zee and Minstrell's (1997) study with an experienced physics teacher using questioning to guide students' thinking during a benchmark discussion about measurement. It typically consists of a three-part structure comprising a student statement, a teacher question and additional student statements. The toss metaphor suggests the teacher catches the meaning of the students' prior utterance and throws responsibility for thinking back to the student and all those present in class.

The Role of Wait Time in Teacher Questioning

The investigation of wait time in teacher questioning initially began in the 1970s. The first study was conducted by Rowe (1969), followed by the investigation of several hundreds of audiotaped science lessons (Rowe 1974). In the following 15 years the results of Rowe have been replicated in a great number of studies in different countries and different subject areas (Rowe 1986; Tobin 1987). Since then, wait time has begun to receive a great deal of attention as an important instructional technique in effective teacher questioning, which has been suggested by a series of studies (Nunan 1991; Johannessen 2003; Maroni 2011; Walsh 2011; Walsh and Sattes 2015; Andrew et al. 2016; Smith and King 2017). This section aims to present the concept of wait-time, its importance, and to what extent the present study needs to explore and to examine the role of wait time in teacher questioning.

Definition of Wait time

[1] The reflective toss refers to *'utterances with which a teacher elicits further thinking about a topic from the students'* (van Zee and Minstrell 1997: 228).

There appears to be a variety of ways to classify wait time. Silences in the classroom context are challenging to classify (Mchoul 1978; Maroni 2011) since the different interpretations that different participants can have of the same silence. Through patterns of questioning and pausing, *'the teacher controls the students' verbal and nonverbal participation, determining who speaks, when and how. At times, the teacher aims to elicit a collective responses from the whole class, while on other occasions the question is constructed to address only one particular student'* (Margutti 2006: 315). Extensive studies have tried to define wait time in their ways (Rowe 1974; Stahl 1990; Ingram and Elliot 2014). Most commonly, wait time is often defined as the period of time a teacher allows to elapse after posing a question and before a student begins to speak. This definition of wait time is slightly different from that of Rowe (1969, 1986) who originally introduced the term 'wait time'. According to her, two types of wait time were identified: wait time 1 referred to '*the pause after asking a question'*, whilst wait time 2 referred to '*the pause after a student response'* (1986: 43). However, in her longitudinal study, it was not clear when measurement of the silences began so it was not clear if the silences between asking a question and nominating a student were included or not. This has made her definition of wait time 1 to be very problematic, which has led to different interpretations of wait time defined by Rowe (1974, 1986). Most scholars (Tobin 1987; Altiere and Duell 1991; Dhindsa 2010) have interpreted wait time 1 as the pause or gap between the teacher finishing speaking and a student starting speaking. Whereas, some other researchers (Dalton et al. 2006; Ingram and Elliot 2014, 2016) have interpreted wait time 1 as the pause between a teacher finishing questioning and the teacher starting to speak again. The majority of previous studies have studied more on 'wait time 1' than 'wait time 2'. This study will also focus on 'wait time 1,' which most studies have followed and where wait time is defined as the pause following a teacher finishing speaking and a student starting speaking.

In ordinary conversation, the silence between two speakers tends to be minimised (Sacks et al. 1974), and the standard maximum tolerance of silence is one second (Jefferson 1989). However, in a classroom context, the lengths of pauses are much more complicated. The necessity of wait-time in classroom interactions stems from student internal information processing. Research has suggested that (Duell 1994; Stahl 1990, 1994), student internal information processing in the development of cognition has to be taken into account in teacher questioning especially after a teacher asks a question and after a student responses. Cognitive processing requires time: time for reflection and for linking new facts to prior individual knowledge.

Therefore, teachers should ideally provide students an amount of time to allow for cognitive processing before answering their questions or after completing the answers (Stahl 1994; Alexander 2017). In some cases, the lack of processing time might cause anxiety and pressure on students' responses to teacher questions (Wilen 2001), leading to incomplete and incorrect answers. As a consequence, it may be preferable for sufficient time to be given to students to process their knowledge once a teacher sets a cognitive focus through questioning. This brings in a critical question: how long is a teacher supposed to wait for students to process cognition?

Outcomes of extended wait time in teacher questioning (*three-second wait time criterion*)

The existing literature has examined the role of wait time and has suggested that extending wait time (beyond three seconds) could improve classroom learning (Rowe 1972; Tobin 1987; DfES 2004; Mercer and Dawes 2008). In theory, it affords the opportunity for both the teachers and students to think, and to formulate answers before speaking (Tobin 1987). Extended wait time, therefore, helps to improve the quality of teacher questions, in terms of minimising teachers' discourse errors and discontinuity in the development of ideas (Rowe 1986). Rowe (Ibid) also reported that the number and nature of teacher questions changes with increased wait time, in which there were fewer questions, but more to invite elaborations, explanations or alternative opinions from students. What is more, teachers' expectations and perceptions of their students have also changed, in which students are characterised not as being less able, but as needing more time to answer questions (Rowe 1986; Kirton et al. 2007; Michaels et al. 2008; Harris and Williams 2012). Teachers have also demonstrated less likelihood of interrupting students (Tobin 1987). Extending wait time to more than three seconds has been found to be strongly linked to students' behaviours, in which it contributes to students' longer and more complex responses (Tobin 1987; McComas and Abraham 2004; Maroni 2011; Elliot and Ingram 2016; Ingram and Elliot 2014, 2016); it can encourage students to reflect more deeply on their teacher's questions, with consequent higher cognitive level achievements (Tobin 1987; Mercer and Dawes 2008); it can also prompt students to participate more actively and provide greater learning opportunities (İnceçay 2010; Walsh 2011; Walsh and Li 2013; Ingram and Elliot 2014). For instance, Ingram and Elliot (2014) examined the role of wait time in the context of mathematics whole-class discussion, with a group of students aged between 12 and 14 years old with four experienced teachers from four contrasting secondary schools, and demonstrated that the extension of wait time was strongly associated with longer and more comprehensive students' responses including reasoning and explanations and an increase in speculative responses. Extending wait time particularly offered students more opportunities to think and construct their responses, which was likely to result in fewer failures to respond (Ibid). Similarly, another study by Smith and King (2017), analysed a series of structured observations of a UK university postgraduate second language classroom, and also found that extended wait time temporarily shifted the discourse chain out of the IRF pattern into a new and more student-centred discourse, also called dialogic discourse (Bakhtin 1986; Mercer and Littleton 2007; Wolfe and Alexander 2008; Mercer et al. 2009; Alexander 2003, 2008, 2010). It also seems to afford students an opportunity to reason through their answers so that they can build up their confidence in them (Ingram and Elliot 2014). As a consequence, many professionals and educators have advocated the deliberate and conscious extension of wait time to at least three seconds (DfES 2004; Black et al. 2003; Johannessen 2003; Sprenger 2005). Despite these reports of the positive effect of increased wait time in questioning, there have also been some studies which give contradictory evidence (Duell 1994; Schneider et al. 2004; Heinze and Erhard 2006; Kirton et al. 2007; King and Aono 2017). For example, findings from Duell's (1994) study with university students contradicted the assumption that extended wait time had a positive impact on student achievement: she did not find the expected impact on achievement when the wait time was extended from one-three seconds to three-six seconds; instead, the results showed poorer performance on higher level cognitive questions from three seconds to six seconds. Likewise, in another study to explore the effect of extended wait time from three to six seconds upon the accuracy of the answers given by medical students (Schneider et al. 2004), there appeared to be no distinctive difference between three and six seconds wait time in the accuracy of the responses of medical students to a teacher's higher cognitive questions. These two studies have been conducted at higher education level, which may explain the different results. But research by Heinze and Erhard (2006) also contradicted the assumption. They investigated the effect of wait time in 22 mathematics lessons from grade 8 in high attaining schools in German classrooms, which suggested that the length of wait time had no strong impact upon student learning outcomes. Additionally, some studies have also suggested that for their higher level students who are able to respond quickly, extended wait time can result in dissatisfaction and boredom (Kirton et al. 2007; Tincani and Crozier 2008). Thus, it seems sensible to suggest that the extended wait time effect does not work for all contexts and students.

Although increased wait time in teacher questioning can have positive effects on both student and teacher behaviour, the length of wait time in the majority of studies above has been deliberately extended and manipulated (e.g. teacher training as in Rowe's study), whilst in others, it has been treated as an independent variable (e.g. Ingram and Elliot's study). In Rowe's study for example, she deliberately trained teacher participants to extend their wait time to three-five seconds (Rowe 1974). However, such deliberate move for teachers to increase length of wait time, seems to cause some methodological issues that might have affected the results, e.g. can teachers easily be trained to change their normal wait times? If they are behaving abnormally, will not this affect other aspects of their teaching? Similar methodological issues might arise from some studies viewing wait time as an independent variable, even though these studies have been conducted under a naturally occurring setting (Maroni 2011; Ingram and Elliot 2014, 2016). For example, in a very recent study by Ingram and Elliot (2016), they used a conversation analytic approach to examine the relationship between turn-taking and wait time through analysing the structure of turn-taking during teacher-led whole class interactions with one mathematics class from each of four secondary schools in England. In their study, they took wait time as an independent variable, which I found unhelpful. When wait time is taken as an independent variable, it seems to initiate another question: what might some of the other reasons be for its variability? For instance, a teacher who deliberately waits longer, and a teacher who waits longer because there is a behaviour issue, might each get very different outcomes.

The practice of wait time also appears to be ignored (McComas and Abraham 2004; Dhindsa 2010), in that studies have suggested that teachers in practice often find it difficult to increase their wait time (Black et al. 2003). The studies of Rowe (1974, 1986) revealed that the average wait time in science lessons in the USA was less than three seconds in naturalistic settings. Particularly, the pause between a teacher question and a student answer in most cases tended to be less than one second. In one study, instructors waited between 0.7 seconds and 1.4 seconds for students to answer questions. Teachers even waited less than 0.7 seconds if they believed their students might not know the answer to the question posed (Rowe 1978). Studies have also suggested that teachers naturally leave an average of less than one second of wait time after asking a question, before repeating, rephrasing, giving their own answers, or asking a different speaker (Liebscher and Dailey-O' Cain 2003; Seedhouse 2004). Second, some studies have suggested that teachers interpret extended wait time as indicating trouble (Black et al. 2003; Seedhouse 2004) or as indicating a lack of knowledge in some social and cultural situations (Bernstein 2000), which might cause an increase in teacher anxiety (Black et al. 2003). Honea (1982), in an examination of the effect of extended wait time, found that there was an increase in teacher anxiety in the use of extended wait time. The increased anxiety might be caused by the implication of long wait time, which makes a big change in their classroom interaction patterns (Ingram and Elliot 2014). Similarly, Black et al. (2003), through a two-year project called the King's-Medway-Oxfordshire Formative Assessment Project with 36 teachers in schools from Oxfordshire and Medway in the UK, also reported that teachers treated the silence as trouble, and felt unease with the extended silences. Ingram and Elliot (2014, 2016), in examining the structure of turn-taking between teachers and students using conversation analysis, found that the teachers and students had an asymmetric relationship, in which the teacher had all the control over who could talk and when. Dalton et al. (2006) observed two high school mathematics classes and examined teachers' practice of wait time when asking questions. They suggested the nature of teachers' questions affect the wait time, in that longer wait times were given for questions which pertained to the objectives of the class according to the teachers. Moreover, considerable research has suggested that wait time is strongly related to the cognitive level of questions (Brophy and Good 1986; Kirton et al. 2007; Kaya et al. 2014). The length of wait time may vary depending on the complexity and cognitive level of questions: in other words different types of questions. Riley (1986) found that teachers did not gain much when they paused for three to five seconds after recall questions and thus he believed that there was an existing wait time threshold phenomenon for lower level questions, and the cognitive demand made on students who responded to lower level questions did not require extended time for processing. Matthiesen (2006) in research with three middle school mathematics teachers measuring the time these teachers gave after asked questions, also found that the average time after low-order questions was 2.56 seconds whilst after high-order question was 4.54 seconds. Further discussion of this point will be given later in the following section.

Training for Questioning

With the recognised importance of teacher questioning, training programs for effective teacher questioning skills have become desirable. The existing literature has suggested that teachers can be trained to improve questioning practices (Gall 1970; Wilen 1991; Cotton 2001; Dori and Herscovitz 2005; Martin and Hand 2009;

Oliveira 2010; Engin 2013; Chen et al. 2017), for example, asking scaffolded questions (Engin 2013), asking student-centred questions that encouraging students to articulate ideas (Oliveira 2010) and asking inquiry argument-based questions (Chen et al. 2017). Wilen (1991) revealed that most of teachers' decision-making about use of questioning in the classroom tended to be based on their teaching experience. However, effective questioning often has reflected informed decisions, which often are partly rooted in '*knowing what theory and research could offer'* (Ibid: 32), which are often received from their training (Oliveira 2010; Engin 2013). Chen et al. (2017) after a four-year professional development program that focused an argument-based inquiry approach, followed up to examine the various roles that teachers adopt in their questioning in 30 lessons on whole-class discussion from three early elementary teachers' classes, found that these teachers' increasingly used multiple roles in asking questions for supporting argumentative and dialogic interaction were positively connected to students' high cognitive responses. Better pre-service training of posing classroom questions to sharpen teachers' questioning skills has the potential to increase students' classroom participation and cognitive level of thinking. Although training for teacher questioning is effective, Cotton (2001) has reviewed a few studies and argued that pre-service teachers are given inadequate training for teacher questioning, since some teachers never received any training.

2.3 Questioning in Mathematics Education

This study is particularly looking at teacher questioning in the context of mathematics education. Thus, this section begins with discussing the role of teacher questioning in light of both the historical findings and the more recent developments in examining teacher questioning in mathematics education, and goes on to explore the special issues raised by this research particularly.

Hodgen and Wiliam (2006: 5) have stressed the importance of talk that is '*central to our view of teaching mathematics formally.'* Mathematics as a discipline has many challenges that pupils and teachers need to overcome. One of the features of mathematics is the way that ideas and concepts can be expressed in a very concise, rigorous and essentially abstract form (Pimm 1987; Kilpartrick et al. 2001; Herbel-Eisenmann et al. 2005; Morgan 2005). '*It has an extensive vocabulary that combines familiar words with either their everyday meanings or significantly different meanings, and new terminology with a mixture of historical roots*' (Morgan 2005:

108). Written mathematics includes many symbols with their own rules of grammar (Morgan 1998; Morgan 2017). Each of these is an aspect of the mathematical register which '*consists of the use of symbols, specialist vocabulary, precision in expression, grammatical structures, formality and impersonality and a high level of lexical density and conciseness'* (Lee 2006: 13). Part of learning mathematics is learning how to use the mathematical register and as with language, *'someone with experience of mathematical language will know it when he or she sees it'* (Morgan 1998: 11). All these features of mathematics make it difficult to teach and learn for teachers and students. Hodgen and Marshall (2005), and Mason (2014) have suggested that it is vital to provide students with opportunities to talk, to express, to argue, and to discuss important mathematical ideas, particularly in the exchanges between teachers and students in questioning-responding. Through unpacking and exploring mathematics, students can begin to see what they know and how well they know it.

Furthermore, as mentioned above, following the developments in learning theories, the research focus has seen a change from a Behaviourist view of learning to the current prominence of constructivist views of learning (Ingram 2012). Students actively construct their knowledge and understanding through interaction with the environment, which includes teachers and learners. This ultimately also leads to a need for learners to communicate and share their ideas, thoughts, and understanding, and to explain and justify these (Scherer and Steinbring 2007; Carlsen 2013; Díaz 2018) to support the learning and teaching process. What is more, research building on the work of Vygotsky (1978, 1986) also emphasises the importance of social interaction with more knowledgeable others, draw upon the notions of the genetic law of cultural development and the Zone of Proximal Development (Vygotsky 1978). The role of culture and society in the learning process has been explored, leading to social-cultural and situated views of learning as '*enculturation*' into a community of practice (Lave and Wenger 1991; Zack and Graves 2001; Hung and Chen 2007; Delamont and Atkinson 2018). Learning mathematics is perceived as learning to talk, including justifying, conjecturing, and making connections both within and outside of mathematics (Barwell 2005; Díez-Palomar and Olivé 2015).

Additionally, Scherer and Steinbring (2007) argued that research saw a 'paradigmatic' shift from a focus on teachers or students towards the reciprocal relationship between teaching and learning. There have been policy initiatives within the educational context of England to encourage more student talk in lessons (DfES 2013; Lee and Johnston-Wilder 2013; Mercer et al. 2017). For example, the Primary

Literacy Strategy asserted that successful teaching was '*characterised by high quality oral work'* and that it was interactive where students' contributions were '*encouraged, expected and extended'* (DfEE 1998). The role of the teacher in facilitating this student talk has been described as listening carefully to their pupils, carefully asking questions and posing problems, and carefully managing the whole class, which will result in the students developing mathematical skills and understanding (Stigler and Hiebert 1999; Ball et al. 2008; Carlsen 2013; Purdum-Cassidy et al. 2015; Saebbe and Mosvold 2015). Barnes (1992) argued that students needed to play a highly active role in classroom interactions if they were to have '*genuine ownership of meaning'*.

Given the prevalence of teacher questioning, questioning plays a fundamental role in facilitating student talk in mathematics education. Some studies of questioning in mathematics have focused on students' talk through questioning and listening to build better understanding of mathematics (Mercer 2012; Mercer et al. 2017; Ingram et al. 2018) and on its role in supporting informal formative assessment (Black and Wiliam 1998; Hodgen and Wiliam 2006; Black and Wiliam 2009). Significant research by Hodgen and Wiliam (2006) in '*Mathematics inside the Black Box'* and Alexander (2008) '*Towards Dialogic Teaching: rethinking classroom talk*' both highlighted extensively the importance of teacher questioning and opportunities for student talk. Alexander (2008) proposed dialogic teaching which was focusing on collective, reciprocal, supportive and cumulative classroom interactions. This dialogic teaching has redirected pedagogical thinking to a more shared and purposeful co-construction of knowledge and understanding between teachers and students (Mercer et al. 2017). What is more, questioning in mathematics education has been found, by many researchers, to have profound influence in shaping students' perceived beliefs about the nature of mathematics, and their experiences of mathematics in that '*the nature and content of teachers' questions are likely to form students' impression of what mathematics is about, and of what the mathematics enterprise is about*' (Mason 2014: 517).

Some studies have suggested that questioning in mathematics education might be different from questioning in other curriculum subjects (Roth 1996; Myhill and Dunkin 2005; Mason 2010, 2014). Myhill and Dunkin (2005) examined teachers' questioning using ground theory approach through observation of 54 teaching episodes of Literacy, Numeracy and a third curriculum area in Year 2 (aged 6-7) in three first schools, and Year 6 (aged 10-11) in three middle schools in primary schools in whole-class teaching in the south of England. They found that there were significant differences in the pattern of speculative and process questioning between Numeracy and other curriculum subjects. Precisely, more process questions inviting the articulation of students' understanding and fewer speculative questions inviting opinions, hypotheses and imaging were observed in a Numeracy classroom, as opposed to what was observed in other curriculum areas such as Literacy. The most common function of a question in Numeracy observed was to practice skills, and Numeracy was the only subject which used these kinds of questions to develop reflection on learning. Thus, they suggested that there may be a subject-specific questioning pattern for mathematical understanding, reflecting the subject's concern with processes and functions, rather than information and ideas. Therefore, it is suggested that there is a demand for research into teacher questioning in the context of mathematics classrooms. With regard to the distinct features of teacher questioning in mathematics education, however, an extensive number of previous studies into teacher questioning has been mostly carried out in the field of EFL or second language teaching classrooms (Sinclair and Coulthard 1975; Wu 1993; Hsu 2010; Phuong and Nguyen 2018), or science (Chin 2006, 2007; Oliveira 2010; Tan and Wong 2012; Smart and Marshall 2013; Kelly 2014; Ernst-slavit and Pratt 2017). It is only very recently that studies have set their investigation into teacher questioning in the context of mathematics education (Mason 2000; Franke et al. 2009; Shahrill 2013a; Martin et al. 2015; McAninch 2015; Schwartz 2015; Aziza 2018). Recent research into teacher questioning in mathematics also supports the idea that questioning is an important part of teaching and assessing mathematics, since it is the most frequently used instructional tool (Mason 2014; Martin et al. 2015; Weinberger 2017). Through questioning, teachers can gather information about students' mathematical procedures and understanding (Heinze and Erhard 2006; Koizumi 2013), clarify the students' understanding (Lee 2017); promote students' participations (Nathan and Kim 2009), and scaffolding students' thinking to develop creativity and reasoning (Ingram 2008; Drageset 2014; Purdum-Cassidy t al. 2015; Ingram et al. 2018; Ulleberg and Solem 2018). It ultimately has also supported the importance of the role of students' talk which has been a long-established view (Vygotsky 1978; Alexander 2008; Mercer 2008). Shahrill (2013a) reviewed the role of teachers' verbal questioning within the context of mathematics classroom and to what extent that would lead to effective questioning. However, the problem is that most of the studies they reviewed are quite old in terms of when the study is conducted, and most of those studies are conducted not within the field of mathematics education. Another recent study into the impact of teacher questioning in mathematics was carried out by Martin et al. (2015): they examined 96 classroom observations, with a total of 48 elementary school teachers in the south-eastern United States during a year-long study. They concluded that the questions posed by the teachers greatly influenced the students' mathematical discourse, and the teachers' choice of questioning influenced the development of mathematical tasks.

This study sets out to explore teacher questioning in mathematics education to contribute further to the current literature on teacher questioning in the specific context of key Stage 3 mathematics teaching.

2.4 Cross-Cultural Comparative Study in England and China

In an era of globalisation and information technology, mathematics education demands reform internationally. Comparative studies can work to increase recognition of the crucial significance of any society's cultural values, social-historical backgrounds and goals for the future in determining the character of that society's mathematics education. Before discussing the comparative study, I would like to give some information about the education systems in England and in China, their curriculums, and their impact on classroom instruction practice, such as teacher questioning.

2.4.1 Education System and Curriculum and Teacher's Role in England and China

China has a highly centralised educational system (Leung and Li 2010; Li et al. 2014; Ma and Zhao 2015), and because of that, they use nationwide unified curriculum standards (also called '*teaching and learning syllabus*') which serve as a '*direct channel'* for all teaching and learning activities across all different grade levels (Ma and Zhao 2015: 307). The Ministry of Education in China officially approves students' textbooks, and teacher manuals, and schools can only use approved textbooks (Ministry of Education 2012). The teacher manuals and student textbooks in mathematics have been developed in line with the unified curriculum standards, guiding teachers' daily classroom teaching and students' learning activities in classrooms across all schools (Li, Chen and Kulm 2009). Given the central role of textbook curriculum in mathematics education in China, two questions arise: to what extent do mathematics teachers in China implement the textbook curriculum into their teaching? Are there any variations between teachers' implementation of textbooks? To answer them, extensive studies have been carried out mostly examining textbooks and the curriculum in China (Li, Zhang and Ma 2009; Liu and Li 2010; Ma 2010; Ding et al. 2012; Li et al. 2014), and some research into mathematics classroom instruction in China (Huang and Leung 2004; Li and Huang 2012), which have all indicated that Chinese teachers adhere closely to their curriculum textbooks (Ma 2010; Li et al. 2014). As Park and Leung (2006: 230) noted, '*in many East Asian countries, teachers and students [regarded] the textbook as 'Bible' which [contained] all the essential knowledge'*. For example, Huang et al. (2014) examined the implementation of Chinese textbooks with two teachers in teaching fraction division over four consecutive lessons, and found that the two teachers essentially adhered to the textbooks, in terms of the conceptualisation of concepts and algorithms, the topic coverage, and the sequence of content presentation, the approach to developing the concepts and algorithms, and the selection of problems and exercises. Thus, it seems that textbook curriculum significantly influences what teachers do in classroom practice in China (Huang et al. 2014). According to Zhao (2016), the mathematics curriculum acts as a powerful influence on teachers' values and beliefs in their teaching. As a result, Chinese teachers often have similar lesson plans for a given teaching unit, with similar learning goals, worked-out examples, homework problems and lesson presentation structures (Li and Li 2009).

What is more, the objectives of the Chinese national curriculum for mathematics (Chinese Ministry of Education 1992, 2000 in Zhao 2016: 132) are '*to promote students' understanding and mastery of fundamental knowledge of numerical relationships and geometry patterns. To develop students' ability to compute the four operation of whole number, decimals, and fractions, develop logical thinking, and spatial sense and acquire knowledge to solve simple practical problems'*. These objectives indicate that the cognitive aspects of learning are the priority in Chinese mathematics education. The Chinese secondary school mathematics curriculum adopts a purist view of mathematics and mathematical learning, emphasising learning the content of mathematics, comprised of the two-basics basic mathematics concepts and basic skills (Zhang 2006; Li, Zhang and Ma 2009), as mathematical competence (Zhao 2016). The two basics view emphasises foundational knowledge and skills over creative thinking (Leung 2001; Zhang et al. 2004). The Chinese classroom instruction focuses on refined lectures and repeated practice, which aids memorisation and holds the belief that greater exposure may help students think about the underlying concepts more deeply (Dahlin and Watkins 2000; Leung 2014). The research has described Chinese classrooms are teacher-centred, in that Chinese teachers often maintain control through direct teaching to the whole class (Zhang et al. 2004). Zhang et al. (2004) indicated Chinese teachers' talk made up 90% of their class time. Direct teaching may help teachers control the lesson flow and maintain class discipline while engaging students in learning activities (Huang and Leung 2004). All these studies have suggested that teachers in China dominate in the teaching and learning of mathematics; and mathematics knowledge is transferred from the teacher to students.

The educational system in England is quite different from the Chinese education system. The Department for Education in England implemented the mathematics curriculum which is called mathematics programme of study: Key Stage 3 national curriculum in England (DfES 2013). Although covering the requirements of the national curriculum is statutory, unlike in Chinese education where the textbook plays a dominant role, textbooks do not dominate English system. Schools in England can choose their own curriculum textbooks for their teaching of mathematics and most teachers have more choice in deciding what content to teach. In other words, they may use the same textbooks but teach vastly different lessons according to their groups of students' ability, using a large range of internet resources (Askew et al. 2010). Much research (Askew et al. 2010; Bokhove and Jones 2014) has revealed that textbook use in mathematics classrooms in England is relatively low. According to TIMSS data, it was *'lower than that in the highest-attaining countries'* (Askew et al. 2010: 34). Bokhove and Jones (2014) carried out an examination on the publicly-available Ofsted inspection reports and interim reports from 2000 to 2014, and indicated that textbooks have been valued less and less over the years, in comparison with the Chinese teachers' reliance on textbooks. The Office for Standards in Education, Children's Service and Skills, also known as Ofsted (2014) as the official body in inspecting schools in England indicated no preference over the use of textbooks, in other words, teachers were free to use whatever resources they saw fit, including textbooks. Bokhove and Jones' (2014) analysis also supported Ofsted's claim. Studies have seen a decline in the use of textbooks throughout the years, which could suggest that the textbook curriculum has less influence over mathematics teachers' classroom practice in England compared to that in China. Furthermore, 'setting' in England is a common way of grouping pupils into classes by ability on a subject-by-subject basis in secondary classrooms (Muijs and Dunne 2010), which leads to the adaptation of the national curriculum according to pupils' ability. This is suggestive of a belief in individualism existing in British humanistic philosophy (Hofstede et al. 2010), which contrasts with Chinese beliefs in the entitlement for all pupils to access the same curriculum (Cui 2009). As DfES (2003: 39) has stressed, '*learning must be focused on individual pupils' needs and abilities … Every teacher knows that truly effective learning focuses on individual children … be critical to helping teachers focus on individual children's needs … Increasing the focus on individual children will serve every child.*' The objectives of the national curriculum for mathematics, as stated, '*provide a foundation for understanding the world, the ability to reason mathematically, an appreciation of the beauty and power of mathematics and a sense of enjoyment and curiosity about the subject'* (DfES 2013: 3).

The national curriculum at Key Stage 3 mathematics also seems to adopt a constructivist view of the nature of mathematics and mathematical learning, and asserts that experiencing the process of mathematics through practical activities is the most important objective for mathematics (Leung 2001; Cai and Wang 2010; Zhao 2016), which emphasises three main core features including: reasoning skills, problem-solving skills and spoken language (DfES 2013). In contrast with the Chinese emphasis over mathematics content consisting of two basics in their curriculum, the English curriculum emphasises the creative thinking of mathematics, as written in the national curriculum: '*mathematics is a creative and highly inter-connected discipline that has been developed over centuries, providing the solution to some of history's most intriguing problems*' (Ibid: 2). The national curriculum for mathematics also stresses the importance of spoken language in pupils' social, cognitive and linguistic development across the whole curriculum. It seems that developing students' appropriate spoken language is vital as '*the quality and variety of language that pupils hear and speak are key factors in developing their mathematical vocabulary and presenting a mathematical justification, argument or proof*' (Ibid: 3). Developing students' spoken language has been explored by researchers using different terms such as 'classroom interactional communicative competence' (CIC) (Walsh 2006, 2011) or 'oracy' (Wilkinson 1965; Alexander 2012; Mercer et al. 2017) in developing pupils' listening and speaking skills in mathematics. This is not mentioned in the current Chinese mathematics curriculum. Apart from creative thinking in the national curriculum, reasoning, as one of the higher thinking skills, is also highlighted as one of the key features of the curriculum. As Ball and Bass (2003: 21) pointed out, '*reasoning is a basic skill of mathematics and is necessary for a number of purposes: to understand mathematical concepts, to use mathematical ideas and procedures flexibly, and to reconstruct once understood, but forgotten mathematical knowledge.'* These key features of the mathematics curriculum have indicated that it encourages student-centred teaching and dialogic talk inside classrooms in England (Mercer 2008; Alexander 2017).

Another important difference in the two education systems is class size. In England, since the introduction of school standards and framework 1998 which later became a law in 2001 (DfES 2011), the class size in key Stage 1 has been limited to 30 students. This then has an effect over the number of students at secondary school level to some extent: for instance key stage 3 remains around 30. In most Asian classrooms however, the class size tends to be larger, with more than 40 students (Chin 2007; Galton and Pell 2012b; Leung 2014). Chin (2007) claimed that teachers were constrained by having to deal with large classes: in her study with Singaporean teachers, the average class size was 40 per class. Studies have suggested that a small class size is better than a large class size for working with individual students' needs (Wang and Finn 2000; Brabo 2014; Blatchford et al. 2016; Schanzenbach 2014, 2016), for adapting a diversity of instructional activities such as group discussion (Blatchford et al. 2011; Harfitt 2013); and for flexibly using certain questioning techniques (Wang and Finn 2000). Studies have also revealed that teachers preferred teaching with a small class size (Pedder 2006; Galton and Pell 2012a).

This section has highlighted the differences in English and Chinese education systems, their content use of a textbook curriculum, and their class sizes during the teaching of mathematics in secondary classrooms. In the following sections, I will present teacher questioning in the context of England and China and the significance of a cross-cultural comparative study between the two nations.

2.4.2 Questioning in England and China

There has been a long history of research investigating teacher questioning in western countries such as England. Extensive research into teacher questioning has witnessed a shift in focus from exploring the relationships between teacher questioning and student attainment based on the process-product paradigm in studies conducted before the 1980s (e.g. Mehan 1979; Winne 1979; Redfield and Rousseasu 1981), towards investigating teacher questioning from social constructivist/ social linguistic viewpoints (Chin 2006, 2007; Erdogan and Campbell 2008; Oliveira 2010; Heritage and Heritage 2013). This has followed the educational reform from a traditional transmissive teacher-centred teaching to an inquiry-based/ constructivist teaching that emphasises the social and linguistic nature of knowledge construction in English classrooms. However, very few studies of teacher questioning have been carried out in places (Ma and Zhao 2015) like China, where cultural values are very different from England (Leung 2014) and where teachers might be constrained by having to deal with larger classes (Huang and Leung 2004; Chin 2007; Leung 2014) or high-stake examinations (Wong et al. 2012; Leung 2014). For example, Wu (1993) in studying teachers' questioning patterns in Hong Kong discovered an interesting phenomenon in which students generally had a habit of waiting to be called up before answering teachers' questions. Such student passiveness and reluctance can be explained from a cultural perspective (Cheng 2000; Cai and Wang 2010). As a Singaporean in a country with a similar Confucian cultural heritage to China, Chin (2004, 2006, 2007) had carried out several investigations of teacher questioning in science classrooms in Singapore and revealed that, given the predominant Confucian views of teaching and learning, teachers typically were perceived as expert role models for students, which made them relatively active in lessons compared to students. Such activeness of one teacher in a lesson can be manifest in the form of teacher monologue.

Similarly, Ma and Zhao (2015) studied features of exemplary lessons under the curriculum reform in China, through observing 13 primary mathematics lessons, they found that teachers' questioning and students' responding appeared to be the most dominant dialogic form between the teacher and students, in which almost all mathematical questions (not including the questioning for lesson management) were raised by the teachers. What is more, Lee (1999) revealed different beliefs about students' ability. He has suggested that Chinese schooling emphasises hard work to achieve 'human perfectibility' (a Confucian belief), whereas individualism is predominantly held in American and England school systems, which assumes that ability is limited by '*genetic predispositions*', and students therefore can only progress at their own speed (Anglo-Saxon fatalism) (Hofstede et al. 2010). Another cultural difference can be seen from a study by Cai et al. (2014) in their survey exploring teachers' instructional coherence across America and China from teachers' perspectives, which revealed distinct cultural differences in studying textbooks in teachers' lesson planning stage. Whilst 55% of the 20 Chinese teachers asked were found to stress the necessity of studying textbooks beforehand, none of 16 American teachers believed in its significance. These striking results may reflect that teachers hold different views and beliefs about their sourcing of questions since school textbooks can be the main source for teacher questioning in class as mentioned above (Hussin 2006; Ma 2010). Leung (1995, 2006), through classroom observations, also suggested that different cultural beliefs were reflected in teachers' teaching practices inside junior secondary mathematics classrooms in London, Hong Kong and Beijing. Specifically, in terms of cultural differences, the predominant belief held by teachers in Beijing and Hong Kong was that students should be taught the same thing to show fairness; therefore they spent more time on whole-classroom teaching (86.3% and 72.52%) and focused more on memorisation in teaching compared with teachers from London, who stressed individual differences and adopted an individual learning strategy by spending less time on whole classroom teaching (42.3%) and more time on seat-work, and allowed students to experience mathematics through other activities such as playing mathematics games in groups. I believe that these different beliefs might lead to different perspectives and practices in the use of teacher questioning in these two countries, making the focus of teacher questioning in these two nations worthy of investigation.

2.4.3 International Comparative Study of Teacher Questioning in Mathematics Education in England and China

According to Sitgler et al. (2000: 87-88), there is a

> '…*subtle reason for studying teaching across cultures. Teaching is a cultural activity. Because cultural activities vary little within a society, they are often transparent and unnoticed…cross-cultural comparison is a powerful way to unveil unnoticed but ubiquitous practices…comparative research invites re-examination of the things 'taken for granted' in our teaching, as well as suggesting new approaches that never evolved in our own society.*'

The literature on cross-cultural comparative studies has highlighted its contribution for understanding researchers' own cultures (Alexander 2000; Stigler et al. 2000; Clark 2003; Leung 2006; Byun et al. 2012; Koizumi 2013; Blömeke et al. 2014; Jerrim and Shure 2016; Zhang et al. 2016). In examining the role of culture closely, cross-nation comparative studies can help in deepening the understanding of the researcher's own education system in making explicit the theories of learning which underpin it (Alexander 2000; Clarks 2003), and can also suggest new perspectives and possible directions that could be of use to researchers, educators, and policy makers (Clark 2003; Blömeke and Delaney 2014; Greany et al. 2016; Bryson et al. 2018; Hodgen et al. 2018; Tatto et al. 2018).

A few cross-cultural studies have examined teachers' questioning in mathematics classrooms (Kawanaka and Stigler 1999; Shahrill 2013b; Shahrill and Clarke 2014; Johar et al. 2017), and have suggested there seem to be cultural differences in the questions asked in mathematics (Perry et al. 1993; Koizumi 2013). Perry et al. (1993) conducted a cross-cultural study in examining the types of questions with observation of first grade addition and subtraction lessons in United States, Japan and Taiwan. They concluded that Asian teachers appeared to ask significantly more challenging questions, which required higher order thinking about conceptual knowledge and about problem-solving strategies than U.S. teachers, and Chinese teachers asked more questions that were embedded in a concrete context than U.S. teachers. They therefore have suggested that the kinds of questions asked in the Chinese and Japanese classrooms may have contributed to the more sophisticated conceptual knowledge of mathematics for their students. Using the TIMSS 1995 video study data, Koizumi (2013) explored the similarities and differences within teachers' questioning in German and Japanese mathematics classrooms with a focus on the stage of introducing new mathematics content, and found that lower cognitive questions that required students to recall memorial knowledge were vital for introducing new mathematical content in both German and Japanese classrooms. However, there is little comparative research into teacher questioning between the UK and China, despite the fact that Chinese students have repeatedly outperformed their UK counterparts in school mathematics in various international comparative assessments (Mullis et al. 2012; Jerrim and Shure 2016; OECD 2018). Alexander (2009) claimed that there was deliberate ignorance in the UK in comparative studies of pedagogy, and teacher questioning, as an important pedagogical feature, might also be ignored. Thus, a comparative study across England and China with a focus on teacher questioning pedagogy in lower secondary mathematics (Year 7 to Year 9) might fill this gap, in enhancing the mutual understanding of Chinese and British cultures and their educational systems, and their questioning pedagogy in particular. The aim of this comparative study is not only to provide descriptions of mathematics teacher questioning in England and China, but also to find explanations for the observed and reported differences and similarities in order to benefit from comparing teacher questioning in the two countries.

2.5 Teacher Beliefs and Practices in Questioning

The study sets its aim to investigate teacher questioning as one of the key components of classroom teaching practice, and in order to have a complete picture and understanding of teacher questioning, this following section is going to investigate the significant role of teachers' beliefs in teaching, and the relationship between teachers' beliefs and actual teaching practices in questioning. Various research efforts have been carried out in the examination of the relationship between teachers' beliefs and their classroom practices (Skott 2001; Philipp 2007; Savasci and Berlin 2012; Farrell and Bennis 2013; Mansour 2013; Borg 2015; Tamimy 2015; Skott et al. 2018) in order to have a better understanding of teaching behaviours in classrooms (Yu 2008; Tleuov 2016; Ates et al. 2018), which subsequently aim to improve teachers' professional development or effective teaching practice (Pham and Hamid 2012; Farrell and Mom 2015; Francis 2015). Before the main discussion, it is worth considering the definition of teacher beliefs in this current study.

2.5.1 Teacher Beliefs

Focus upon teacher beliefs began from the 1970s, and researchers have studies teachers' beliefs in a variety of different ways (Pajares 1992; Philipp 2007; Levin 2014; Borg 2003, 2015; Francis 2015). Such investigations have been carried out through many different terms and definitions including beliefs, perceptions, attitudes, perspectives, assumptions, explicit and implicit theories, judgments, opinions and more (Pajares 1992; Borg 2003, 2006; Philipp 2007; Song and Looi 2012; Skott 2015). As Pajares (1992) and Philipp (2007) noted, there was no clear consensus on how to define teacher beliefs. The existing literature has indicated a contradiction over the two notions of knowledge and beliefs. Some studies have found that the two are inseparable (Pajares 1992; Poulson et al. 2001; Buehl and Beck 2015). Some have assumed that belief is a kind of knowledge (Clark and Peterson 1986; Nespor 1987). Others, however, have argued that most of teachers' professional knowledge can be categorised as beliefs (Coburn 2004; Fives and Buehl 2012). Pajares (1992: 316) defined teacher beliefs as '*an individual's judgement of the truth or falsity of a proposition, a judgement*', seeing beliefs and knowledge the same. On the other hand, some other studies have believed the two notions of knowledge and beliefs are distinct (Borg 2001; Philipp 2007; Pham and Hamid 2012), featuring teacher beliefs on a personal basis and knowledge requiring conformity or group consensus for validity (Richardson 1996). Borg (2001) distinguished beliefs and knowledge based on '*true element'*, defining beliefs as referring to 'a *mental state which has as its content as proposition that is accepted as true by the individual holding it'* (Borg 2001: 186), whereas, knowledge was defined as '*being true'*. Similarly, Philipp (2007) made a clear distinction between knowledge and beliefs, and attempted to untangle the differences between many similar terms such as affects, beliefs, conceptions, knowledge, and values. In his working definition (Ibid: 259), beliefs were regarded as:

> '*Psychologically held understandings, premises, or propositions about the world that are thought to be true. Beliefs are more cognitive, are felt less intensely, and are harder to change than attitudes. Beliefs might be thought of as lenses that affect one's views of some aspect of the world or as dispositions towards action. Beliefs, unlike knowledge, may be held with varying degrees of conviction and are not consensual. Beliefs are more cognitive than emotions and attitudes.'*

Knowledge is defined as *'beliefs held with certainty or justified true beliefs. What is knowledge for one person may be belief for another, depending upon whether one holds the conception as beyond question'* (Ibid: 259).

In this study, instead of drawing a line between knowledge and beliefs, teacher knowledge is regarded as a core part of teacher beliefs. Given the difficulties in defining teacher beliefs and the lack of shared understanding of such a term (Song and Looi 2012; Buehl and Beck 2015), teacher beliefs in this current study, are being used in a weak sense, referring to teachers' perceptions including teachers' personal and cognitive thinking and interpretations of their teaching involving their feelings, values, attitudes, experiences and decisions.

2.5.2 Teacher Beliefs and Classroom Practices

This section starts to examine the influence of teachers' beliefs over their practices in questioning, since the research has suggested that teacher beliefs play a major role in teachers' decision making: in other words, their teaching behaviours (Pajares 1992; Fang 1996; Crawford 2007; Sullivan and Woods 2008; Basturkmen 2012; Francis 2015; Wang et al. 2017). Under challenging circumstances, it is the belief, rather than the knowledge, that teachers have received from their training that guides their teaching (Wilen 1991; Pajares 1992; Francis 2015). Before teachers are able to change their teaching behaviours, they have to be aware of not only their behaviours but also their beliefs that prompt the behaviours (Borg 2011; Wang et al. 2017). For example, Song and Looi (2012) studied the impact of teacher beliefs over teacher practices, with two primary mathematics teachers in the same lesson on division and fractions in a CSCL environment, and concluded that teachers who had a understanding of student inquiry-based learning and technology use tended to have a better understanding of instructional principles and produce principle-based practice patterns. On the other hand, Poulson et al. (2001: 273) claimed that the relationship between teachers' beliefs and practices was complex: it was 'dialectical' rather than 'unilateral' and thus practice did not always come after beliefs, but might sometimes precede them. Other studies have suggested that teachers' beliefs and teaching practices form a reciprocal relationship, in which teachers' beliefs serve not only as the causes, but also as the outcomes of teaching practices (Haney and McArthur 2002; Levitt 2002; Borg 2011). Borg (2011) analysed six English Language teachers' beliefs through an intensive eight-week in-service teacher education programme in the UK and claimed that teachers' prior beliefs on aspects of teaching and learning were extended with new beliefs being developed from the sources - teacher education.

Nevertheless, existing research on teacher beliefs has shown that changes in teacher beliefs and changes in teaching practice are correlated and interplayed (Beyer and Davis 2008; Speer 2008; Cross 2009; Song and Looi 2011; Li 2013; Farrell and Ives 2015; Farrell and Mom 2015; Francis 2015). Studying the relationship between teachers' beliefs and practices may help to generate a better understanding of the interplay between beliefs and practices, and particularly in this study, the practice of teacher questioning (Sahin et al. 2002; Pham and Hamid 2012; Farrell and Mom 2015). Teachers have been found to hold strong beliefs about their learners and about teaching (Forbes and Davis 2010), which then ultimately shape the kind of learning experiences students have (Mewborn and Cross 2007), and the kind of questions they ask (Ornstein 1995; van Zee et al. 1997; Good and Brophy 2003; Forbes and Davis 2010). Cross (2009) showed that teachers' beliefs strongly underpinned their way of posing questions. A teacher who often asks questions with right or wrong answers may see their students' role as memorising the answers and giving back upon their students' request (Muis 2004). Similarly, Carlsen (1991) suggested that teachers' insufficient knowledge about subject matter might lead them to rely heavily upon the textbooks or other materials provided by the curriculum to ask questions. Alternatively, questions focusing on text-based knowledge could also reflect their beliefs about students' learning capacity, that is, that students are incapable of answering questions requiring higher cognitive thinking and, as a consequence, they demand knowledge of facts and basic concepts to pass exams and tests (Dillon 1990; Newton 2002; Farrell and Mom 2015). As a result of beliefs held by their teachers, students subsequently could easily pick up the right answers from textbooks (Ornstein 1995; Good and Brophy 2003; Tavakoli and Davoudi 2016), which in turn, from a cognitive viewpoint, could limit the scope of their thinking, as they are limited in their ability to extend it beyond factual knowledge, and fail to stimulate their critical thinking skills. From a social viewpoint, the use of a textbook might not stimulate their interest and curiosity and could lead to them getting bored in lessons (Oliveira 2010). Besides, Cady and Rearden (2007) examined the beliefs of K-8 preservice teachers about mathematics and science teaching and learning during a content methods course, which indicated that in terms of teaching paradigms, teachers who hold the Behaviourist belief that learning occurred when knowledge was transferred passively from one to another ended in limiting students' opportunities to learn through asking their own questions or building on their own responses.

2.5.3 The Relationship between Teacher Beliefs and Classroom Practices

Extensive studies have investigated the relationship between teacher beliefs and practices across different subjects (Fang 1996; Skott 2001; Song and Looi 2011; Tan 2011; Basturkmen 2012; Savasci and Berlin 2012; Mansour 2013; Farrell and Mom 2015) and using different methodologies and theories (Sahin et al. 2002; Pham and Hamid 2012). Some have suggested that the beliefs and practices are consistent (Breen et al. 2001; Cundale 2001; Farrell and Kun 2008; Kuzborska 2011; Basturkmen 2012; Neumann 2014; Yang and Leung 2015). A study by Cundale (2001) looked closely into two language teachers' beliefs and practices about CLT in Mexico through observations and interviews, highlighted that teachers asked more referential questions and open questions which corresponded with their beliefs in CLT. Similarly, Farrell and Kun (2008) through observing and interviewing with three primary school teachers in Singapore found that they infrequently corrected students when they used Singlish in their speaking in language classrooms, which were also in line with their expressed beliefs.

However, others have suggested the opposite: teachers' beliefs are incongruent with their actual practices in that teachers do less than they claim (Basturkmen et al. 2004; Phipps and Borg 2009; Skott 2009; Cai and Wang 2010; Tan 2011; Pham and Hamid 2012; Li 2013). For instance, a study by Basturkmen et al. (2004) involving observations and interviews with three second language teaching teachers in formal focused teaching, concluded that challenging beliefs embedded in teachers' knowledge led to inconsistencies between beliefs and practices. Tan (2011) also reported incongruences between teachers' stated beliefs and observed practices in a study of three secondary mathematics and four science teachers which focused on the teaching of language in content learning in Malaysia, revealing that teachers had difficulties in implementing a language instruction policy into their practices. In a three-year study with 161 beginning mathematics teachers, Ates et al. (2018) also conducted a case study with eleven prospective physics teachers in Turkey and found that half of the teacher participants experienced challenges in implementing their beliefs about constructivist teaching into practices. Pham and Hamid (2012) examined the beliefs and practices in terms of questioning purposes, content focus, students' cognitive level, and wording and syntax with 13 beginning EFL teachers working at Vietnam National University using questionnaires and observations, and also concluded that teachers' beliefs and practices were inconsistent: their reason was a lack of teaching experience. In contrast to the claim that teachers do less than they claim, Sahin et al. (2002) investigated the relationship between teachers' beliefs and their practices with a focus on teacher questioning, using observations and interviews with seven to thirteen teachers teaching Numeracy and Literacy at Key Stage 2 (aged 7-11) at four schools in the west of England, and concluded that there was a mismatch between teachers' beliefs and practices, in that teachers did more than they claimed. The methods and methodology may explain why their results contrast with the findings of previous studies. They (Ibid) used ground theory to examine beliefs and practices, involving two stages of interviews and observations, the first stage of interviews was conducted with 13 teachers, with only five of these followed up with observations. The second stage of interviews was carried out with seven teachers, only four of whom were observed. Nevertheless, the research have suggested the significant role of context in determining the consistency and inconsistency between teachers' beliefs and practices (Basturkmen 2012; Kissau et al. 2012; Farrell and Bennis 2013; Borg 2003, 2015; Francis 2015; Wang et al. 2017)

Despite some studies on teacher questioning conducted in second language teaching (Breen et al. 2001; Pham and Hamid 2012; Farrell and Mom 2015), in Numeracy and Literacy at Key Stage 2 in England (Sahin et al. 2002) and in science (Forbes and Davis 2010), there has been very little research into the relationship between teachers' beliefs and their practices focused on questioning in particular, especially in the context of mathematics at key Stage 3 from a cross-cultural perspective. Given the significance and pervasiveness of teacher questioning and the growing attention to cross-cultural comparative studies over the last decades (Kaiser and Blömeke

2014), this seems to be an important gap in the literature. In response to the need for research into the relationship between teacher beliefs and their questioning practices, this study therefore examines the relationship between teacher beliefs about questioning and their actual questioning behaviours in the context of lower secondary mathematics classrooms in England and in China respectively at an intra-country level, and goes on to examine the relationship of teacher beliefs and practices in questioning at a cross-national level.

Although there is no universally accepted definition for teacher beliefs, all the definitions above have revealed that beliefs are related to one's cognition, knowledge, or affect; and that the development of beliefs may be a '*mental construct'* shaped by the culture, where one obtains experiences (Tang and Hsieh 2014). Therefore, beliefs can be seen as bounded within social and cultural context (Perry et al. 2006; Wang and Hsieh 2014; Yang and Leung 2015; Miriam 2018). Teachers' beliefs are embedded in their cultural context, and are developed over long periods of time (Perry et al. 2006; Correa et al. 2008; Rahman et al. 2018). Correa et al. (2008: 152) argued that '*teachers [were] a product of their culture and experience*.' Their beliefs are '*rooted in, and constrained by, the culture of the society in which the teachers are living and working, in the culture of education systems and traditions of society and in their own experience as school students, teacher education students and members of school communities'* (Perry et al. 2006: 446). Wang and Hseih (2014), and Tang and Hseih (2014) both highlighted the cultural notion of beliefs with future mathematics teachers in lower secondary schools, and concluded that country was an important factor for shaping teachers' beliefs. In another example of cross-cultural study carried out by Yu (2008), the study compared the teachers' beliefs on three perspectives including mathematics teaching, the nature of mathematics and the purpose of mathematics education in the UK and China, using questionnaires with 44 English mathematics teachers from 10 secondary schools in Cambridgeshire and 96 Chinese mathematics teachers from 10 secondary schools in Shanghai and two follow up interviews from each country, and suggested that Chinese teachers and English teachers prioritised differently in terms of mathematics teaching and the purposes of mathematical education, although the sample is small, making it hard to generalise from. Thus, a cross-cultural investigation can be a critically valuable approach to studying the relationship between teacher beliefs and practices in questioning. Noting that beliefs are considered as key components of coping mechanisms teachers use to navigate the realities of teaching in challenging circumstances (Pajares 1992), it is hoped that framing this current study with a focus on questioning can provide some focused insights that can facilitate the adoption of adaptive and effective questioning techniques, the assimilation of advanced questioning principles into teachers' beliefs, and the translation of such principles into practice.

2.6 Summary

This chapter has reviewed the literature of teacher questioning from four perspectives: teacher questioning and its current practice and key features from a general perspective; teacher questioning in a mathematics context; cross-cultural comparative study; and teacher personal belief and practice with regards to questioning. I am going to make a summary for each section. Firstly, the review of the general perspective on teacher questioning has highlighted the dominant and important role of teacher questioning in teaching and learning, together with outlining the key components of teacher questioning including the purposes and types of questioning, the sourcing and preparation of questioning, and the strategies of questioning. Given the prevalence of teacher questioning in classrooms, this review has raised the need to re-examine teacher questioning, and to set it as the centre of this study. Secondly, reviewing the existing literature on teacher questioning in the context of mathematics teaching has suggested that teacher questioning is subject-specific, in that teacher questioning in mathematics might be different compared to other curriculum subjects. Thirdly, along with the increased globalisation and internationalisation of mathematics education, a cross-cultural comparative study could provide opportunities for sharing, discussing, and debating important issues in an international context. Despite the very different cultural values and education systems in England and China, there has been little comparative research carried out in these two countries with a focus on teacher questioning pedagogy in mathematics. It is worth investigating the similarities and differences between teachers' questioning in the two different contexts to fill in this gap. Fourthly, despite the importance of teacher beliefs in teaching, there has been very little research examining the relationship between teachers' beliefs and their practices with a focus on questioning, particularly in the context of mathematics. This study aims to fill in the gap by examining the relationship between teacher beliefs about questioning and their actual questioning behaviours in English and Chinese context firstly at an intra-country level and then at a cross-national level.

To conclude, this current study aims to explore the similarities and differences between teacher beliefs and teaching practices in terms of approaches to questioning in secondary classrooms in both England and China. In particular, teacher beliefs and practices of questioning in classrooms were examined in relation to the purposes in asking questions; cognitive levels and types of questions; the sourcing and preparation of questions; and strategies of questioning through a comparison of the two countries. The perceived cultural differences and similarities underlying the use of teacher questioning were also subsequently examined, in the hope of contributing to a deeper understanding of Chinese and British culture and education systems.

Derived from the research gap above, the research questions are as follows:

1. What are the current practices of a group of secondary school teachers in each of England and China in terms of the types and levels of the questions they pose and the strategies they use in asking these questions? What are the similarities and differences between the practices of questioning in England and in China?
2. What are the beliefs of these teachers in each of England and China in terms of their purposes for using questioning in their teaching, their sourcing and preparation of questions, the training for questioning that they receive, the types and levels of the questions they pose and the strategies they use in asking these questions? What are the similarities and differences between the beliefs about questioning held by these teachers in England and in China?
3. Are these teachers' beliefs about questioning consistent with their classroom questioning practices? If not, what are their divergences and convergences?

Chapter Three Methodology

3.1 Introduction

Given the research gaps and questions illustrated above in the literature review, this chapter sets out to propose and justify the research methods employed in the present study from the initial considerations of how to approach the topic and the research questions, to the design of the research methods, to data collection procedures and the analysis and interpretation of the data.

So to be precise, I will present this chapter in 3 sections consisting of the research plan and design, the data collection, and the data analysis. Within the research plan and design, I will firstly explain how the research questions and the aims of the study were answered and achieved. I will explore the theory underpinning the methodology adopted in this research, as well as its philosophical position. Following that, I will set out the research methods, including classroom observation and interviewing, and their rationales, as well as explaining the preparation of the two methods. Then the research population and sampling including sampling strategies and sample size will be discussed. Within the data collection section, I will describe the operationalisation of the study by discussing issues surrounding: access to research sites, the pilot study, the data collection procedure, the validity and reliability of the study, and ethical considerations. Finally, I will discuss data analysis, using an analytical framework.

3.2 Theoretical Perspectives Informing Methodology

Research methodology and methods, according to Cohen et al. (2011), are determined by research questions, which in turn are driven by epistemological and ontological assumptions. Ontological and epistemological assumptions lie at the heart of philosophy as- the nature of understanding and enquiry (Bryman 2012). Ontology is concerning about '*the nature of being and existence'* (Hammond and Wellington 2013: 114), while epistemology is the '*philosophy of knowledge'*. Put another way, ontology is concerned more about the object of inquiry, whilst epistemology is concerned more with the very nature of knowledge, and how knowledge can be obtained (Bryman 2012; Scales 2013). Ontology and epistemology are tightly entwined, for example, if an example of a question of ontology is '*Does God exist?*', then an epistemological question would be '*how do we know if God exists*?' (Example taken from Scales 2013: 2). Therefore, ontological assumptions are directly concerned with social reality (Cohen et al. 2011; Bryman 2012), with a view of a reality being objectively independent from individual understanding and unaffected by any social factors referring to objectivism and positivism. In contrast, a reality inherently affected by social factors and constructed within social groups relates to a constructivist and interpretivist perspective (Burrell and Morgan 1979; Marsh and Furlong 2002; Blaikie 2007). Researchers often acknowledge that philosophical assumptions and beliefs are usually brought into their work (Bryman 2018), which are discussed below.

3.2.1 Interpretivism

Interpretivism emerged as a response contrasting with the positivist paradigm's view of social reality. Positivism sees reality as objective, and claims that social sciences should follow the methods and methodology of natural sciences (Hammond and Wellington 2013). In this case, Positivism also assumes that the researcher can observe and measure reality objectively without any influence from the researcher him/herself. The anti-positivist approach of Interpretivism, however, assumes that access to social reality is only through social constructions (Myers 2008). That is to say, it has acknowledged that the researchers and the participants both have profound influences on the data collection or interpretations. This worldview '*concentrates on the meanings people bring to situations and behaviour, which they use to make sense of their world'* (O'Donoghue 2007: 16). It views social reality as a creation of our own consciousness (Hammond and Wellington 2013: 90) since '*as human beings we are meaning makers*'. Therefore, it seeks an understanding of people's behaviours from the perspectives of people themselves, which is often considered an inside or emic perspective (Hennink et al. 2011). This involves studying the subjective meanings that people attach to their experiences. The subjective meanings people attach to their social world are often shaped by their knowledge and experiences that are embedded in certain social-cultural contexts (Rubin and Rubin 2012). Therefore, Interpretivism emphasises the significance of interpretation and observation and the importance of contexts in understanding the social world.

3.2.2 Social Constructivism

Consistent with Interpretivism is Social Constructivism. Social Constructivism emphasises that reality is constructed through human activities, which are always situated and contextualised (Denzin and Lincoln 2008; Schunk 2012; Eggen and

Kauchak 2013), since people construct their experiences and knowledge within social, cultural, historical or personal contexts (Denzin and Lincoln 2008; Schunk 2012). Accordingly, individuals are self-interpreting beings, and thus the mind is active in the process of knowledge construction (Schwandt 2000). Since individuals have values, people's historical, social and cultural contexts impact a great deal on the way they construct and negotiate subjective meanings towards their experiences (Ibid). So the way individuals experience and interpret social reality varies according to the values, customs, and beliefs they internalise. This also influences the meanings they give to their social world (Creswell 2007; Bryman 2012). Therefore, it is important for a researcher to consistently consider the different ways in which individuals perceive their social reality and how these affect their own behaviour and views (Burr 2015).

This study aims at investigating teachers' questioning behaviours and beliefs about questioning, which are in line with the concerns of Interpretivism and Social Constructivism. More precisely, within the context of this study, an interpretive perspective was adopted to give insight into how the teacher participants interpreted and made sense of their own questioning experiences, which were situated within two the contexts of British and Chinese social-cultural, political and economic milieus. Within the situated cultural contexts, it also sought to offer an in-depth understanding of teachers' opinions, beliefs and experiences. The application of Social Constructivism in this study also highlights my role as a researcher in the process of co-construction in data collection and interpretation since the background and experiences of a researcher shape the interpretation of the data. It also indicates that I am aware as a researcher that the questioning experiences of the teachers are products of social interaction within specific contexts. Thus, the approaches of Interpretivism and Social Constructivism employed in this study have led to the choice of subjective strategies with multiple methods, including classroom observations, and individual interviews, which are discussed in the following sections.

3.3 Research Methodology

This section discusses how the study was designed, consistent with the methodological considerations highlighted above.

3.3.1 Research Strategy: The Qualitative Approach

Based on the nature of the research questions, and adhering to the approaches of Interpretivism and Social Constructivism, this study adopted a qualitative approach (Robson 1993; Silverman 2001; Teddlie and Tashakkori 2009; Mertens 2014; Bryman 2018). A qualitative approach, according to Denzin and Lincoln (2011: 3) could be defined as:

> *'… a situated activity that locates the observer in the world. It consists of a set of interpretative, material practices that make the world visible. These practices transform the world. They turn the world into a series of representations, including field notes, interviews, conversations, photographs, recordings and memos to the self. At this level, qualitative researcher involves an interpretive, naturalistic approach to the world. This means that qualitative researcher study things in their natural settings, attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them.'*

As the definition shows, there is a close relationship between the researcher and what is studied in qualitative studies, and data consists of perceptions of the people in the environment. Thus, qualitative research is able to help the researchers gain a better understanding or interpretation of what they see and hear. Bryman (2012) has suggested that qualitative research, as opposed to quantitative research, is a research strategy that seeks to achieve deeper insights into the participants' social worlds. What is more, it also enables the researcher '*not to depend on predetermined categories of analysis and this contributes to the depth and details of qualitative data during the data collection processes'* (Patton 1990: 9). In this respect, it allows for the discovery of new ideas and unexpected occurrences under investigation (Punch 2009). Additionally, it allows the researcher to develop a complex, detailed understanding of particular issues, provides opportunities for individuals to share their stories and experiences, and minimises the power relationship often existing between a researcher and the participants in research (Creswell 2007). In conducting qualitative research, the researcher is better able to understand the context or setting where the participants encounter a problem or issue (Ibid).

This study firstly investigates the complexity and dynamic nature of teacher questioning inside a classroom, which is classroom-centred research. Classroom-centred approach is descriptive in nature, in that it emphasises describing what actually happens in teacher-student interactive classrooms with a focus on teachers' whole classroom questioning. It often involves observation, recording, and transcription which leads to thick description (Van lier 1988; Hennink et al. 2011). These aims and characteristics are similar to those of the qualitative research or interpretative research (Cohen et al. 2011). Moreover, the literature reviewed generally supports the idea that teachers' naturally occurring classroom questioning behaviour should be studied using a qualitative, in-depth, descriptive perspective (Duff 2000; Hsu 2001; Hussin 2006; Chang 2009; Pham and Hamid 2012). Secondly, the study also focused on teachers' perceptions of questioning; therefore an examination of teachers' feelings, attitudes, experiences and decisions was required. A qualitative approach also enables me to explore different individual teachers' feelings, attitudes, and perceptions towards questioning (Sahin 2002; Flick 2009). It is not possible to quantify every single component involved in teachers' questions, especially due to the 'potentiality' and 'unpredictability' of the wide range of factors involved (Edwards and Westgate 1994). For instance, teachers' beliefs may have been impacted by teachers' personal affective factors such as personal preferences. Such factors cannot be generalised simply using quantitative methods, but require interpretation in a relatively representative and descriptive way (Chang 2009).

3.3.2 Research Methods

Research into the beliefs and practices of teacher questioning can be done through a combination of observation and interviews (Sahin 2002; Hussin 2006; Pham and Hamid 2012). Classroom observation can reveal teachers' actual questioning behaviours, whilst, individual in-depth interviews can uncover teachers' personal values, feelings and beliefs underpinning their questioning practices. The purpose of the use of both observation and individual in-depth interviews together is also to identify discrepancies between what people say and what they actually do (Hennink et al. 2011). By that, it means the convergences and divergence between teachers' beliefs in questioning and their actual questioning practices. A qualitative approach combining both interviews and observations has therefore been selected as appropriate for this cross-cultural study. The rationale for choosing these two methods will be discussed in detail in the following sections. The selected research methods for this study aims to gather rich information in order to answer these three research questions. The relationship between each research question and the suitable research tools are shown below in Table 3.1.

Research Questions	**Research Tools**
What are the current practices of a group of secondary school teachers in each of England and China in terms of the types and levels of the questions they pose and the strategies they use in asking these questions? What are the similarities and differences between the practices of questioning in England and in China?	Classroom observation Individual in-depth interviews
What are the beliefs of these teachers in each of England and China in terms of their purposes for using questioning in their teaching, their sourcing and preparation of questions, the training for questioning that they receive, the types and levels of the questions they pose and the strategies they use in asking these questions? What are the similarities and differences between the beliefs about questioning held by these teachers in England and in China?	Individual in-depth interviews
Are these teachers' beliefs about questioning consistent with their classroom questioning practices? If not, what are their divergences and convergences?	Individual in-depth interviews Classroom observation

Table 3.1 Research questions and research tools used

Classroom Observation

Rationale for Classroom Observation

The method of observation falls under an interpretive and qualitative framework, since it allows the researcher to systematically observe and record people's behaviour, actions, and interactions in the social settings (Hennink et al. 2011). Classroom observation is based in the rich context of classroom setting (Wragg 1999). The purpose of classroom observation is to understand and interpret people's behaviours and actions within their own socio-cultural setting (Hennink et al. 2011).

The advantages of observation are recognised in social research. Firstly, the recording of classroom observations could provide '*thick description*' of social settings, activities and people studied. This also allows the researcher to understand the contexts, to be open-ended and inductive, seeing events that might otherwise be missed or unnoticed, and discovering things that participants might not say in interviews (Cohen et al. 2011). In this study, classroom observation was employed in order to take a comprehensive and in-depth look at the practice of teachers' classroom questioning in mathematics lesson in both England and China. As discussed earlier, teacher questioning is a cultural activity, and classroom observation allows me to examine naturally occurring questions in naturalistic settings, in order to establish the similarities and differences between England and China, and identify the underlying silent social norms and cultural values.

It has been recognised that researchers use different methods of classroom observation to meet their research purposes and aims (Cohen et al. 2011). Participant observation and non-participant observation, and structured and non-structured observation are among the types of observation largely used and discussed (Cohen et al. 2011; Hennink et al. 2011). Non-participant observation, also called 'the complete observer,' (Mulhall 2003; Cohen et al. 2011) refers to conducting an observation without participating in the activities that being observed. As this study's objectives were to identify and explore teachers' questioning practices in a natural setting, non-participant observation was chosen for this study. In other words, as a researcher I saw herself as an outsider from the classroom being observed and tried to remain objective (Gay 1992) and unnoticeable (Slavin 1992) from any classroom activities.

Although observation can be used as stand-alone method, as Hammond and Wellington (2013: 114) have pointed out, with only one method of observation, '*we cannot ascribe intention on the basis of observed behaviour and we can only suggest possible motives.*' Thus it is best to '*seek for clarifications and confirmations from those being observed.*' In other words, it is often recommended to combine observation with other qualitative methods such as in-depth interviews, in order to provide complementary data to further understand issues and situated behaviours from different perspectives (Mulhall 2003; Hennink et al. 2011). Additionally, an in-depth individual interview can supplement observation with the unspoken thoughts and feelings of a participant (Dufon 2002). The in-depth individual interview will be discussed in the following section.

Another challenge of classroom observation is '*the observer's effect,'* in which the new figure of the researcher comes to observe the lesson in the classroom, and the effect of their presence causes the students and teachers to behave differently from normal (Robson 1993; Wragg 1999; Hennink et al. 2011). The teacher and students may be irritated or excited by the visitor, and they may try to provide what they think the visitor would expect (Cohen et al. 2011). Since in this study, all teacher participants were provided with exact information concerning the nature and the basis for conducting the study through an outline sheet (Appendix 11, Appendix 12), this raised an issue: when the participants know the topic of the research, it can create the effect of 'cooperative-subject effect' (Kirk 2013). '*This source of bias is caused by the influence that a researcher's expectations and motives have on a participant's performance. As a consequence, the subjects often respond in way expected by the researcher'* (Hsu 2001: 38). In other words, if the participants knew exactly what researcher wants before the start of the study, it is likely that they may consciously or unconsciously perform accordingly. As consequence, the findings for this research may carry potential bias, but there is little which can be done about this issue, if ethical guidelines are to be followed.

In order to minimise the observer's effect, it is suggested to best to observe a few lessons to begin with, to get people to be familiar with the presence (Chang 2009; Hennink et al. 2011). However, in this study, constraints of the time of teachers and their discomfort with my presence, meant that teacher participants indicated unwillingness be observed more than once.

Individual Interviews

Rationale for Individual Interview

Interviews are a universally widespread research method in educational research (Yin 2009; Cohen et al. 2011; Hennink et al. 2011; Braun and Clarke 2013; Bryman 2018), particularly in qualitative research. Interviewing is often a successful mean of exploring individual's personal experiences, beliefs, perceptions, feelings and interpretations of social situations (Mason 2002; Punch 2009). Indeed, interviewing is a powerful device, which allows the researcher to '*go deep'* through clarifying particular questions, and identifying unexpected issues (Hammond and Wellington 2013). An interview often allows participants to freely express their own thoughts and ideas about certain topics, although from a methodological point of view, it is very difficult for the researcher to know the degree to which the interviewee is being open in the research (Ibid). Furthermore, interviewing is '*prone to subjectivity and bias on the part of*' *the researcher'* (Cohen et al. 2011: 411), which is to say, the researcher's interpretation of individual interviews may be too subjective and biased. Concern over the validity and reliability of the interviews will be discussed in detail in the following section.

There are various types of interviews, such as narrative interviews, group interviews, ethnographic interviews and group interviews (Braun and Clarke 2013). Depending on the degree of structure, interviews can be divided into three types, namely structured, unstructured and semi-structured interviews (Punch 2009; Yin 2009; Bryman 2018). Structured interviews, also known as standardised interviews, are most commonly used in quantitative research, using a series of predetermined questions by the researcher (Punch 2009). Distinct from structured interviews, unstructured interviews and semi-structured interviews are both qualitative interviews. Unstructured interviews are more or less like conversations, and are strongly led by the participants, without pre-defined closed questions, instead using solely open questions. Semi-structured interviews, meanwhile, consist of both predetermined questions and open-ended questions, and are the dominant form for qualitative research (Braun and Clarke 2013) as they are completely contextual and responsive to the participants. They allow the researcher to ask unplanned follow up questions where necessary (Bryman 2012; Braun and Clarke 2013). Legard et al. (2003: 141) suggested that using a series of probes following up the response of participants could achieve greater depth and permit '*the researcher to explore fully all the factors that underpin participants' answers: reasons, feeling, opinions, and beliefs.'*

This study used face to face individual semi-structured interviews. This interview was designed to be conducted after classroom observation, as mentioned above. It carried out two primary purposes. Firstly, it was to explore the participant teachers' personal beliefs about questioning. Secondly, it was used as a supplement to classroom observations to further understand certain patterns and functions of individual teachers' questions from their own perspectives, which may differ from the researcher's perspective as mentioned above. Through the teachers' explanations and justifications of their decisions in asking questions, it was hoped that some interesting themes would be uncovered, which may not otherwise be accessible to the researcher. For instance, in this study, the researcher observed the questioning patterns of Chinese teachers in class, without knowing why the Chinese teachers used these until they explained further in the interview, which enabled the researcher to identify a new theme in the teachers' questioning strategy. This will be fully explained and discussed in Chapter 4 and 5. Therefore, the combination of observations and interviews allowed me to gain research data with greater depth in order to compare and contrast the teachers' questioning in the whole classroom setting. In this respect, semi-structured interviews provide opportunities and flexibility for participants to express and discuss issues important to them that the researcher has not anticipated. Given that the results from classroom observations provided some guidance for the individual interviews, this study adopted semi-structured in-depth interviews in order to explore teachers' personal beliefs about questioning, and to clarify my interpretation of observations of individual teacher questioning practice from the teachers' own perspectives.

3.4 Sampling and Population

Sampling can be defined as the process that a study uses to select units for the group that they wish to investigate. This section will illustrate the sampling strategy and the sample size selected for this current study. Sampling strategies and processes in this qualitative study comprised of two research methods were selected purposefully because of the nature of the research and sites of practice.

3.4.1 Purposive and Convenience Sampling

The study employed a combination of purposive and convenience sampling for recruiting research participants. Both approaches fall under the non-probability sampling approach, which is the most commonly used in qualitative research (Cohen et al. 2011; Bryman 2018). Non-probability sampling emphasises sampling places, events and people who fit the required criteria for the research (Cohen et al. 2011). Through non-probability sampling, a sample is selected purposefully to meet the need of the research, but does not attempt to make generalisations (Bryman 2018). This study was designed to explore the similarities and differences in a group of teachers' questioning practices and beliefs in China and England. It aimed to explore and discover rather than to generalise. Purposive sampling often refers to small and purposeful sampling, identifying and selecting participants *'based on specific purposes associated with answering a research study's questions'* (Teddlie and Yu 2007: 77). In any study, it is important to sample relevant research participants.

Purposive sampling enables researchers to identify and select researcher participants who potentially provide in-depth information on the research topic (Matthews and Ross 2010; Palinkas et al. 2015). In recruiting a reasonable number of participant teachers in England, I adopted a purposive sampling strategy, focusing on mathematics teachers teaching at Key Stage 3 through getting in touch with the heads of mathematics department in a number of secondary schools.

In addition to purposive sampling, the study also employed convenience sampling, which was also called '*opportunity sampling*'. This involves '*choosing the nearest individuals to serve as participants or those who happened to be available and accessible at the time*' (Cohen et al. 2011: 155). In other words, convenience sampling allows researchers to choose the sample according to ease of access (Matthews and Ross 2010). In this study, I attempted to recruit Chinese mathematics teacher participants from lower secondary schools. Through social networking, I initially approached to some potential participants and invited them to join in this research. This process continued till an adequate number for the sample was reached. As its name suggested, convenience sampling was chosen because it was both convenient and flexible. Convenience sampling may benefit the researcher in building a rapport with the potential participants and increasing their levels of participation since they are linked to the study through a familiar and trusted community member (Hennink et al. 2011). However, a disadvantage of using convenience sampling is the degree of bias caused by limiting the participants into the same social network and excluding potential respondents who are not part of social networks.

3.4.2 Sample Size

In this study, the research participants were mathematics teachers teaching to Key Stage 3 in England and to Year 7 and Year 8 in lower secondary schools in China. There are no rules in sample size in qualitative research (Patton 2002). The number of participants in qualitative research can vary widely, and the size is often informed by fitness for purpose (Cohen et al. 2011). According to Baker and Edwards (2013), a sample size between 12 and 60, with 30 being the mean, was an ideal size in a qualitative research. The aim of this study was to compare and contrast teachers' questioning beliefs and questioning practices between England and China, and cross compare and contrast the teachers' beliefs and practices in questioning at national level and cross-nation level. With the availability and time, the sample size for this study was 23, including 12 teachers in China and 11 teachers in England. This should have allowed for any detailed in-depth investigations or comparisons of the study, since small sample sizes are valuable when studying hard to reach participants in qualitative research (Ritchie et al. 2014). All of these 23 participant teachers were studied using classroom observations, and follow-up semi-structured, individual in-depth interviews for collecting teachers' perceptions together with justifications of their decisions behind questioning practices seen in classroom observations.

3.5 Preparing and Designing Classroom Observation and Individual Interview

In this section, the detailed procedures of how to design classroom observation and individual interviews are presented. The design of classroom observation including field-notes and audio recording is presented, together with the advantages and disadvantages of each research tool. The design of semi-structured individual interviews is also explained; together with the translation of the Chinese version of interview question items from English, since some of the participant teachers are not English speakers, and it is necessary to provide them with the Chinese version of the interview.

3.5.1 Preparing and Designing Classroom Observation

Observations involved keeping a record of what is happening inside the observed classrooms, with a supplemental digital recorder, together with the field-notes taken by the observer. As mentioned above, I as the researcher in this study played a role of '*completely observer*', which allowed me to sit at a distance from the teacher to gain a broader view of classroom questioning. As I was not participating into any classroom activities, it allowed me to observe, listen and take field notes freely. Meanwhile, an audio-recorder was also used to objectively record teacher questioning behaviours inside the classroom.

Field Notes and Audio Recording

Effective field notes not only help to '*record a series of important events, but also help to recreate the vividness and atmosphere of a certain scene observed*' (Berg 1998: 150). How to write field notes depends a lot on the value the researcher places on them (Mulhall 2003; Hennink et al. 2011; Bryman 2012). Research has recognised that with too much time devoted into detailed note taking, the researcher is more likely to lose the deeper experience of a culture (Mulhall 2003) in the field.

The nature of classroom observation, where so many things are happening, makes it impossible to note down all behaviours. When the researcher is doing research, they tend to look for what interests them and carry this out with a purpose (Pirie 1996). In this study, the field notes were secondary to '*becoming immersed in a culture'* (Mulhall 2003: 311). In this respect, I prioritised experiencing the culture and environment of questioning in order to develop an understanding of teacher questioning including where the questions had been raised, how and why teachers' questions were asked, how the lesson was structured and any emerging issues in class. This is because that the classroom is a very complex setting where the practice of a teacher's question always driven by multiple factors (Edwards and Westgate 1994; Mercer 1995; Myhill 2006).

Concerning what should be included in the field notes, my research focused on teachers' questions and how these were being asked in the lesson. Thus, I mainly noted down teachers' questions and students' answers that were of particular interest in the whole classroom setting, the relationship between the speakers, the situation in which the question arose, the non-verbal exchanges, and the responses offered by students. Other issues which related to the construction of teacher-learner question-answer exchanges were also taken into account and written down in the field notes. In the note taking, key words and abbreviations were used to grasp brief ideas of what teacher-student question-answer exchanges were like, instead of writing down the full sentences of teacher questions. The researcher also attempted to allocate teachers' specific questions to individual students. The classroom observation protocol including the design of field- notes can be seen in Appendix 1.

However, disadvantages of field note-taking are that the process of notes taking can be time consuming and field notes can be subjective since *'classroom observation involves not only 'recording the scene by pen or recorder, but also the observers' personal understanding, their evoked interpretation and theoretical insights concerning the situation'* (Emerson et al. 2001: 355). The field notes are thus already an interpretation of what is observed (Swann 2001; Mulhall 2003). In order to mitigate such subjectivity, audio recording was used as another supplementary tool in this study to amend the field notes. It is considered to be more credible than field notes taken by human researchers (Cohen et al. 2011), in that it can provide the researcher with more '*complementary and solid linguistic information'* than field notes (Cohen et al. 2011: 470), which then reduces the dependence on the researcher's prior interpretation from field note taking. What is more, audio recording buys the researcher time. While taking field notes, the observer can hardly write down everything the interlocutors said since the speed of writing is much slower than speaking. Through playbacks, audio recording could facilitate the complete analysis of teacher questioning behaviours and patterns to develop in-depth description of the utterances (Cohen et al. 2011) produced by teachers and students in the question-answer exchanges. Thus, a combination of field note taking and audio recording was used during classroom observations.

However, audio recording could not capture the non-verbal interactions between teachers and students, such as hands-up, all of which could only be recorded through note taking. The reason why this study did not choose video recording using a digital camera was that it was not necessary for the research purpose, and it might cause some ethical issues because the classroom observation involved students between the ages of 11-14. More details of this will be discussed in the ethical consideration section later.

Observation Tools	**Advantages**	**Disadvantages**
Field notes	Immediate and fresh recording. Direct culture and contexts to behaviour. Full picture of classroom activities. Unspoken language and Non-verbal behaviour can be seen e.g. body language, eye contacts.	Can be subjective. Cannot record every single word in the conversation. Time consuming.
Audio recording	Versatility. Sufficient material. Successfully monitor all conversations.	Distracting to participants due to its presence. Loss of important non-verbal behaviour and silent activities such as eye contacts, body language and teachers' movement

Table 3.2 Advantages and disadvantages of field notes and audio recording

3.5.2 Preparing and Design Interview Questions

Good questions are essential to interviews (Patton 2002), and must be clear, easy to understand and relevant to the issues (Krueger and Casey 2009). The questions in the semi-structured individual interviews were developed primarily based on the research purposes and research questions. These included two elements: the first was to clarify the researchers' interpretations on observation from the teachers' perspective; and the second was to explore teachers' personal beliefs about questioning. Thus, questions in individual interviews were exploratory: seeking rich information and further elaboration. Some of the individual interview questions could not be designed but emerged from the findings of classroom observations. Classroom observations were concerned with the identification of the types and levels of the questions teachers posed and the strategies they used in asking these questions. Therefore, the interview in part sought further elaboration on the strategies the teachers used in asking questions, and why they asked questions to some students specifically. To increase the validity and minimise the '*time delay between events and recall'* (Gass and Mackey 2000: 42), the interviews aimed to be conducted as soon as possible after the class was observed since it was very likely that the teachers would forget what questions they asked and why they asked such questions in the classroom observation. Thus, this study conducted semi-structured individual interviews either on the same day or the following day of classroom observations.

As mentioned above, these individual interviews were also concerned with teachers' beliefs about using questioning in their teaching, their sourcing and preparation of questions, the types and levels of the questions they posed and the strategies they used in asking questions. Thus, some descriptive questions to explore these beliefs were designed. '*Descriptive information lays the foundation for the questions that access the interviewee's perceptions, opinions, values, emotions, and so on*' (Merriam 2009: 103). Many open-ended questions were included in the interviews in the hope of '*yielding descriptive data'* (Ibid: 99), with other probing questions occurring from the conversation between interviewer and interviewee (Bryman 2018). In order to use probing questions effectively in semi-structured interviews, it is important to have an interview guide that will support the collection of data in a systematic and focused manner so as to address as many issues within the research questions as possible (Hennink et al. 2011; Braun and Clarke 2013). The questions in the interview guide (Appendix 2) were carefully designed after having been systematically reviewed and following an examination into the literature into teacher beliefs on questioning (Hussin 2006; Chang 2009; Pham and Hamid 2012). Pham and Hamid (2012) conducted open-ended questionnaire surveys and classroom observations with 13 beginning EFL teachers in Vietnam National University to investigate the relationship between teachers' beliefs about quality questions and their behaviours in terms of questioning purposes, content focus, students' cognitive levels, wording and syntax. Hussin (2006), meanwhile, interviewed 7 English teachers and observed two Form 5 science classrooms from Malaysian secondary schools. Both studies explored teachers' beliefs about questioning using open-ended questionnaire surveys or individual interviews. The sequences and details of these designed questions can be seen in the interview guide in the appendix (Appendix 2). The questions in the interview guide were designed in English, and translated into Chinese (see Appendix 2 and Appendix 3 for the English and Chinese versions). The interview guide was carefully piloted in order to make sure it was comprehensive for participant teachers. Questions in the interview were able to be redefined and reorganised across the entire data collection if new issues were to arise (Charmaz 2002).

Audio recording of semi-structured individual interviews assisted me in recording the conversations with the participant teachers, preserving the integrity of the data (Cohen et al. 2011). The following table demonstrates the advantages and disadvantages of semi-structured interviews (Table 3.3).

Interviews	**Advantages**	**Disadvantages**
Individual semi-structured in-depth interview	To obtain teacher's opinions, values and beliefs about teacher questioning. To seek clarifications and a different understanding of certain teachers' specific questioning practices from the teachers' perspective.	Openness of an interview might limit the extent to which it truly demonstrates the teacher's thinking at the time. The subjectivity of the researcher.
Audio recording of interviewing	Long and complete verbal conversations can be obtained.	Can be time-consuming in later transcription of interviews.

Table 3.3 Advantages and disadvantages of individual semi-structured interviews

Translation

As the interview in this study was also conducted with the individual Chinese teachers, who were speaking Mandarin instead of English, translation of interview questions became necessary in this research. Questions in the interviews were originally designed in English, and then translated into Mandarin, before semi-structured interviews were conducted with Chinese teachers. The quality of translation was vital (Hennink et al. 2011). I firstly translated the English version into Chinese version. The translated questions were then checked using 'back-translation': I translated a Chinese version back to the original English language version to ensure that the precise meaning of questions was fully captured and expressed appropriately.

3.6 Data Collection

This section presents the data collection including gaining access to schools, the pilot study, and the main data collection process.

3.6.1 Approaching the Participant Teachers

The first step of data collection in this study was to obtain permission by accessing research sites. As a researcher with the limited teaching and research experiences, I decided to start by finding schools in China since permission from Chinese teachers could be obtained through personal social networking. The teachers in this study were selected with these considerations in mind. They were interested in this research and willing to participate. The second criterion was that they all were mathematics teachers teaching Year 7 to Year 9 (students aged between 11 and 14) in lower secondary schools.

3.6.1.1 Gaining Permission for Chinese Schools

I started by looking for friends and family relatives who might know of mathematics teachers teaching at lower secondary schools. Luckily, a friend was teaching at a lower secondary school, where she approached 7 of her colleagues who showed great interest and willingness to join into this study. Additionally, another friend's family relative who was the head of a mathematics department in a state-run secondary school helped to recruit another 5 teachers. I then approached the teachers individually and explained to them the purpose of this study and the methods and tools which would be used to collect the data. Since the Chinese teachers expressed concern over whether this would be related to an evaluation of their teaching performance, I assured them that their participation would be used for this Ph.D. research project only. There was only oral informed consent obtained from teachers, with no written informed consent acquired from teachers. The reason for this was that in the Chinese cultural context, signing a consent form could give the teachers and parents an impression of formality that they were not comfortable, due to an association with legal documents. In the end, I issued them an outline sheet explaining the nature of this study and the methods would be used (Appendix 12). Ethical considerations are potentially not a well-developed concept in China. No informed consent was obtained in either oral or written form from either students or their parents after consulting the teachers. The ethical concerns of this will be further discussed in Section 3.9.

3.6.1.2 Gaining Permission for English Schools

To gain permission from schools in England was much harder than getting access to schools in China. I had no personal social networks. I therefore firstly emailed some head teachers of potential secondary schools which met the criteria and sought their interest in participating in this research. In the emails, I briefly introduced myself, with an explanation of the purpose of the research project, the methodology that would be carried out and the recruitment of the participants, in the hope that they might be interested. In England, the head teachers of schools play a crucial role of gatekeeper, in which they can enhance the trustworthiness and credibility of the data collection process (Hughes 1992; Hennink et al. 2011). Two head teachers replied and requested more detailed information about the methods, tools and numbers of participants. In their emails, they expressed concerns over pupils' voices being recorded in the audio-recorder, and I therefore assured them that all audio-recordings would be stored safely and destroyed after use. After giving me consent, the head teachers reported to their schools that I had permission to enter the schools.

After gaining permission from both the head teachers and schools, the next step was to gain informed consent from teachers and their students' parents. This informed consent was obtained from the teachers and children through the head teachers who had been approached. I was also required to bring the Disclosure Barring Service (DBS) check on the visits. A DBS check, which is also called Criminal Records Bureau (CRB) check, refers to the requirement by the Home Office of the UK to check someone's criminal record when applying for jobs or volunteer work, especially work involving children or vulnerable adults (Gov.uk webpage). In essence, a DBS check allows schools to make safer decisions on recruitment, and to prevent vulnerable children from being harmed.

3.6.2 Pilot Study

Prior to the main study, it was piloted with one Chinese teacher who was teaching English to Year 7 in a secondary school. It was initially piloted to test the data collection instruments including the data collection structure (Appendix 4) and the interview guide (Appendix 3). Pre-testing the data collection instruments was hoped to show whether the participants could easily understand the questions, and whether the guide was good enough to generate data which could answer the research questions (Bryman 2012). It was also hoped to shed light on the prevailing conditions in the field and reveal any adjustments in the data collection instruments, such as the audio recording and field note taking, which might need to be made.

The pilot interview also aimed to ascertain whether or not the questions were clear, unambiguous and easily understood by the participant teachers, and to find out the right time frame in which to conduct the interview (Nunan 1992). The pilot observation was used to check whether the observation structure was appropriate, and to check the quality of audio recording used for the classroom questioning. It was also designed to see whether or not the lesson observation would yield data relevant to the research topic.

During the pilot, the individual in-depth interview was split into two. A 15-minute individual pre-observation interview was undertaken with the teacher, and following this, a 40-minute lesson was observed and audio recorded. After this, a 10-minute recall interview was conducted with the same teacher next day. The original interview with the teacher was planned to take roughly 30 minutes, with some elements focused around the teacher's reflection on the lesson I had just observed. In the event, because of timings, there were 15 minutes or so free before the lesson took place and we were able to use some of this to discuss the elements of the interview (biographical details, some attitude questions etc.), which meant that the post-observation interview took rather less time than being planned. This did not appear to affect the way the teacher in the pilot study approached the interview questions, so it was kept in mind as a possible way to conduct future interviews, depending on available timings and interviewee preference.

The pilot revealed some practical issues with the field note taking and the quality of audio recordings. Initially I was hoping to assign teachers' questions to specific students in the Chinese classroom. However, in practice, since there were over 45 students on average in the classroom, it was impossible to do so. I also found it to be very useful to use key words and abbreviations to show what teacher-student question-answer exchanges were like, rather than writing down full sentences for teachers' questions and students' answers. After the observation, the audio-recording was played back to adjust some of these questions and answers, to inform the questions asked in the post-observation interview the following day. In order to help in later transcription, the field notes were also aligned with the audio recorder from the time of starting the recording to the end of the recording, e.g. 12 minutes, 28 minutes, and 40 minutes according to the time on the recorder.

The observation session and the interviews were audio recorded and transcribed. Data from the observation transcripts indicated that the quality of audio recording was good enough to note down all teachers' whole classroom questions, but not those teacher questions in small groups or individual seatwork, since some teachers and student voices were unable to be captured due to the distance from which I put the recorder to the teachers. Moreover, such group discussions were full of chorus questions and answers. This made me aware that it was impractical to record all teacher's questions in all of the classroom activities, therefore I adjusted the research's focus on teachers' questioning to just those taking place in a whole-class setting.

Regarding the interview questions, the Chinese teacher in the pilot study reported that some questions were too broad and abstract, and she found it hard to give an answer. For example, the question '*what sort of questions do you usually ask?*' was considered too broad to answer. Based on her feedback, a small number of broad questions were broken down into a number of sub-questions to try to make them easier to answer. For example, '*what kinds of questions do you ask?*' was broken down into a more precise question, such as '*do you ask questions requiring the students to remember information, understand concepts or apply or evaluate*?'

3.6.3 Data Collection Procedure

The aim of the research was to examine the relationship between teachers' questioning beliefs and their questioning practices in mathematics classroom settings in both England and China; and then to explore the differences and similarities between the two countries in relation to teacher's beliefs and practices with a focus on questioning. The data was therefore collected from two countries: China and

England. I collected the first half of the data from China in the third semester of the academic year 2015, and collected the other half of the data in England in the first semester of the academic year 2016. The duration of the time spent collecting data in China was 6 weeks, starting from the beginning of May, and going on until the middle of June. The duration of time spent collecting data in England was 2 weeks, from the end of September to the middle of October. 23 teachers from four schools (two from China; two from England) were involved in this study: the details of these individual teachers (Appendix 5), the environment of the school sites (Appendix 6) and school day timetables (Appendix 7) are listed in the appendix. The profiles of all teachers are given, including the detailed personal information about their educational backgrounds, gender, years of teaching mathematics and total teaching experience, and class information including class size, year group and lesson topics. All four schools were all academy co-educational secondary schools.

Data Collection Procedure in China

Classroom Observation

The classroom observations were 40-60 minutes in length. They intended to capture the teacher's questioning behaviour regarding the types and levels of the questions they posed and the strategies they used in asking these questions. The schedules of classroom observation were carried out based on the individual Chinese participant teachers' availability and preferences (Appendix 8). During the observation, descriptive field notes were taken, which contained general records of the class size, the structure of the lessons (Appendix 9), the topics, the physical settings (Appendix 10) and teacher questions which were interest. In order to do so, I sat next to the back door in the corner of the classroom. This position allowed the widest view of the entire classroom. Meanwhile, the textbooks and supplementary teaching materials were collected from the teachers before and during the lesson, in order to keep up with the lesson topics and activities in each lesson observation.

Semi-structured Individual Interview

According to the original research plan, a classroom observation with the teacher would be conducted first. Following this, a semi-structured interview with the same teacher would be carried out on the same day or the following day. In practice, because of timing and availability, the semi-structured individual interviews were split into two interviews: before and after observations. This was revealed in the pilot study, as a potential way to conduct interviews. The pre-observation interview attempted to ask the teachers questions following the interview guide (Appendix 3), whereas the post-observation interview was developed from classroom observation to ask the teachers to recall and reflect on their questioning practice. The details of the data collection procedure can be seen in Appendix 8.

Pre-observation Interview

On the day of the observation, before the lesson, a semi-structured individual interview was carried out with to discover teachers' beliefs, feelings and values regarding questioning following the interview guide (Appendix 3). These pre-observation interviews mostly took place in teachers' offices, with each lasting from 10-20 minutes in length.

Post-observation Interview

As pre-planned, this interview needed to be done within 48 hours of the classroom observation. However, in practice, these interviews were carried out based on the timetable of the teachers. Some of them were conducted on the same day within 24 hours; some were postponed for two days. Before conducting the interviews, I viewed the observation tape, took down some notes on particular issues and made a list of questions. For example, I asked especially about the kinds of questions the teacher used and why they chose to use the particular questions they asked in the classes observed, and what the role of questions played in achieving the teacher's goals in the classroom. A comparison and contrast of data between the observation and the post-observation interview with the teachers provides a basis for more accurate and valid interpretation of the classroom data concerning the teachers' questioning behaviour in practice.

Data Collection Procedure in England

Classroom Observation

The majority of classroom observations in England were conducted following the planned schedule (Appendix 8) arranged with the head teachers. These classroom observations were 60 minutes in length. In practice, Teacher I's lesson in School 4 was chosen to be observed, which was different from the original plan (Appendix

8). In this case, the timetable was rearranged with the head teacher and in the end only 11 teachers in England took part in the study (Appendix 8).

As the seat arrangement of English classroom was much different from the Chinese classroom (Appendix 10), most of the time I sat with the students in a group or shared a table with them. There were no textbooks in the class, but some teaching materials such as exercise sheets, colourful slips, timetable sheets, and mini whiteboards. Similar to the Chinese classroom observations, I noted down the class size and physical setting (Appendix 10), the structure of the lesson (Appendix 9) and the teachers' questions that were of particular interest. Some interesting questioning behaviours were also noted, for instance, many teachers in England frequently asked students to write their answers on mini whiteboards in the whole-class setting. A wide range of classroom activities were observed such as group work, pair work, or group discussion. The teachers intended to circulate themselves among students to answer their individual questions during the activities. This led to some difficulties in picking up the voices of teachers from the crowd. Additionally, the students' responses were hoped to be recorded in order to analyse teacher's classroom questioning behaviour from a relatively comprehensive perspective. However, most of the time the students' voices were too low to be picked up by the recorder even in the whole-class setting.

Semi-structured Individual Interview

On the same day, after the class sessions, semi-structured interviews were conducted with each individual participant teacher. These interviews ranged from 30-50 minutes in length. This semi-structured interview aimed to collect data regarding the teachers' perceptions of questioning, and their explanations of the purposes and types of questions they addressed to individual students or the whole class in the lessons observed. These interviews took place in a variety of places, including a teacher's office, an empty classroom, and a small meeting room. The choices of both location and meeting time were made based on teachers' willingness and convenience. In some cases, the interviews were carried out the next day if the teachers were not available to be interviewed on the same day, or the interviews were conducted on the same day but were conducted in breaks between lessons when the teachers were not available to be interviewed after school time. For instance, Teacher H could not make the arranged time of Thursday afternoon after school time, so we re-arranged the interview to the next day during Friday lunch break. Teacher K was unavailable after school, so I ended in interviewing her twice in the break between lessons, as shown in the appendix (Appendix 8).

3.7 Validity and Reliability

Validity and reliability are important criteria concerning the quality of research (Cohen et al. 2011). As Merriam (2009: 209-210) has noted, *'all research is concerned with providing valid and reliable knowledge in an ethical manner'* and these two issues should be considered *'in the way in which the data are collected, analysed and interpreted'*. In quantitative research, rigid sampling strategies, the use of measurements and the use of statistical analysis are crucial to maximum validity and reliability (Cohen et al. 2011; Bryman 2018). The criteria of validity and reliability are thus often discussed with regards to quantitative research (Cohen et al. 2011). Many researchers have claimed that the concepts of reliability and validity in quantitative research should be reconsidered before being applied in the qualitative research (Stenbacka 2001; Golafshani 2003; Cohen et al. 2011). Validity refers to '*the integrity of the conclusions that are generated from a piece of research'* (Bryman 2012: 47). Issues of validity in qualitative research are often related to the positivist perspective of validity (Shenton 2004), since such qualitative research can be linked to be lacking in a set of rules for designing instruments and data analysis. Reliability is concerned with the consistency and replicability of the measurements (Cohen et al. 2011; Bryman 2018). As qualitative research is often dealing with the understanding of individual practice in social contexts, the notion of dependability (Lincoln and Guba 1986) in qualitative research closely corresponds to the notion of reliability. This can be achieved by providing details of research design and data collection and by reflective appraisal of the study in specific research contexts (Shenton 2004).

Credibility and transferability are often regarded as internal and external validity for qualitative research (Lincoln and Guba 1986). Internal validity and external validity are two types of validity that are often discussed in educational research (Cohen et al. 2011; Bryman 2018). Internal validity often is interpreted as the extent to which the findings can explain certain events and social practices and how the events can be presented by the data (Onwuegbuzie and Leech 2006; Cohen et al. 2011). External validity involves the degree to which the findings are generalisable (Davis 1992; Cohen et al. 2011) and can be applied to other research contexts. However, the qualitative researcher is expected to provide sufficiently rich and thick description for the readers of the research to decide the extent to which the study is transferable (Cohen et al. 2011). Thus transferability is how well a study has made it possible for the researcher to decide if similar processes can translate into different settings and cultures (Lodico et al. 2006). Transferability (Davis 1992; Cohen et al. 2011) which is parallel to external validity, should be the focus in qualitative research. I in this study attempted to provide sufficient descriptive data in order for readers to make such judgements.

This study adopted mainly qualitative research methods, classroom observations and interviews, and the aim of this current study was to explore and examine teachers' questioning beliefs and practices with a group of mathematics teachers in China and in England; it did not aim to achieve any generalisations and predictions. The same procedures and instruments (classroom observations and follow-up semi-structured individual interviews) were employed to obtain clear descriptions of teachers' beliefs and practice with a focus on teacher questioning in different social and cultural settings.

The issue of credibility similar to internal validity (Davis 1992), refers to the participants' perspectives of events matching up with the researcher's portrayal of them in the research. In other words*, has the researcher accurately represented what the participants do, think and feel and the process that influence their actions, thoughts and feelings*? (Lodico et al. 2006). There were several ways to increase credibility such as prolonged engagement (Lincoln and Guba 1986), triangulation of methods (Golafshani 2003; Crishna 2006; Chang 2009) and member checking (Tobin and Begley 2004; Rolfe 2006). Prolonged engagement refers to a process where the researcher spends some time building a rapport with the participants and learns their culture. Member checking is where the researcher sends the transcripts back to the participants to check that they represent accurately what has been said (Tobin and Begley 2004). Triangulation is the use of multiple methods to study aspects of human behaviour (Cohen et al. 2011). In this respect, the employment of multiple methods, observation and interviewing in the case of this study, could lead to more valid and reliable data. After observing the lesson, I followed up with an individual semi-structured interview in order to check my interpretations of observed data with the individual teachers and clarify my interpretations of teacher questioning behaviours from their own perspectives in the interviews. Rolfe (2006) supported this approach as the most important technique needed to establish credibility.

In this study, to increase the reliability of the interviews, analysis of data was peer reviewed by my supervisor, who read and reviewed the interview guide, the transcripts and the analytical frameworks. This helped in improving the quality of the research (Alkass et al. 1998; Emden and Sandelowski 1998; Chiovitti and Piran 2003). Chiovitti and Piran (2003) claimed that investigator triangulation by experts was not only effective but also could potentially improve the credibility of findings by highlighting both the weaknesses and strengths, and suggesting areas that required improvements. With the majority of the Chinese school teachers, I interviewed each of them twice, before and after the classroom observation, which was found to be very useful since I had the chance to listen and read through the classroom observation and review every single question asked by the teachers from the audio-recorder. It subsequently sharpened and widened the questions in the follow up interviews with these teachers. I therefore explicitly asked them to recall and explain why they had chosen the types of questions they had asked or had addressed particular students, as a result of looking at the full transcripts of the observations.

The recordings of the interviews with the teachers were mostly of good sound quality, because they involved one to one interviews in the teacher's office or in a fairly small room. The quality of classroom recording varied. Whilst the teachers in the Chinese lessons mostly asked questions in a whole-class setting, the teachers' questions in the English classrooms were poorly recorded, because the teacher, teaching assistant, and students were often talking all at the same time, and the teacher's voice was not loud enough on occasions such as group discussions or seat work. However, as mentioned many times, this research was focused on questioning in whole-class settings, and in fact, the teacher's questions in this context in both Chinese and English mathematics lessons were recorded in a reasonably high quality.

3.8 Positionality

The power relation between myself as a researcher and the participant teachers must also be considered. The power relations between a researcher and the participants are often referred to by the term positionality (Hennink et al. 2011: 122). Alongside the communication between the researchers and the participants, both sides bring in their personal values and identities to the research procedure, such as masculinity and ethnicity, and in doing so, they co-construct the reality between them. The appearance, gender and attitude of a researcher can have profound influence upon the information that the participants are willing to share. For example, a researcher dresses in a formal dress or suit would send a different message than a researcher dresses in t-shirt. In this study, I conformed to the local cultural norms and values by seeking guidance from the gatekeepers and participants in informal meetings and emails relating to appropriate conduct of personal appearance and dress.

Researchers can either be insiders or outsiders in any given research. Therefore, they may consciously or unconsciously contribute to the construction of the social world. Indeed, the researcher's personal values can potentially have an impact upon how data is collected, analysed, and interpreted. In qualitative research, it is vitally important to consider the reflexive relationship that might exist with the participants (Hennink et al. 2011). Braun and Clarke (2013) have pointed out that there is the power relationship between interviewer and participant, especially when interviewing people with high social status. There is a potential for the researcher to feel vulnerable and to lose control of the interview, and for participants to dominant the interviews (Odendahl and Shaw 2002). As a young, female student facing professional teachers, I was prepared to manage the power and control in the process of interviewing the participant teachers, who were in a more powerful situation in some ways.

This study placed me as a researcher as both an insider and an outsider. The research was conducted in both China and England. To the research environment in China, I was an insider as I am Chinese and familiar with the social-cultural context of the research setting. As an insider, I had shared social and cultural experiences with the participant teachers, which helped me to understand the participant teachers' perspectives both literally and with respect to their body language. I had insider status in another way, due to previous work experience as a teaching assistant in China. Simultaneously, I also had outsider status due to the fact that I am a researcher and I am studying abroad. I was an outsider to the participant teachers in England, as I had never experienced the social-cultural context of this research setting. I also had a degree of insider status as I have done extensive reading about this culture, and the interview guide was based on the western literature. Having elements of both insider and outsider status helped me prepare for any possible challenges that might happen in interviewing the participant teachers. I was continuously reflecting on my actions, values and perceptions, and how these might have had an impact upon the research process.

To acknowledge the teachers' contributions to the research, they were given some little gifts to thank them for their valuable time and experiences. These gifts were given after each of the interview. For example, the teachers in England each were given some Chinese paper cuts and a greeting card for their willingness to participate into my study.

3.9 Ethical Considerations

Ethical issues exist in any kind of research. In fact, the research creates tension between its aims to '*get the truth or make generations for the benefits of others, and the participants' rights and values which are potentially threated by the research*' (Cohen et al. 2011: 78) but this harm can be reduced by following the appropriate ethical principles. This study set teachers as the target participants, and involved audio recording of interviews and classroom observations in data collection process. To undertake classroom observation, as with the individual teacher interview, it required the informed consent of participants, the right not to be observed or interviewed, the permission from the schools and the parents to observe vulnerable young students, and particularly in England, clearance concerning the researcher's reliability and safety to work with young children aged 11-14 in schools (e.g. criminal record checks). This study systematically followed the BERA ethical guidelines (BERA 2018). The headings of the BERA guidelines below were adhered to demonstrate that everything was covered in this study concerning confidentiality, consent, and data ownership:

- Voluntary Informed Consent
- Privacy and Confidentiality

Before conducting this research, an ethical approval form was completed and then assessed by the department (Appendix 18).

3.9.1 Voluntary Informed consent

Amongst all ethical principles, informed consent is considered as particularly important to be obtained for respecting participants' '*right to know*'. Informed consent is defined by Hennink et al. (2011: 63) as the process in which '*participants should be provided with sufficient information about the research, in a format that is comprehensive to them, and make a voluntary decision to participant in a research* *study*'. In this research, the primary research population is the teachers, who were interviewed after each observation. In the classroom observation session, both participant teachers and students were observed and audio-taped. The interviews with teachers were conducted and also tape-recorded. Since the students' voices were recorded in classroom observation, the situation was complex. The participant students were aged between 11 and 14, and may not have had sufficient understanding of my research, the process used, and the implications of their participation to give informed consent. In addition, these students were young and vulnerable, so the rights of these young students '*must be the primary considerations'* (BERA 2018: 6). As mentioned above, I consulted the teachers from schools, and was recommended to bring a Disclosure Barring Service (DBS) check on the visits to English schools, which allowed them to make safer decisions to let me observe the lessons.

Verbal informed consent was obtained before conducting the study and before each session in England and China. Two language versions of the outline sheet (English version and Chinese version in Appendix 11 and Appendix 12) explaining the nature and basis for carrying out the study were given to the head teachers and the teacher participants to read before taking part into this study. All participants were on strictly voluntary basis. All participants were offered the right to withdraw from the study at any time and for whatever reasons (BERA 2018). In this study, this was offered to the teacher participants individually before conducting the research, and before conducting each session including observation and interview.

3.9.2 Privacy and Confidentiality

The entire research strictly conformed to privacy, anonymity and confidentiality guidelines (BERA 2018). Confidentiality and anonymity are often used interchangeably in the research. Confidentiality refers to not disclosing information discussed between the researcher and the participants. To ensure complete confidentiality, all participants were anonymous. In this study, all schools, students and teachers' names were kept confidential and anonymous, their names or other identifying factors will not appear in the report, and they were assigned to letters as H, S and T.

Furthermore, another important issue related to privacy and confidentiality is the storage and the use of data. Aligned with data protection requirements, all of the transcripts and audio recordings were kept in a safe and secure place, which only I has access to. The data and transcripts in this study were only shared between myself and my supervisor and will only be used for academic purposes.

In addition, the more detailed information related to ethics was included in the ethical approval form, in which there were specific discussions about ethical considerations related to the project in terms of the process of data-handling and analysis, data storage, reporting and authorship.

3.10 Data Analysis

This data analysis section consists of two parts. The first was to transcribe all of the observed data and interviewed data and to get familiarised with the transcriptions; the second was to develop an analytical framework. The data was transcribed and analysed in its original language, in this case, the teachers' interviews and observations in two nations were analysed in Mandarin and English respectively, in order to avoid the meaning loss in translation (James 2002; van Nes et al. 2010).

3.10.1 Data Transcription

When facing the enormous data sets, which tend to be generated during qualitative research, the priority is to become familiar with the data, described as the '*bedrock*' for the entire data analysis by Braun and Clark (2006: 87).

All recorded interviews and observations of this study were transcribed verbatim by myself. Transcription is the foundation for data analysis, which starts to '*identify some key ideas and becomes aware of similarities and differences between different participants' accounts*' (Bryman 2012: 486).The transcription of classroom observation proved to be an intensive job, which took over ten hours to transcribe each one-hour observation. Although the process of transcription was very time-consuming, it also helped me to become familiar with the teachers' different approaches to questioning in the observation. As mentioned earlier, the process of transcribing the observations enabled me to shape and broaden the follow-up interview questions, rather than limiting the interview questions to a pre-defined structure. Additionally, with transcription, I became familiarised with the teachers' different accents in England, which helped me to better understand what they said in the interviews and shortened my time spent on transcribing the interviews. However, the process of transcription was slow: for instance, in order to capture what the teacher said in the classroom and in the interviews, I sometimes became stuck in deciphering some of their words, and this constrained me in developing a full understanding or interpretation of the participants. In the process of transcribing classroom observation data, a transcription convention was developed (Appendix 13) in order to display all the teachers' questioning behaviours in a format which would enable me to make interpretations.

After transcribing and becoming familiarised with the data, the systematic analysis of the data began with coding. The process of open and initial coding was for '*identifying and labelling aspects of the data that potentially related to your research questions*' (Braun and Clarke 2013: 61). Anything that related to the research questions were coded on the basis of '*inclusivity*': which in practice meant that everything was coded. Generating themes started after all of the data was coded inclusively. The process involved linking individual codes to form coding clusters, and then form themes (Cohen et al. 2011; Bryman 2012; Miles et al. 2013) through drawing overlaps and similarities to obtain themes. Computer-assisted qualitative data analysis software such as Nvivo was used in retrieving codes and themes from the data (Bryman 2018) in this study.

As discussed earlier, one of the aims of this study was to identify the similarities and differences in teachers' practices and beliefs about questioning between the two groups of teachers in England and China. Thus, '*thematising meanings'* of each group was the best way to make the comparison between the two groups, rather than looking at characteristics of individuals (Holloway and Todres 2003: 347). Thematic analysis is the most widely used method for identifying themes and patterns of meaning with a clear set of procedures in qualitative research (Braun and Clarke 2006). Most importantly, it provided flexibility in allowing me to analyse across the entire data set to draw out themes from social-cultural perspectives, which was vital for this cross-nation study. Therefore, thematic analysis was used for this (Braun and Clark 2013). The data was collected from classroom observations and interviews respectively. Analysis of the two will be presented separately below.

3.10.2 Analysis of Classroom Observation Data

This section provides an account of the process undertaken to analyse the data arising from the lesson observations in China and England. It also attempts to justify for the use of the particular framework in this analysis. The aims of conducting the classroom observations were to explore and examine the differences and similarities between teacher questioning behaviours inside a number of mathematics classrooms in England and China. Teachers' questioning behaviours in the lessons observed were considered under three headings: what kinds of questions the teachers asked; their apparent reasons for asking these questions; and the questioning strategies which appeared to be used. Therefore, to analyse these mathematics teachers' questioning behaviours in lessons, I firstly identified all the questions asked (as described later) and then examined each one under the three headings above. Finally, a comparison was made across the two different countries. Therefore, both deductive and inductive approaches were used for analysing these classroom observations. An analytic framework for distinguishing types and purposes of teachers' questions was developed as a starting point for deductive coding and issues and themes began to emerge unexpectedly from the analysis. In the following section, I will present the analytic framework, codes and steps of analysis along with examples of how the analysis was conducted.

An Analytic Framework for Analysing Types and Purpose of Teachers' Questioning (Deductive and Inductive Coding)

The research here aimed to explore the kinds of questions that teachers asked and why through analysis of observed practice. The starting point was to examine some previously-used frameworks developed to explore teachers' questioning in mathematics lessons. As reviewed in the literature, this study adopted Denton's (2013a) classification of teachers' questioning (Appendix 14) which was a combination of the Mathematical Assessment Task Hierarchy taxonomy framework (MATH taxonomy framework) (Smith et al. 1996) and Andrews et al. 's (2005) mathematical foci, supported by mathematical prompts proposed by Watson (2007) and Hodgen and Wiliam (2006). The reasons are explained below.

Firstly, and most importantly, it fitted the research purpose, which was to analyse the types and purposes of teacher questioning. Being constrained by the use of classroom observations, with no access at that point to what those teachers may have been thinking or intending, I could only infer what mathematical knowledge was emphasised by the teachers, together with a follow-up individualised semi-structured interview. This framework was felt to be a useful tool for analysing the intended mathematical thinking.

Secondly, this framework was designed specifically for classifying questioning in a mathematics classroom context, a key characteristic of which was that mathematical understanding was not necessarily a linear progression (Sfard 1991). For instance, in an example by Gray and Tall (1994), 2 + 3= 5 involved two strategies; the count-all strategy 3 + 2 involved the procedure of one, two, three plus the procedure of one, two. In the count-on strategy, meanwhile, 3 + 2 involved the concept of three plus the procedure of four, five. According to them, the count-on procedure was a more sophisticated strategy than the count-all process. The differences between these learning strategies seem to suggest that mathematics is quite distinctive to other subjects, and therefore so is mathematics questioning.

Some other common classifications of teacher questioning in the literature were not used in the analysis. For instance, there is a distinction between open and closed questioning. The former only have one clear answer (e.g. what is 4 + 3?), whilst the latter have a number of possible answers (e.g. what two numbers multiplied make 35?). However, as mentioned previously, this classification is too simple, because a closed question can sometimes do better than an open question in offering students the chance to adapt, extend and refine their personal understanding of mathematical concepts (Watson 2007). For example, a closed question '*what is the lowest common multiple of 6 and 8?*' is helpful in reinforcing the concept of lowest common multiples. Another widely used classification of questioning is the use of cognitive level of questions which originally stemmed from Bloom's taxonomy (Bloom et al. 1956). However, as reviewed in the literature, mathematical thinking does not follow the hierarchy of Bloom's taxonomy. Most importantly, all these classifications have tried to categorise teacher questioning from the perspective of learning outcomes, which neglect to address disparities between what teachers intend to teach and what learners might actually learn.

There were also limitations when adapting the analytic framework of Denton (2013a). Firstly, this framework only examined each of the questions in isolation without considering the broader discourse context. Thus, it failed to show how teachers might influence learners' verbal engagement and mathematical conceptual development through a sequence of their questions. In other words, it looked closely at what kinds of questions were asked but eventually lost sight of how these questions were posed. However, this issue could be addressed in later analysis of sequences of teacher questions.

The starting list of codes was adapted from Denton's (2013a) questioning framework. This was to address the sub-question concerning the 'types of questioning' in research question 1. The analysis procedure contained two parts: 1) Identifying all teachers' questions and responses from each instructional lesson for analysis, 2) Analysing transcripts of observations to determine initial codes.

Type of comparison	**Procedure**	**Expected outcomes**	**Questions**
Select teachers' questions in mathematics	Identify all teachers' questions for analysis Develop initial lists of codes from previous research	To identify all teachers' questions in a mathematics context	What were the questions asked by the two groups of mathematics teachers observed?
Identify and classify all questions into different types	Complete initial coding of observation transcripts	To categorise the types of questions observed	What kinds of questions did they ask? Why did they ask these questions on the basis of their mathematics focus? How do these question types meet the criteria of the initial list of codes?

Table 3.4 Three steps of analysis for research question 1

Research Question one

For the initial phase of analysis pertaining to question 1, the audio recordings from each lesson observation were all transcribed verbatim. Research question 1 focused on teachers' questioning practices in whole-class settings. To consider a teacher's question, the research focused on a teacher's utterance that had the grammatical and intonation form of a question, whether they were for the purpose of eliciting information about students' knowledge or thinking or were social acts for keeping students' attention. The whole-class settings in this study were the focus of the analysis: small-group teacher-student interactions were not studied in this research due to the constraints of audio recordings. Thus, questions to the whole group were selected from each observation to analyse. Following Denton's questioning framework (2013a) in table 2.3 above, every single question was coded into appropriate categories. In the process of coding these questions, some clearly fell into more than one category. For example, in one lesson focused on finding X using the knowledge that the sum of all inner angles in a triangle is 180 degrees, teacher 9 and their students spent quite a long time going through this mathematical concept, and the teacher gave students time to think about all three questions written in the textbook. He then asked students to follow the procedure, and to find the third angle X, practicing the mathematical concepts just learnt.

Excerpt 1

Line 1 T: 对答案！第一道大题全部是用三角形内角和180！第一小题 x=33度，对吗？

Line 2 SS：对.

Line 3 T：第二小题x=60度。第三个x=？

Line 4 TS：54度.

Line 5 T：第四个x（SS60）加起来等于180，求出来x等于？

Line 6 SS：60度.

Line 1 T: Ok, let’s get to the answers. The first question is using that the sum of inner angles of a triangle is 180 degrees. So the first small one x = 33 degrees, right?

Line 2 SS: Right.

Line 3 T: The second one x = 60 degrees. What about the third one x =?

Line 4 TS: 54 degrees.

Line 5 T: The fourth one x? All added on is 180 degrees, so the x equals?

Line 6 SS: 60 degrees.

(some questions being assigned to multiple codes[2])

The teacher’s question (line 1) was coded under ‘*classroom management*’, then sub-coded into ‘*activity management*’. The teacher’s questions (line 3 and line 5) were both coded as ‘*procedural questioning*’, and then sub-coded into finding answers following a procedure.

Additional codes also emerged through the data analysis, as described in Table 3.5 below. These emergent categories all came under ‘*classroom management*’, which

[2] In subsequent examples of excerpts, only translated English version of observation transcripts will be given, but it should be noted that data analysis was originally done on the Chinese text.

provided a richer description of teachers' questions and responses. An example of the use of questions in these categories can be seen in Appendix 15.

Categories of questions	**Sub-codes**	**Features**	**When used**
Classroom management		Questions or statements used in response to students	Used to maintain and manage a classroom environment
	Redirect/ activity management	Teacher responds to a student comment or acts (behaviour) with the goal of keeping students engaged with the learning tasks	Used to manage students' behaviours Used to redirect questions to other students
	Relationships	Teacher responds to students in order to relate to them and build relationships outside of the content area	Used to provide students with affective support

Table 3.5 Questions related to classroom management

The Analysis of Approaches to Teacher Questioning (Inductive Coding)

It is clear that an analysis of types of questions can only reveal part of the overall approach used by each teacher. Of equal importance are the ways in which these teachers structured and sequenced their questions. An analysis of these aspects might, it was hoped, reveal important aspects of teachers' questioning strategies. The research thus also attempted to use a discourse analysis approach (Sinclair and Coulthard 1975) to analyse the teachers' questioning. Instead of focusing on isolated questions, the main unit of analysis here was of content units (Hsu 2001). This concept, developed and modified by Hsu (2001), highlights the content or topic of a question in relation to the discourse context in which it occurs. According to Hsu (2001: 62), '*a content unit is a piece of discourse that consists of a main question and all the verbal moves made by classroom participants that are directly related to that question in content*'. In other words, a content unit may not only include a question-answer exchange but might go beyond into the sequences of connected talk associated with a main question. The following extracts offered a good example of a content unit:

<u>*Except 2*</u>

T:	*How do we describe this equation using the mathematics language? What equals what, right? So S2, it is what equals what?*
S2:	The cost of a previous call equals the cost of a later call after price was dropped.
T:	*Ok, so it is what of the previous call? (LP) What exactly?*
S2:	The cost of a call.
T:	*What?* <u>*Is it the cost of a previous call?*</u>
SS:	Length of a call.
T:	*Is it call cost or length of a call?*
SS:	Length of a call.
T:	*S3, you tell me, is it the call cost or length of a call?*
S3:	Length of a call.
T:	*So what about the call cost? What does it mean in here?* (LP) *What is the cost of a previous call?*
SS:	6 yuan.
T:	*6 yuan, how about a current call?*
SS:	6 yuan.
T:	6 yuan. *So when you use this equation, it equals 6, does it matter which equation?*
SS:	No, it does not.
T:	It does not matter. *So here it means the previous what?*
SS:	Length of a call.
T:	Length of a call. Ok, now S3. *What is the relationship between the previous length of a call and current length of a call? (SP) equals the present length of a call to do what? (SP)*
SS:	Minus 5.
T:	*What happens?* S3, you say it.
S3:	Add 5.
T:	*Add 5?*
SS/S3:	Minus 5.
T:	Minus 5. *So which one is more? The previous one or the current one?*
SS:	The current one.

T:	The current one. *So the current length of a call minus 5 equals the previous length of a call?*
SS:	yeah.
T:	Ok, so this is the equation I want you to find. We answered the first questions (PO S2 to sit down).

In this extract, there was only one content unit, and teacher 1 initiated only one verbal conversation. The content unit was related to the main question: '*How do you describe the equation in mathematics language*?' As shown in the transcription, this main question generated other following up probing and prompting questions, such as '*what about the call cost? What does it mean here?*' These questions together with the responses that they elicited were all related to the main question in content. Using discourse analysis and content units for data analysis would, it was hoped, help elicit and understand the functions and patterns of teacher questioning, which would not able to be found simply through the analysis of single and isolated questions.

3.10.3 Analysis of Interview and Coding Structure

The aims of conducting individual interviews were two fold. Firstly, they were designed to examine the findings emerging from the classroom observations, with the aim of clarifying the issues emerging from the analysis of classroom observation and providing the teachers' own perspective to inform my interpretations of the questioning behaviours observed. Secondly, there was an attempt to understand the differences and similarities between teachers in England and in China in their beliefs, values and feelings about questioning. They were also designed to focus on understanding the differences and similarities between teachers' beliefs and their practices related to the use of questioning in the teaching of mathematics to Key Stage 3. Therefore, this research firstly explored teachers' beliefs from individual interviews across country level to explain and explore the similarities and differences between teachers' beliefs in England and in China. It then examined the differences and similarities between the beliefs and practices in the use of questioning within each country.

In the process of analysing teachers' interviews from the two groups, I applied an inductive and deductive approach, in which some of the themes were taken from classroom observation to be included into interviews such as the sequences of questions and strategies of questioning. There was also a semi-structured interview guide to follow at the start of analysing the interviews (Appendix 2 and Appendix 3). Alongside the analysis of the interviews using Nvivo (an example can be seen in Appendix 16), new issues were emerging from the data, therefore, I worked to refine the codes and sub-codes back and forth in a process of inductive and deductive coding. The interview guide (Appendix 2) consisted of six sections, including information on teachers' backgrounds, their values, the frequency and purposes of their questioning, their ways of sourcing and preparing questions, the cognitive level and types of questions, their language and manner in questioning, their perceptions of students' ability and how their questioning might vary. Themes stemmed from these sections.

3.11 Summary

This chapter has discussed the methodology of this study including the research plan and design, data collection, and data analysis. Interpretivism and Social Constructivism were the theoretical principles underpinning the aims of this research and the nature of research questions. Qualitative research consisting of classroom observation and interviewing was adopted in this study in order to provide thick descriptions of teacher questioning beliefs and practices in England and China, and also to cross examine the relationship between teacher beliefs and practices in questioning. Issues of ethics were also carefully considered throughout the research. The next chapter will present the findings from both classroom observation and interviewing in order to give a clear picture of the similarities and differences between England and China in teachers' questioning practice and their beliefs. Discrepancies and convergences between teachers' beliefs and practices in questioning will also be revealed.

Chapter Four Findings

4.1 Introduction

This chapter will present the findings from the observations and interviews. It firstly will explore the observations showing the differences and similarities in the two groups of mathematics teachers. Following this, the findings from interviews describing teachers' beliefs and reflections about questioning will be presented from a cross-cultural perspective. Finally, the convergence and divergence between teacher beliefs and practices of questioning in the two nations will be presented at an intra-country level, and then at a cross-country level.

4.2 Findings of Classroom Observations

4.2.1 Frequencies and Types of Teacher Questioning

The following analysis aims to categorise the types of questions that these teachers asked in the observed lessons and the intended mathematical thinking they appeared to be encouraging based on their observed questioning practices. Using the analytical framework presented earlier, the comparisons between England and Chinese teachers are described in terms of the frequency and variety of questions asked in the following sections. Table 4.1 shows the frequencies and percentages of each type of questioning for both groups of teachers.

Category	**England**		**China**	
	Frequency	**Percentage of total questions asked**	**Frequency**	**Percentage of total questions asked**
Factual questioning	158	19.3%	677	31.1%
Procedural questioning	604	73.8%	868	39.9%
Structural questioning	19	2.3%	286	13.2%
Reasoning questioning	90	11.0%	122	5.6%
Reflective questioning	5	0.6%	25	1.2%
Derivational questioning	10	1.2%	112	5.2%
Classroom management	574	70.2%	1471	67.7%
Clarification	80	9.8%	22	1.0%
Total (including non-academic questions)	818		2173	
Total per teacher	1 question per min		4 questions per min	

Table 4.1 Frequencies and percentages of questions in each category

Notes: some questions were assigned to multiple codes.

In the whole-class settings observed, all 12 Chinese teachers together asked a total of 2173 questions, with each teacher's lesson lasting about 45 minutes. The average frequency of questioning was therefore 4 questions per minute per teacher. All 11 teachers in England together asked 818 questions in total, with each teacher's lesson lasting about 60 minutes. The frequency of questioning was thus 1 question per minute per teacher. It was clear that both groups of mathematics teachers asked a large number of questions in lessons, and mathematics teachers in China appeared to be asking many more questions than those in England.

As table 4.1 indicates, most of these teachers' questions fell into three categories: classroom management, factual questioning, and procedural questioning. In these three categories, the proportion of classroom management questions in England and Chinese classrooms seemed to be more or less the same, as both accounted for nearly 70% of the overall questions. The findings between factual and procedural questioning in England and China showed an important difference, however. Factual questioning in the Chinese classrooms seemed to be twice as prevalent as factual questioning in classrooms in England, whereas procedural questioning in classrooms in England appeared to be twice that in the Chinese classrooms. As mentioned above, classroom management questions from both groups took up nearly 70% of the overall teacher questioning. Such high frequencies of classroom management questions suggested that there was a big overlap between questions aimed at classroom management and other categories of questioning such as factual questioning and procedural questioning. The following two classroom extracts attempt to show what I mean by the overlap between different categories of teacher questioning.

<u>*Excerpt 3*</u>

T:	*Rhombus, do you remember?*
SS:	Yeah.
T:	*Right?* Parallelogram has the particular situation. *Rhombus has four sides which all have the same length, but its four angles are not the same, right*? So the correct answer should be B.

In the conversation above, teacher 10 asked if students remembered facts about a rhombus, which was asking for their factual knowledge (coded as 'facts' under 'factual questioning'). But in this context, '*do you remember?*' also was used by the teacher to manage the classroom (coded 'activity management). The other question, ‘*Rhombus has four sides which all have the same length, but its four angles are not the same, right?’* was also coded as both ‘*factual questioning’* and ‘*classroom management’*. The reason for coding it ‘*factual questioning’* was that the purpose of asking that question was ostensibly to check students’ understanding of previous knowledge. Nevertheless, in the context, it was also being used to keep members of the class on track in their thinking – the ‘*right*?’ at the end of the sentence was not really intended to elicit a response, but acting as a classroom management tool, and thus was coded as ‘*activity management’*.

<u>*Excerpt 4*</u>

T:	Who *can remember what the first thing we need to do, when doing a trigonometry question?* Yes. S6.
S6:	You label it.

In the excerpt above, teacher B posed a question ‘*who can remember what the first thing needs to do when doing a trigonometry question*?’ This question was also coded into two categories: ‘factual questioning’ and ‘*classroom management*’. Under ‘*factual questioning’*, it was coded as *‘facts’*. Under *‘classroom management’*, it was coded as *‘redirect management,’* as it was directing the question to a specific student.

Both questioning excerpts from England and Chinese contexts indicated that there was a level of overlap in categorising these questions into different types. The importance of this will be discussed in greater detail in the discussion chapter.

4.2.2 Patterns and Strategies of Teacher Questioning

Wait Time

Wait time in this study refers to the period of silence between the time a question is asked and the time when one or more students respond to that question (Rowe 1974; Ingram and Elliot 2014). The study has examined the length of wait time in both groups of teachers in England and China. The research followed the 3 seconds criteria, therefore, it coded wait time into two sub-codes: LP for wait time longer than 3 seconds, and SP for wait time shorter than 3 seconds. The results can be seen in the table 4.2 below:

Wait time in length	England	China
LP	205 (25.2%)	92 (4.2%)
SP	613 (74.9%)	2081 (95.8%)

Table 4.2 Wait time of both groups of teachers in England and China

As illustrated in the table above, the majority of the lengths of wait time in both groups of teachers were shorter than 3 seconds (613 out of 818 questions, 2081 questions out of 2173 questions). In examining the number and percentage of questions which were followed by wait times of either LP or SP in England and in China, in the case of the Chinese teachers nearly 96% of their questions were followed by less than 3 seconds in wait time, whereas 74% of teachers' questions in England were followed by a wait time of less than 3 seconds. It appears that the teachers in England offered a rather more extended wait- time than their Chinese counterparts. The following two examples were taken from a classroom in China and in England respectively (Excerpt 5, Excerpt 6).

Excerpt 5

T: Let's have a look at this equation with fractions, *can you tell me what difference it has to the 2-variable line equations?* S15, you tell me, *what differences do you see from your observations?*

S15: (1s) Fractions.

T: *What do you mean by fractions?*

S15: (1s) On both sides of the equations.

In this extract, the student, following a wait time of one second, initially gave an answer of '*fractions*'. Then following her answers, the teacher 1 asked her to clarify allowing one second for the student to think before she started to elaborate on her own answer. Following each pause, the student had expanded her answers to make it more specific.

Excerpt 6

8 – 6 = 2

T: S1 *please tell me one way you did it.*

S1: (1s) 6 takes away 8.

T: *Are you going into minus numbers or do you mean 8 takes away 6?*

S1:	(2s) … 8 takes away 6.

In this example above, after the teacher's question, S1 gave a response after one second of wait time. In response to the teacher's follow-up question, the student corrected herself, after a pause of two seconds. The two examples above are meant to show the lengths of wait time less than 3 seconds in both contexts.

Another interesting finding was that in most of the Chinese classrooms, the students appeared to be answering the teachers' questions in unison, that is, they self-selected themselves to answer teachers' questions without the teachers giving an allowance on the length of wait time, as can be seen in Excerpt 7 below.

Extract 7

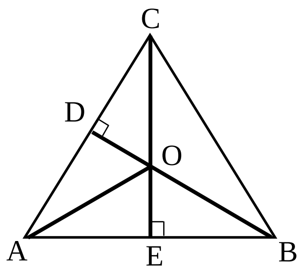
T:	What is the sum of inner angles of a triangle?
SS:	(1s) 180°.
T:	Good. 180°. The second question, why is the sum of inner angles of a triangle 180°?
SS:	(1s) Prove it.

In the interaction above, the teacher did not select any individual students to answer her question. So students self-selected and answered the questions in unison, with very short responses consisting of one or a few words. In the questioning process, the length of wait time appeared to be very short, less than 1 second.

Longer Wait Time was given during Individual Seat Work or Group Discussion

The observations revealed that all the 12 teachers in China and 10 out of 11 teachers in England tended to deliberately give students a set of time (5-10 minutes on average) for students to discuss possible answers in a group or to work out individually before asking them to answer questions. Excerpt 8 and excerpt 9 were two examples taken respectively from a classroom in China and in England respectively as below.

Excerpt 8



Question No. 15: as shown in the triangle, CE⊥AB at point E, BD⊥AC at point D. BD and CE crossed at point O, and AO is the angle bisector of ∠BAC.

To prove: AB=OC

T: Now I want you to do this question No.15, at page 28 in your practical book. Off you go!

Excerpt 9

Numbers nearest 10, nearest 100, nearest 1000

6701

3289

5377

3042

T: From the table we did yesterday in class, and I will put it up on the board. I am going to give you five minutes to do the tens and the thousands.

In excerpt 8, teacher 11 and the students took out their practice book, the teacher picked up a question, question No. 15, which was asking students to demonstrate how two line segments were equal. Facing a mathematical question involving many steps to the solution, the Chinese teacher gave five to ten minutes to the students to think of possible answers individually and to write down in their homework. Similarly, in excerpt 9 above, the teacher in England wrote down a few numbers on the board, and she also deliberately gave the students five minutes to discuss and consider their answers within their groups.

Questioning Distribution Strategies

It was found that the teachers in England and in China demonstrated distinctive questioning distribution patterns, in that all 11 teachers in England indicated their strong preference in using hand-up strategy. For instance, at the start of one teacher's lesson she asked '*can someone remind me what we did yesterday? Hands up (teacher A)!'* Similarly, in another teacher's lesson, she started asking '*can somebody tell me,* *by putting up their hands, obviously not shouting … (teacher H).'* Conversely, all 12 Chinese teachers predominantly used no-hands rule in their questioning: the teachers posed questions to the entire class, with students answering altogether in unison. A good example can be seen in excerpt 7 above.

Despite their predominant use of the two strategies described above, it was found that all the teachers from both countries also shared another questioning distribution strategy-nomination. For the teachers in England, they sometimes nominated students who did not put their hands up, and for the Chinese teachers, they nominated students by their names (see Excerpt 10 below).

Excerpt 10

On the board, teacher 3 wrote the question down:

K = p – q / s,

1)	k, s, q are known, to get p.
2)	k, p, q are known, to get s.
T:	I am going to ask two people to write on the board … Ok, I am going to pick up someone to answer, S3 and S4 please come up to the board to write down your answers.

Hands Up for Checking Understanding or the Progression of Their Work

10 out of 12 Chinese teachers and 7 out of 11 teachers in England were found to be frequently asking students to put their hands up to check students' understanding or the progression of their work. For instance, in Chinese teacher 3's lesson, she asked '*has anyone worked out?'* to students only to help her understand how students were getting on with the working out and to keep the lesson moving. In another example from teacher 11, she asked students to do some individual seats work, and after a couple of minutes, she asked '*hands up if you have finished this question No.12?*'

Questioning through the Use of Mini Whiteboards

Apart from asking students to put their hands up, 8 out of 11 teachers in England also employed the mini whiteboards for checking understanding of the entire class. The following is an example of using mini whiteboards in lesson.

Excerpt 11

T:	We're going to try some on mini whiteboards … 39 divided by 3 <u>remember I don't want you to shout out</u>, I just want you to write on your board. Remember don't shout out, just write it on your board and then show me.
T:	Right, let's see all answers 3, 2, 1.
SS SW on mini whiteboards	
T:	Lovely, bus stops in the room, good. 3 into 39, good. 1, 3.

As shown in the above extract, teacher F and students were practicing what they had just learnt which was to divide by a single digit. All students were given time to write down answers on the mini whiteboards, and then present to the teacher, so she could see if they had all got the answer right.

Questioning Patterns and Strategies

Individualised vs. Collective Questioning

One distinct difference lay in the number of students involved in the teacher's questioning, which illustrated two opposite questioning patterns. The questioning pattern used by Chinese teachers often was described as collective questioning, whereas the questioning pattern of teachers in England was more likely to involve individualised questioning. From table 4.1 above, it can be seen that all 1l teachers in England together asked a total of 569 individual questions compared to the 225 of questions to the class, whereas the 12 Chinese teachers altogether only asked 375 individual questions compared to 1796 questions to the class.

Questioning to the entire class, as the predominant form, involved more than one individual student. Even though Chinese teachers did ask questions to individual students, their questions were not individual-centred, since during this questioning process their eyes were still looking at the entire class rather than having eye contact with that individual alone. Along with the question-answer exchanges, the teachers' follow up questions with the individual were shared and answered among all students in the class, and eventually the teachers and students together all came to answer the questions. The excerpts below (Excerpt 12 and Excerpt 13) are typical examples of questioning to the entire class, and questioning to individuals involving the rest of the class.

In a lesson on finding the sum of interior angles of a polygon through the numbers of diagonals, teacher 10 asked students to fill in a table below, inside which the polygon was given, and they were asked to solve the number of triangles in each polygon and the sum of interior angles. The first one was a triangle, so the number of triangles was one, and the sum of their interior angles of a triangle was 180˚. This had been learnt previously. Then the teacher and students moved on to the next question in the table below, which was a quadrilateral. That was when the following conversation started:

<u>Excerpt 12</u>

Polygon	**A triangle**	**A quadrilateral**
Number of triangles	1	2
Sum of interior angles	180°	360°

T: *What is the sum of interior angles of a quadrilateral?* A quadrilateral has two diagonals, and can be split into two triangles, *so the sum of interior angles is []?*

SS: 360°.

T: *How about a pentagon? How many diagonals does a pentagon have? How many diagonals can we draw from one point?*

TS: Two.

In this short interaction above, when teacher 10 posed a question, students shouted the answer '*360°*' out in unison. Following the response from the class, she then moved on to the next question about a pentagon and the number of its diagonals.

This distinct pattern of questioning to individuals involving the entire class was only found in Chinese classrooms. Every single teacher observed adopted this questioning strategy, and used it multiple times in their lessons. Teacher 6 asked students to solve a practical mathematical issue choosing sampling strategies in the textbook.

<u>Excerpt 13</u>

In order to know the eye health of all students from secondary schools across the nation, someone presented the following three sampling methods:

1. To get eye tests for all secondary school students
2. To get eye tests for students from one secondary school

3. On the country level, for the first, it is to divide the country into five areas: east, west, south, north, and middle. Secondly, it is to pick up 3 secondary schools from each area. Thirdly, it is to get eye tests for all students from these 15 secondary schools picked.

Which sampling method do you think it is the most appriopriate?

T:	So, someone presented these three sampling methods in order to understand the vision situation of all secondary school students across the country. *S4, which one do you think?*
S4:	The third one.
T:	Ok, you think it should be the third one, *tell me why don't you choose the first one?*
S4:	*Because the first one is too big to get eye tests for the entire country.*
T:	It is too big to do so.
S4:	And if.
T:	*Any other reasons not choosing the first one?*
S4:	If choosing one, it is going to be too complicated to run throught out the country.
T:	*We are not going to deny this, but to make a comparision, right? What kinds of issues would rise if we get eye tests for the entire country?*
SS:	Waste of time.
T:	Waste of time. Some students are right. *What do we waste?*
SS:	Waste of energy, waste of people and waste of money…
TS:	Waste of money.
T:	Waste of *people. Right?*

We can see that, teacher 6 initially called an individual student, S4, to answer his questions. As he continued questioning S4, he set his eyes on the rest of the class,welcoming others to join in this process. In the end, the individual student, teacher and the rest of the class all said their answers in unison. Teacher 6 also followed an agenda which made him prioritise some student responses such as '*waste of money, and waste of people'* but ignored responses such as '*waste of energy'*.

On the contrary, the English mathematics teachers asked their questions mostly at an individual level, sticking to one individual student, and keeping eye contact with that individual student until they finished answering the questions or came to the right understanding. During the entire questioning process, no other students were allowed to interrupt the interaction between that individual student and the teacher, even when the individual student's answer was incorrect. A classic example can be seen below in Excerpt 14. In one lesson on grouping different cubes and a list of numbers to make a square, rectangle and stick, teacher J had given each group a set of different tasks to complete. As they were looking at the square 4 on the board, the following conversation ensued.

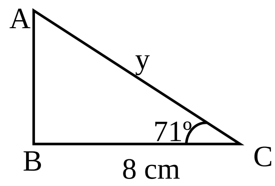
<u>*Excerpt 14*</u>

T:	*S7, how's that 4 made up on the board? How many rows*?
SS:	(Inaudible)
S7:	Erm (Inaudible).
T:	No, <u>that S7 I'm talking to</u>. *The 4, S7, how many rows has it got?*
S7:	2.
T:	*2 and how many columns has it got*?
S7:	2.
T:	*Yeah, it's 2 by 2 isn't it?* 3 by 3. 4 by 4. *What would the next square be? 5 by?*
S7:	5.
T:	5, well done.

In the excerpt above, teacher J emphasised her individualised questioning by saying '*that, S7 I am talking to'*. After S7 finished the questions, she concluded this through praising him for his contributions.

What is more, they also often began by asking questions based on the tasks for all the students, but soon followed this with individual students. Depending on how well they answered the questions, their follow-up questions were frequently modified according to the student's response. In one lesson on Pythagoras' problems, teacher B asked S10 to answer question 2 (*written on the board).* S10 said '*I do not know*', so teacher B adjusted her questions, and led S10's thinking process throughout as shown below.

Excerpt 15



Question 2:

$\angle C = 71^{\circ}$, BC = 8 cm, get y.

T: Ok and Question 2 please. Let's have:: S10.

S10: I don't know.

T: Right, that's what I'm asking you to do. First you've got to label the sides.

S10: A and H.

T: Means the hypotenuse on this side. (PO) *What is 8?*

S10: O.

T: *Why O*?

S10: Because it's the shortest one.

T: No. O means opposite the given angle. *Is the 8 opposite the given angle?*

S10: No it's the other one.

T: *Ok so what's the 8?*

S10: A.

T: A, the adjacent, good because it's next to the bigger angle. Right, now we write out sohcahtoa. *So are we wanting Sin, Cos or Tan?* We've got the adjacent and the hypotenuse.

S10: Erm, I don't know.

T: *Which one has got the adjacent and the hypotenuse in? Is it Sin, Cos or Tan*?

S10: The middle one.

T: *The middle one which is what?*

S10: I don't know.

T: *The middle one which is what? Sin, Cos or Tan?*

S10: *Cos.*

T: Cos, lovely.

In the excerpt above, S10 replied '*I do not know*' seven times after the teacher's question. No matter how many times S10 gave this reply, teacher B insisted on sticking to questioning her until she eventually came to the final answer. Every time S10 replied with '*I do not know*', teacher B made sure to probe and challenge her understanding through a series of guiding, prompting and probing questions.

Check the Understanding of the Entire Class through Student Representatives

Another distinct questioning strategy observed in 7 out of 12 Chinese teachers' lessons was where they posed questions to a series of students, with some answering correctly and some answering incorrectly. The following excerpt is a typical example. The lesson was based on examining an example from the textbook using a fractional equation, teacher 1 and their students went through the steps of this example together, and the teacher wanted to make sure the students had understood the use of the fractional equation in practical mathematics.

<u>*Excerpt 16*</u>

Example 2 (written on the textbook): To solve: (2 - x) / (x - 3) = 1 / (3 - x) - 2.

So: Both sides of the fractional equation times (x - 3), get 2 - x = -1 – 2 (x - 3). To simplify, get x = 3. Bring x = 3 into the original equation to check, the result is the original fractional equation's denominator equals 0, thus the fraction has no meaning, so x = 3 is not the answer for the original formula, the original fractional equation has no answer.

T:	Let's have a look at this example, *is it a fractional equation?*
SS:	Yeah.
…	
T:	*What is the first step?*
SS:	To remove denominator.
T:	To remove denominator, I have demonstrated to the class. Ok, *how to remove denominator? S23.*
S23:	To times the common denominator.
T:	Times the common denominator. *Where to times the common denominator?*
S23:	Both sides.
T:	Both sides of fractional equation, *so what is the common denominator?*
S23:	(x - 3) (3 - x).
T:	x - 3 times 3-x. That is very good. *Ok, S24, what do you say?*
S24:	It is the square of (x - 3).
T:	Ok, the square of (x - 3). Now, stand! *S25.*
S25:	Put (3 - x) into –(x - 3).

T: *Which becomes a minus []?*

S25: x - 3.

T: *Put 3 - x into - (3 - x)? Or put x - 3 into – (3 - x)? Why do you see the minus?*

S25: Because x - 3 and 3 - x are inverse numbers.

T: *Did you guys standing up hear that? Including those sitting down heard clearly? He said because x - 3 and 3 - x are what?* <u>Inverse numbers!</u> So he decided to take one out into minus. *Either one works that way right?*

SS ND

In this excerpt, the teacher firstly asked S23 and S24, who gave incorrect answers, then she redirected the same question to a third student S25. Following his correct answer, the teacher asked follow-up probing questions to get him to elaborate on his ideas and to explain the point that '*x - 3 and 3 - x are inverse numbers'*. Then the teacher asked questions to the entire group and made sure that the rest of them had all heard this answer. She also went back to S23 to check if she had understood by asking the original question '*what is the common denominator?'* and asked her to give the final answer to this fractional equation.

This questioning pattern was later explained by the Chinese teachers in their follow-up interviews, and was then identified as a theme.

Differentiating Questions or Not

It was found that the teachers in England tended to differentiate the difficulty level of questions according to their estimates of students' abilities (see Excerpt 17). In contrast, no differentiations were found in the Chinese teachers' questions and all students were given the same questions at the same time.

For example, in one school, all 9 teachers used a paper sheet in their lessons, in which questions were differentiated into 3 types, including MUST, SHOULD, COULD. MUST questions were the easiest ones that all students could do including the lowest level students; SHOULD questions were slightly more difficult than MUST ones, which some students may be able to do; COULD questions were the most difficult ones which only a few high ability students could do. The teachers allowed their students to choose the questions which they wanted and were capable of doing from the three types of questions. The students were also allowed to move from one type to another freely as long as they felt they were capable of this. In doing so, every single student was provided with a chance to answer the questions that suited their level of ability. In one lesson on how to use types of angles to estimate and measure angle sizes, teacher D explained to the students to choose whatever questions they wanted to do in a worksheet, the conversation went as follows:

Excerpt 17

T:	I'm going to give you a worksheet and a table… So I'm not telling you which questions you want to do, you can pick them yourself. You might do some must, some should, some could, but whatever question you do, make sure you write the letter of it. So if you're doing A, you write A there. *You're going to then tell me what the type of angle is, so is it a reflex, is it obtuse, is it acute etc, and then you're going to estimate the size of it.*

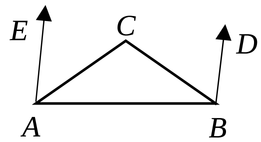
Questioning for Students' Explanations through Presentations and Demonstrations on the board vs. through Why Questioning

From lesson observations, it was found that the teachers in the two nations also demonstrated very distinctive questioning strategies in getting students to explain themselves regardless of right or wrong answers.

9 out of the 12 Chinese teachers observed frequently asked their individual students to come to the front to write their answers down on the board, and to explain to the rest of the class loudly and clearly how they solved the mathematical question step by step, with the expectation that all of their peers could follow their reasoning and checking against their own. In the process, these individual students were facing the entire class, to explain to their peers, and their peers demonstrated active participation by asking questions in the process. The role of the teacher here was only monitoring the flow of the lesson and monitoring the students' thinking and understanding. Through this process, the lesson turned into a student-led lecture. 9 of the Chinese teachers observed used this strategy a total of 30 times between them in their lessons. In teacher 9's lesson, she used this approach 5 times.

The following example is illustrative of teachers giving authority to an individual student and letting them lead the lesson. In teacher 9's lesson on the practical use of the theorem that the sum of the interior angles in a triangle is 180˚, a worked example was presented in the textbook, so she was asking for alternative methods for solving this mathematical problem. S4 was called up to the board to present and explain his method to the entire class. This is how the following conversations started:

<u>*Excerpt 18*</u>



In example 2,

As shown in the picture, island C is located at 50˚ on the north east of island A. Island C is located at 40˚of northwest of island B. *From island B looking at island A and C, What degree will ∠ABC be? And what degree will ∠ACB be?*

S4: Because ∠DAB = 80˚, and ∠DAC = 50˚. Thus ∠CAB = 30˚.

T: Ok, *did you guys understand what S4 just said that, did you guys understand what S4 just said that, did you guys understand what S4 just said, that ∠CAB = 30˚?*SS: Yeah.

T: S4, you can continue please.

S4: Because line AD and BE are paralleled, thus ∠BAD + ∠ABE = 180˚.

T: Ok, I am going to be his assistant, now, *S4 just said that the two lines are parallel, right? Then the two angles are supplementary angles (PO to S4's answers). Do you mean this S4?*

S4: Yes.

T: Ok, continue please.

S4: Because ∠DAB = 80˚, thus ∠ABE = 100˚.

T: *Do you all agree with that?*

SS: Agreed.

T: Good, 100˚, that is correct.

S4: Because ∠ABE = 100˚, 100˚- 40˚, then ∠ABC = 60˚.

T: Ok, he said this ∠ABC is 60˚. *Did you understand?*

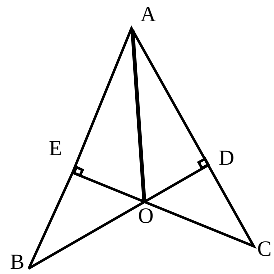
SS: Yeah.

T: Ok, S4 please continue.

In the transcript above, when S4 was giving his presentations on the board facing the entire class, teacher 9 made sure that the rest of students were following his thinking and understood what he meant by his every move in solving this case, through questions to the rest of the students such as '*did you guys understand what S4 just said? Do you all agree with that?*'

Another example occurred in which individual students gave wrong answers and wrong explanations on the board. For instance, in one lesson on angle bisector theorem, teacher 11 asked students to work out the following mathematical problem:

<u>*Excerpt 19*</u>



Example No. 12: As shown in the picture, CE⊥AB at point E, BD⊥AC at point D. Lines BD and CE intersect at point O, and AO is the angle bisector of ∠BAC. To prove: OB = OC

T: *Who would like to write down their answers on the board?* S9!

<u>*(S9 WT his solutions on the board)*</u>

T: Now *let's have a look at how S9 solved this? (Looking at S9's answers on the board.)*

In this excerpt, teacher 11 started looking at S9's answers but failed to understand these answers. S9 then explained to the entire class how he came to his answers step by step. As he explained, teacher 11 asked questions to the entire class such as '*do you understand here?*' whenever she saw that students seemed to be puzzled or confused. Teacher 11 then stopped S9, and posed the question '*he said because AO is the angle bisector of ∠BAC. Thus these two angles are the same, right?*' and explained more explicitly what S9 had explained. After a few questions asking S9 for more elaboration on his steps to solve the problem on the board, he came to discover that the last few steps were wrong. Teacher 11 then stepped in to explain the steps:

T: Because of the angle bisector theorem, segment OE thus equals segment OD. *And also together with the right angle, and opposite angles, so we can see []?*

SS: Congruent triangles.

SS: ASA.

T: *Yeah, then using ASA, we can prove △BOE and △DOC are []?*

SS: Congruent.

Then teacher 11 concluded this question with a summary.

The excerpt above shows that, when S9 gave incorrect answers on the board, teacher 11 posed some provoking and prompting questions, further leading him to identify his problems himself. In the end, S9 provided the teacher with the answer and the teacher asked a series of prompting questions to check students' understanding.

However, no students were called upon to give their explanations and answers on the board in the English classrooms at all, except one student who offered to write the answer on the board in a lesson of teacher H. Instead, all 11 teachers asked the individual students they questioned verbally to explain why and how they had arrived at their answers through 'why questioning' (see examples below in Excerpt 20 and Excerpt 27).

<u>*Excerpt 20*</u>

T: 'It is 161 days until Ben's birthday, *how many weeks are there?' What did you have to do S14?*

S14: 161 / 7.

T: 161 / 7. And that is because, *why did you say that? Why did you divide by 7?*

S14: 7 days.

T: Good, we have 161 days, we know there 7 days a week, so to find out how many weeks there are, you need to divide by 7. *What did you get?*

S14: 23.

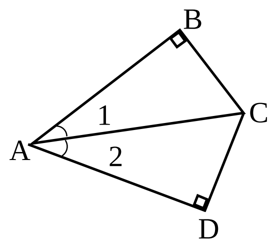
T: Good, 23, give yourself a tick.

As we can see above, a lesson on dividing a triple digit number by a single digit, after S14 gave the answer, teacher F followed up with a question 'why'. S14 then explained '*7 days'*. Then she wrapped up the question with praise for S14.

Funnelling and Focusing Questioning Patterns

In the observations, one similarity found in the two groups of mathematics teachers (10 out of 12 from the Chinese group, 8 out of 11 from English group) was that they frequently posed a series of questions that led the students' thinking to one correct answer. These questions appeared to be in a sequence from general and broad questioning to relatively precise and focused questioning that eventually students could answer without any effort. The following (Excerpt 21) is a good example from a Chinese classroom. In a lesson on the practical use of angle bisector theorem, teacher 11 asked students to finish the questions below in the textbook.

<u>*Excerpt 21*</u>



As in the triangle, ∠b = ∠d = 90°, according to angle	bisector theorem to fill in the gaps below,
1)	If ∠1 = ∠ 2, then __.
T:	*S10, tell me what we should put in the blank in question 1?*
S10:	ab = ad.
T:	*Is that the right answer?*
SS:	Nope.
SS:	cb = cd.
T:	*∠1 = ∠ 2 suggests the angle bisector of which angle? The left one or the right one?*
SS:	∠BAD.
T:	*It is the left one ∠BAD, right?*
SS:	Yeah.
T:	*And then? On the angle bisector there is one point []?*
SS:	Point C.
T:	Point C, the lengths of point C to the two other sides of the angle are equal. So the blank in question 1 should be bc = dc. You sit down please (PO S10).

In this excerpt above, when S10 gave the wrong answer 'ab = ad', the teacher started to lead S10's thinking through a sequence of easy and simple questions to the correct answer.

The same questioning process was also recorded in English classrooms: teacher E's lesson provides an example. The lesson was on finding the midpoint, the questions below asked for the coordinates of one point B (X, Y), when the students knew the coordinates of another point A (8, 10) and the coordinates of the midpoint (5.5, 8).

<u>*Excerpt 22*</u>

A (8, 10), M (5.5, 8), find B (x, y).

T:	Well, we want the method which works. … *If I were to write it there so that I've got a method that I can show you here, how would you go about it? What would you do? Yes S8?*
S8:	Erm, you'd put M.
T:	M is something to watch (Inaudible).
S8:	Because you find the midpoint, you need to times the bracket by 2.

…

T:	Yes but we want to collect this from what we did there. *Can you lead up that so that it must use that there, so what should it be? (PO the board)*

(No response)

T:	Let's start with what we did there. We've got X, we don't know it. *That's what we want to find, is that ok? Let's edit to what, to the X coordinate of what?*
S8:	8
T:	Of A which is 8. *What do we do?*
S8:	X plus 8.
T:	We have this, *is that ok?*
S8:	Yeah.
T:	Right.
S8:	And then that would be…
T:	And then listen, we've got another one here. *We've got X, this is equal to what? What is this one? What is the X called midpoint?*
S8:	11.
S8:	5.5.
T:	5.5. *Is that ok? Do you see that they reverse? Now can you solve that equation then? What should we do, what by the what?*
S8:	2.

From the above excerpt, teacher E typically posed a series of questions that were leading student S8 to the next steps of the thinking process he intended, which was using the given coordinate of the point (X, Y) to eventually being able to generate and formulate the equation (8 + x) / 2 = 5.5, (10 + Y) / 2 = 8, and find X = 5.5 * 2 – 8 = 3, Y = 2 * 8 – 10 = 6. He initially asked S8 to explain and elaborate more on her own answers, which appeared not to be the answer that he wanted to hear. Instead of following S8's thinking, he started to direct S8 to his intended mathematical thinking through leading questions '*Let's start with what we did there …to the X coordinate of what?*'. S8 was able to grab the X coordinate to generate (X + 8) and the teacher continued to probe and lead S8 by posing the question '*we have got another one here. We have got X, this is equal to what? What is this one? What is X called midpoint*?' Following this, student S8 successfully produced the first equation 'X + 8 = 11'. Then the teacher led student S8 in solving this equation with a series of questions: '*if we double 5.5, what do we get? ...we want X now. What would be the X? 11 take away what? … and that gives you what?*' until S8 gave the answer '*3*'. Similar questioning was directed at S8 when she was trying to find the Y coordinates. Finally, the content pursued by the teacher's probing questions was summarised by the teacher and consolidated in a 'mini-lecture'.

Another good example of this can be seen in Excerpt 15, in which teacher B appeared to be simplifying one big question into a series of leading questions in order to make sure that S10 was able to follow her steps of thinking. From the lessons observed, the two groups of Chinese and English mathematics teachers used this questioning strategy at least four times throughout the course of their lessons.

It was also found that 4 teachers in England used another questioning strategy in their lessons, but only 10 times in total. This strategy, in contrast to funnelling students' thinking along a narrow path, focused on students' responses, and adjusted the follow-up questions to build up on students' thinking. A typical example can be seen in an English lesson in Excerpt 23 below. The lesson was revising what had been learnt previously, and the teacher asked students to fill in two columns- a pair of numbers A and B, given that AB and A + B were known.

Excerpt 23

Finding A and B, where AB and A + B were given:

A	B	A + B	AB
		1	-42

T: *-42?*

S4: Is it -7 and -6?

T: *-7 and -6?* Let's check. -7 times -6. *What does a minus and a minus give me?*

S4: Plus.

T: *So can it be two negatives?*

S4: No.

T: No, because I need a negative.

S4: We need one negative and one positive.

T: Good. I need one negative and one positive. I am keeping with the 6 and 7.

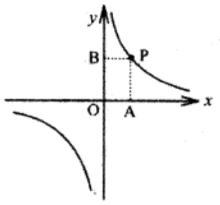
In this excerpt above, S4 volunteered to offer an answer 'a = -7, b = -6', which appeared to be wrong. Teacher I then posed a follow-up question to constructively challenge his understanding, and prompted S4 to reflect upon and reconsider his answer through his focusing question '*what does a minus and a minus give me?* And '*can it be two negatives*?' S4 eventually was able to correct his understanding himself.

Teacher Questioning Incorporating Student's Answers into The Entire Class vs. Teacher Questioning Ending in a Mini-lecture

It was found that all 12 Chinese teachers frequently asked questions to the entire class incorporating or building upon individual students' answers. In total, they employed this approach 34 times. Within this approach, two strategies could be identified. The first one was that the Chinese teachers appeared to restate or repeat the answer just given by the individual students in a neutral manner, then asked the rest of the class to comment on the answers their classmate just gave. Two good examples can be seen in Excerpt 19 and Excerpt 21 above. In Excerpt 19, after S9 gave answers and explanations, teacher 11 stopped S9, restated his answer and asked the rest of the class to evaluate '*he said because AO is the angle bisector of angle BAC. Thus these two angles are the same, right?'* Similarly in Excerpt 21, the teacher asked the rest of the class whether they understood and accepted S10's answer by saying *'is that the right answer?'*

The second strategy that could be identified was that the Chinese teachers adjusted their questions to the individual’s response, with each subsequent question building on from previous ones to help the rest of class progressively construct integrated ideas. An example can be seen below in Excerpt 24.

<u>*Excerpt 24*</u>



As in the picture, the moving point P is on inverse proportionality y = k / x. Through point P PA⊥x at point A, and PB⊥y at point B,when point P is moving on y = k / x， is the area of △OAB going to change? Why?

T: S11. *Can you tell me if the area of △OAB is going to change?*

S11: It is not going to change.

T: *Why?*

S11: Because xy is (Inaudible)

T: *Because xy is what?*

…

S11: *xy = K.*

T: Good, because xy = k, *and what is this to do with the area of this triangle?*

S11: k / 2.

…

T: Because the area of this triangle always equals [x] [y] / 2, which is xy / 2. Ok, everybody looked at it now, *when point P is moving on y = k / x, point P is moving, is K going to change?*

SS: Nope.

T: *So the area of this triangle is []?*

SS: It is the same.

We can see that teacher 7 adjusted his questions in response to S11’s answers, then went on to ask the entire class ‘*when point P is moving, is K going to change?*’ She then asked again ‘*so the area of this triangle is []?*’ in order to help students to see this problem from different angles, and understand why the area of the triangle was the same.

This finding suggests that, for the group of Chinese teachers, asking students for responses, explanations or demonstrations is not only done to examine the understanding of these individual students, but also serves as a stepping stone to build upon or incorporate the teacher's follow up questions into the entire class. In doing this, the teachers observed were able to keep involving all of the students, whether they were following the progression of thought or monitoring the thinking of their classmates.

In contrast to the Chinese teachers' sequences of questions, 10 out of 11 English mathematics teachers tended to conclude their questioning in a summary or a mini-lecture after individual students provided answers. For example, in a lesson on multiplying decimal numbers by 10, teacher H asked students to look at 5.0 * 10. His first question was asking students '*where am I going to put the 5?*' S7 and S5's hands up to provide their answers of '*in the hundreds'* or *'in the tens'* respectively but neither of their answers were correct. The following conversation ensued:

<u>*Excerpt 25*</u>

T:	*Where does the 5 go?*
S7:	5 goes in the units and you put the point in the middle.
T:	5 goes in the units, because it's 5... *What happens when I times by 10, S7?*
S7:	It becomes all 5.
T:	*So what is the answer?*
S7:	50.
T:	The answers 50 or 50.0 if you like. If you can't do that one you're going to be blown for the next slide. Ok, so it tells us here that's exactly what, and a lot of you I went round and this is what was going on, ok I got 5 and 0 so I can add an 0 on the end, it won't work, it's the same answer, it's still 5. You can't do that, you've got to move the number.

In the excerpt above, after S7 gave the answer, teacher H closed the conversation in a mini-lecture- explaining the answers in a statement rather than through questions.

Example-based vs. Inquiry-based Questioning

Another difference in teacher questioning patterns lay in how questions were brought up. All 12 Chinese mathematics teachers brought their questions up through a series of worked examples, whereas the 11 English mathematics teachers' questions arose through students' problem-solving processes.

All 12 Chinese teachers observed predominantly asked a large number of questions to support the problem-solving of students using worked-examples. In their lessons, students and the teacher generally worked together on at least three to four worked examples in their mathematics textbooks or on the board. A worked example refers to '*a step by step demonstration of how to perform a task or how to solve a problem*' (Retnowati et al. 2017: 666). They are designed to support students who just begin to study how to solve certain types of problems, and they are effective in fostering the initial acquisition of cognitive skills (Renkl 2014, 2017). In this research, the worked examples in Chinese classrooms mainly refer to the worked examples written in the textbook curriculum. All Chinese students were given textbooks, containing extensive worked examples. They were required to have studied these worked examples by themselves prior to the lesson. Then during the lesson, the teachers asked a series of questions to examine their understanding of mathematical theorems or structures through worked examples. A good example can be found in a lesson on the practical mathematical use of equations with fractions: teacher 4 went through two worked examples in the textbook curriculum in detail, which can be seen in example 4 in Excerpt 26 below.

Excerpt 26

The principles of camera imaging: $1 / f = 1 / u + 1 / v$ ($v \neq f$), f stands for the focal length, u stands for the distance from the front nodal point to the object to the photograph, and v presents the distance from the rear nodal point to the image plane. For example, if the focal length was set, it needs to adjust u, v to make the image clear. Consider a normal lens for a camera with a focal length of f = 35 mm, to focus a flower of u = 2 m away, how far the lengths should be moved away from the image plane?

To solve: because $1 / f = q / v + 1 / v$, thus $1 / 35 = 1 / 2000 + 1 / v$,

Then $1 / v= 1 / 35 - 1 / 2000 = 393 / 14000$,

$\therefore$ $v = 14000 / 393 \approx 35.6$ (mm)

Answer: the distance from the rear nodal point to the image plane approximately is 35.6 mm.

Using the above worked example in the textbook, teacher 4 asked the following questions to help students comprehend this worked example in order to avoid the possible misunderstanding and difficulties she anticipated that learners might encounter that.

T:	In example 4, the function of a camera used a very important mathematical principle, *1 / f = 1 / u + 1 / v. What do we call it in science?*
SS:	Pinhole image.
T:	Ok, pinhole image. Good, right, now then you have to solve this question in example 4. There is no need to give me the answer but only to tell me how you solve it.

(Students were given time to solve this example themselves for one minute)

T:	1 / f = 1 / u + 1 / v, this is what the example 4 tells us. Now then, *consider a normal lens for a camera with a focal length of f = 35 mm, to focus a flower of u = 2 m away, how far the lengths should be moved away from the image plane?*
T:	*What do you guys think we should do?*
SS:	Put the number into the equation.
T:	*Oh, isn't it this equation right here?*
SS:	Yeah.
T:	*Now, it tells me that f = 35 mm, <u>u = 2?</u>*
SS:	No.
T:	*But in the question, u = 2 isn't it?*
SS:	2 m, unification of units of measurement.
T:	Good. Unification of units of measurement. One is 2m, the other is 35 mm. *What is between the metre and millimetre?*
SS:	Units of measurement.
T:	*What different between the metre and millimetre?*
SS:	1000.
T:	*1000, so u equals?*
TS:	2000.
T:	*Now how can we get V?*
SS:	Put f = 35 mm, u = 2000 mm into the equation.

In the conversation above, the students were given a period of time to study the worked example independently. Teacher 4 then asked a series of questions linking to scientific knowledge, such as using the concept of the ‘pinhole image’ and asking questions about the steps involved in solving this worked example. She also emphasised one key point that could cause difficulties for the students, which was about the units of measurement, through her ‘trick’ question ‘*now, it tells me that f = 35 mm, u = 2?’* and *‘but in the question, u = 2 isn’t it?’* Through these questions, teacher 4 made sure that students had a comprehensive understanding of worked example 4.

Unlike the dominance of worked examples in the Chinese classrooms, there were no worked examples used in the English classrooms. Students were given a set of mathematical tasks to solve by themselves on the board or on projectors. Then the teachers asked questions based on their problem-solving. This seemed to give a level of flexibility for mathematics teachers in England to tailor their questions to students’ levels of ability, and the teacher questioning observed served as explorative questioning to find out what students knew and did not know through their process of problem solving. For instance, in a lesson on multiplying by 10, teacher H firstly examined what they had just learnt previously, asking students to solve questions such as 8 times 7, 7 times 6, and 5 times 12, then he moved onto the lesson’s objective of multiplying by 10. He had already created his own questions, such as 61 times 10, 16 times 10, 32 times 10, and 57 times 10. Building on this, he asked students to work out more difficult questions and write them in the right place on the grid, using written questions such as 13 times 10, 77 times 10, 276 times 10, 301 times 10, 54 times 10, 561 times 10, 709 times 10, 30 times 10, 996 times 10, and 5.0 times 10. As we can see from his questions, there was a clear progression towards more difficult questions.

Questioning for Peer-Assisted Learning

A similarity found between the Chinese and English classrooms was that teachers redirected their questions to a student’s peers when they gave incorrect answers. A classic example of this in a Chinese lesson can be seen in Excerpt 16 above. In this example, the Chinese teacher redirected her questions to a series of different students when they all gave wrong answers. In an English lesson on multiplying numbers, teacher H asked students to look at question number four: 7^2. He looked at students who had put their hands up, and the following conversation ensued:

<u>*Excerpt 27*</u>

T: *I'm going to turn around and S5?*

S5: 92.

T: 92 *did you say?* No it's not 92. Ok so we'll try again. 92 is not the answer. *S7*?

S7: The answer is 49.

T: *Why is the answer 49?*

S7: Because…

…

S7: Actually that little 2 means you have to times it by itself.

T: Times it by itself, fantastic. It actually means 7 times 7 and the answer to 7 times 7 is 49.

In the excerpt above, S5's answer was wrong, so the teacher redirected the question to S7 to answer.

Although both groups of teachers redirected questions to other students, the majority of teachers in England often asked the students to explain themselves through why questioning, before turning their peers to provide help. This questioning strategy often provided students with an opportunity to be clear about their understanding and to justify their thinking. A good example follows below in Excerpt 28. In a lesson on finding the midpoint, one question was looking for the coordinates of another point B (X, Y), in a case where the coordinates of point A (8, 10) and the coordinates of the midpoint (5.5, 8) were known. Teacher E asked the entire class 'you *are given one existing point of the line, and you are given the midpoint, but you want to find the other existing point. How do we do that? From what have you done that*?' The following conversation ensued.

<u>*Excerpt 28*</u>

A (8, 10), M (5.5, 8), find B (x, y)

S7: Do you times it by 2 and then.

T: *I'm going to turn around and S5?*

T: *Can you talk me through step by step so that I do it (Inaudible)?*

S7: 5.5.

T: *Why should I do that?*

S7: Because you halved it there so you times it by 2.

T: Well, we want the methods which works. No … *can you elaborate on that?*

(No response)

T: *If I were to write it there, so that I've got a method that I can show you here, how would you go about it? What would you do? Yes, S8?*

In the transcript above, in response to S7's incomplete answer, the teacher expected him to provide an explanation and further elaboration before asking the next student, S8.

Another questioning strategy shared by four out of 11 teachers in England and seven out of 12 teachers in China, was one where, in response to students' incorrect answers, they asked all students to put their hands up in agreement or disagreement with these answers, in a neutral manner. Then they chose one student from each group to explain their answers. Excerpt 30 below is a good example. In this excerpt, after a student gave an answer, the teacher then started to check on other students' answers by asking 'hands up if you agree with six. *Ok, shall we check?*' and '*hands up if you disagree?'* The following Excerpt 29 is another example from an English lesson.

<u>*Excerpt 29*</u>

LO: To be able to follow the rules of operation

Starter: Do the following calculations

a) 7 + 4 * 3

T: Ok, before we go onto that I have written four calculations on the boards. Right, we'll start with …*I will go with S1 (HP)?*

S1: 7 plus 4 equals 11, then times it by 3 equals 33.

…

T: We are going to think about it. *How many of you agree with this answer?*

(HP)

T: How many of you disagree with this answer? (HP) *S2, did you get something different then?*

S2: Oh yes sir.

T: *What did you get?*

S2: I got 19.

T: *You got 19? How did you get 19 from that?*

S2: I did 4 times 3 and then I added it.

T: *Did you all get 19?*

S: Yeah.

T: Right. *Did anyone get anything different to that?* Ok. Right, we will leave that one.

In this excerpt above, the lesson was on learning the rules of an operation. To answer the mathematical calculation (7 + 4 * 3), teacher G called up students S1 and S2 who then gave two completely different answers. She then redirected this question to the class to see what answers they had arrived at and to see if anybody had different answers from S1 and S2.

Written vs. Verbal Questioning

All 12 Chinese teachers observed placed a significant degree of emphasis on writing their own questions, together with their systematic step-by-step demonstrations, and on writing students' answers on the board following their verbal answers. Excerpt 18 and Excerpt 19 above are good examples. In these two excerpts, S9 and S4 were asked respectively to present their answers with explicit solution steps on the board. The teachers also wrote on the board following the step-by-step explanations of their students. In doing so, the entire class could visually follow the teachers' systematic demonstrations of the step by step solutions to the mathematical questions, and could be visually reminded of these steps on the board while doing independent work, which would make it easier for them to ultimately grasp the rigorous mathematical language and produce their own steps of demonstrations on the board or in their homework.

In contrast, the majority of teachers (10 out of 11) in England did not show any preference for writing down their students' answers or the demonstrations of problem-solving procedures on the board. Rather, they appeared to work to engage students to listen actively to their verbal questions in lessons. For example, in a lesson on multiplying decimals, teacher A gave students a question: 2 times 14, then times 3, halve it, add 58, times 10, divide by 4, and minus 125. The following conversation ensued:

Excerpt 30

T: *What is the first thing we have to do, S6?*

S6: Times it by 14

T: *Ok, so two times 14 gives me?*

S2: 28.

T: Yes, *should we check?*

(*Checking on the calculator*)

T: Good. *What is the next answer?*

S7: Six

T: *Hands up if you agree with six?*

(HP)

T: Ok, *shall we check? Hands up if you disagree?*

(HP)

During the entire questioning process, teacher A did not show any sign of writing down the process of solving this equation.

4.3 Findings of Individual Interviews

4.3.1 Values, Frequency and Purpose of Teacher Questioning

This section presents the findings of teachers' personal perceptions of their approaches to questioning. The teachers claimed to hold very different opinions on the values underlying their questioning between England and China, but they shared a variety of purposes for questioning.

Values and Frequencies of Teacher Questioning

It seemed that the majority of Chinese mathematics teachers did not value teacher questioning highly, whereas all of the English mathematics teachers were positive about the role of questioning.

More precisely, the majority of Chinese teachers (9 out of 12) were not aware of the use of questioning and its importance. For example, one Chinese teacher said '*I am not sure whether it is useful to ask questions, but everyone does ask questions in class, I got used to asking questions as well (teacher 3).*' A similar point was made by another teacher: '*I never really thought about my questioning (teacher 7).*' What is more, most Chinese teachers thought that teacher questioning was quite time-consuming. Five teachers suggested that teacher questioning was sometimes unnecessary, and two others even considered teacher questioning as a waste of time, because *'teachers already knew what answers students could offer (teacher 3)'*, and they saw asking questions as a procedural thing to go through in the lesson. They all mentioned that in the 40 minutes a lesson consisted of and with over 50 students, if they spent too much on questioning, they would not be able to accomplish their lesson objectives and tasks. According to one Chinese teacher, '*if a question was asked to an individual student who could not answer, then the whole lesson would slow down because of that (teacher 4).'*

In contrast, all 11 English mathematics teachers were aware of teacher questioning and saw this as very important to them. For example, one teacher believed that '*the questioning is key, isn't it? It is the key bit. It is…aiming the right question at the right child to try and tease just that little bit more out of them (Teacher J).'* Similarly, another teacher E stressed that *'without questioning, that is not teaching.'*

The frequency of questions asked by teachers between England and China were also quite distinct. Most Chinese teachers (8 out of 12) suggested that they asked a very limited amount of questions during the lesson. For example, one Chinese teacher said '*I have no questions in my lesson, because even if you ask questions, the students do not respond at all (teacher 12).'* Only two Chinese teachers (teacher 9, teacher 10) suggested that they asked a lot of questions, because they always gave '*the floor to the students to talk'* through their questioning. Of 11 English mathematics teachers who claimed that they asked a lot of questions, they reported that they asked questions '*all the time (teacher A)*' and '*as much as possible, so throughout the class ideally (teacher C).'* A teacher even suggested that '*I think I probably ask about 100 questions a lesson, so I think I ask a lot of questions in one lesson (teacher B).'*

Purposes of Questioning

All the teachers used their questions for all kinds of purposes. Three main questioning purposes were identified, including checking students' understanding, prompting students' learning and questioning for classroom management.

Checking students' understanding was amongst the most frequently mentioned purposes of teacher questioning by the all teachers participating in both countries. According to one Chinese teacher, '*my questioning was to see if students have* *understood these knowledge points I just taught (teacher 11).'* Similarly, another English mathematics teacher explained:

> '*Primarily to check their understanding of what we're doing …some of them you want to check that they understand the basics… So questioning is to find out where they are right now in terms of their understanding, but also if you want to check on specific students and what their understanding is. So in general but also specific to the students as well. So yeah, it is to check their understanding…'* (Teacher K)

Six teachers in China and five teachers in England said that they would ask questions to review previous knowledge at their beginning of the lesson, through which they could check students' understanding of what had been taught previously. It was also believed by most Chinese teachers to act to reinforce the knowledge learnt previously for students. Additionally, five teachers in China and six teachers in England suggested that teacher questioning also helped to reveal their students' misunderstanding and misconceptions. For example, '*through questioning, students would expose some of their thinking problems such as misunderstanding… the purpose of questioning is to get them to uncover those parts. Then we can correct or explain to them correspondingly (teacher 4).*' This was also supported by another English mathematics teacher, '*I am also asking questions to tackle their misconception, to find out whether there are any gaps in their knowledge (*teacher B*).'*

By asking questions to check their understanding, seven and six teachers in England and in China respectively believed that questioning helped them to know students' current levels of understanding better, and to plan for the next thing to teach. One teacher indicated that they would know '*where to start with kids. You now know that they are there (teacher E).*' Similarly, another Chinese teacher suggested *'through questioning, I can get to know my students, knowing what they are thinking and they can also know what I am thinking, and then we can know whether we are on the same page* (*teacher 3).*' So knowing what students' understanding was, was also helpful for the teachers in '*deciding the pace of the lesson in either moving onto the next sections of they were going to learn or staying at current section to reinforce the mathematics learning of students (*Teacher 1*).'*

Nine out of 12 teachers in China and all 11 teachers in England also suggested to ask questioning to promote learning. For example, one Chinese teacher said '*without questioning, the students might not think at all (teacher 10).*' Similarly, an English mathematics teacher said:

> '*If you get it wrong that's part of learning… So it's an assessment tool and it's also a learning tool.'* (Teacher G)

To be precise, all 11 teachers in England explained that they pitched and structured their questions in a way that would challenge their students and extend their thinking: they called these scaffolding questions. For instance, one teacher claimed that *'through questions, you could structure it to see if they would be able to do something more challenging, initially they might look at it and think 'I can't do it' but if you structure questions and scaffold them they might be able to get there (teacher F).'* Furthermore, six of these teachers also mentioned using questions to get students to reflect for themselves through questioning '*why is it working, or how could this be different* (*teacher K*)' in order to deepen students' thinking, rather than being '*a making up thing (teacher C).*' What is more, four believed that the purpose of asking questions was to get their students to discover things themselves first rather than telling them everything, through questioning such as '*what did you see in this? Why? What is happening? (Teacher I)*'

Seven out of 11 teachers in England and nine out of 12 teachers in China shared another purpose in that their questioning, classroom management, The teachers asked questions to keep all students engaged and focussed on the lesson or tasks, particularly to those who were drifting away or misbehaving. As one English mathematics teacher suggested '*questioning is also just to bring focus so if I notice that a child maybe is drifting off, a question will just mean that they have to focus on what is happening at that present moment (teacher F).'* One Chinese teacher echoed this: he posed his questions particularly to *'those students who were off-task during the lesson, talking to other students (teacher 2)',* to remind them to pay attention to the lesson. However, there seemed to be some variations in the manner of asking questions to students with behavioural issues. Some teachers asked questions to embarrass these students because they believed it would make them listen since they did not want to be embarrassed in front of their friends for not listening. Others asked questions in a respectful way to make them realise that they should be paying attention *such as 'M, can you repeat the instructions? (Teacher A)*'

Ten out of 12 Chinese teachers also asked questions for the purpose of maintaining a high level of interactivity during whole class teaching. As one Chinese teacher believed '*teacher questioning is the medium of classroom interaction between the teacher and students (teacher 8).'* when they were teaching in front of students, they needed to hear them engaging. To these Chinese teachers, communication meant interacting with all of the students, not one individually.

4.3.2 Content Focus and Types of Questions

Findings from this study suggested that most Chinese teachers did not have any explicit theoretical knowledge about the types of questions they asked in that they focused their aim on getting students to fully understand '*the key mathematical concepts*', and to be able to apply these into practice properly. For example, one Chinese teacher explained '*my questions are mostly to enable students to apply these into skilfully solving mathematical practical issues in real life, after they have had comprehended the concepts (teacher 9).'* Only one Chinese teacher (teacher 7) claimed that she was aware of Bloom's taxonomy as a classification of types of questions, from when she was training to be a teacher at university.

Half of the Chinese teachers tended to ask mathematical questions with more than one correct solution. These mathematical questions were believed to enable them to communicate with their students and discuss altogether, which offered students of different levels the opportunity to express their thinking and ideas. As one teacher said, '*different kids would propose different methods for that one question. With the different methods, that might extend the students' learning and thinking (teacher 6).'* Furthermore, they suggested that the questions with more than one correct solution could help in increasing their students' curiosity and interest by engaging in the interaction, which would subsequently challenge their thinking.

Concerning the content focus, it was also found that all 12 Chinese teachers emphasised the fundamental role of factual and procedural knowledge[3] in learning mathematics for their Year 7 or Year 8 students, thus they claimed to spend half of the lesson asking questions about this knowledge to make sure that students had

[3] 'Procedural knowledge in Mathematics focuses on the rules and procedures used in carrying out mathematical process'; whereas factual knowledge in Mathematics focuses on the mathematical terms, definitions (Purdum-Cassidy et al. 2015: 82)

understood the basic mathematical concepts, terms, definitions, procedures and steps towards solutions. For example, one Chinese teacher claimed:

> '*The key point of this entire lesson was to comprehend the definition of equations with fractions, if they do not get the definition right, they will not be able to solve any practical mathematical problems later involving the use of equations with fractions.*' (Teacher 1)

Many Chinese teachers also reported that their students appeared to ignore or miss out the definitions of mathematical terminology, because these definitions were written in the textbooks, which they then read through without thinking. Without fully understanding these basic terminologies and definitions, they claimed that the students would encounter many mistakes and misconceptions later when they were applying them in practice. In one teacher's words,

> '*Like some definitions of mathematical concepts, there might be two or three key words that most likely were missed out by nearly half of the entire class. You asked them to read out loud individually or together, but they just read out without thinking. For example, ask students to tell whether some equations are linear equations, it might appear to be very easy for them understand its definition, everyone seems to know whether it is a linear equation, but some students who often did not have a full understanding of the definition, they do not know where to start and whether it is a linear equation.'* (Teacher 11)

Only one teacher in England mentioned that it was important to draw out students' understanding of mathematical knowledge and symbolism of mathematics before they could apply this in practice.

Most teachers in England seemed to be fully aware of different types of questions and they mentioned that they were encouraged to use open-ended questions or open questions. As one suggested, '*so with the questioning, there are so many different types we use. When I started, when I was at the university, they said you must always use open questioning, so higher order skills, and I love it (Teacher A).*' Similarly, another teacher also said '*a teacher should try to give open ended questions, in your opinion like 'in your opinion, how do you do that? Or what can you elaborate? So* *what are you trying to do is to create not to give many close-ended questions… (Teacher E)'*

It was also found that many English mathematics teachers (7 out of 11) used Bloom's taxonomy as a way of classifying questions. However, of these teachers in England, some thought that Bloom's taxonomy did not seem to fit mathematics. They explained that the definition of Bloom's taxonomy was vague and mathematics questions had a different order, in that *Create* was put at the top of Bloom's taxonomy but a student could create a mathematical question without necessarily fully understanding it. They claimed that being able to explain and understand how to do something in mathematics was a much higher skill than being able to create a question. For example, one teacher explained,

> *'I think for Maths, it has a different order to what Bloom's has got in, because quite often you are looking at the questions that, you are like, well, actually to be able to do that is much higher up than to be able to do this.… so they have got creating right at the top but to be able to create a question, you do not necessarily to fully understand it. But to be able to understand and explain how to do something in Maths is much higher skill than being able to like create a question or to evaluate question. So I think Bloom's taxonomy is different for Maths questions.'*
> (Teacher B)

Therefore, their department of mathematics changed their approach from Bloom's taxonomy and developed their own types of questions in worksheets which '*spread into three sections, which are practice, apply and create. And in practice they have 'MUST, SHOULD, COULD (teacher A).'* The teachers gave these questions to learners with different abilities for them to answer different sections on the same sheet.

When considering the factors which affected which type of questions was used, many teachers in both groups stated that contexts such as classroom activities and lesson topics were important in affecting the types of questions they used. As one Chinese teacher said, '*'what kinds of questions I usually ask depend a lot on my lesson content or topic (teacher 1).'* Similarly, an English mathematics teacher explained:

> '*It depends on the activities. If they're doing a worksheet on something that we've already done, then I'll say - these sort of questions will be - tell me how you got that answer, which question is the hardest? Why is that different to that one? What have you had to do different? You know, that sort of thing. It depends on what they're doing. It depends on whether it's previous knowledge that you're trying to get them to recall, so tell me about a square, what do you know about it? Well what's the difference between a square and a rectangle? Or is it that they're working on something now and it will be like I said, how did you do that question? Tell me about that one. Which is the hardest one? Why is it harder? What have you had to do different? What makes that question different to that question? That sort of thing. So it depends. The questions depend on the activity*.' (Teacher J)

Some teachers from both countries said that as mathematics has so many trends and topics, they asked types of questions differently when they were dealing with different topics. As one teacher claimed:

> *'It tends to vary depending on the topic. There are different…, I mean the Maths has different strands, the spatial awareness side of things with geometry and you've got the data handling side of things and the probability statistics, and you've got the basic number and you've got the algebra, and some kids are really good at one strand but not good at another, and so it depends which strand I'm in and what I'm doing...'* (Teacher G)

What is more, the different abilities of students were also suggested to be an important factor that affected the types and levels of questions posed by both groups of teachers. All teachers in England explained their tendency to adjust their types and levels of questions to accommodate the levels and learning abilities of the students in their class. For example, one teacher said:

> *'You're thinking all the time about which questions are suitable for which child so that they are getting you know, they are getting questions that are going to make them think but not a question that they have no way which they can access.*' (Teacher J)

In other words, the teachers could not ask a question which was inaccessible for the students in terms of understanding. For instance, another teacher explained:

> '*I think based on their level and ability, from what you have seen in class or from the levels that you know they have and that they have performed in their test, you do change or alter the way you ask the questions so if for some of them you just want to check that they can do the method, some of them you want to ask them to explain why the method works so you want to deepen their thinking, you want to make them think about right ok, well why is it working? Or how could this be different? So a question like one of the ones over there and more open ended questions. You want to make them think around the subject not just whether they can get the answer or not, and you do, you base it upon how you know they do in class in lessons and in tests, what their level is and also depending on what set you've got as well.'* (Teacher K)

While most Chinese teachers claimed they were aware of their students' different abilities, they attributed the difficulty in accommodating their questions to suit their individual students to the large class size in mixed-ability groups. Therefore, it was reported that easy and simple questions were posed to lower level students and difficult questions were then posed selectively to students of higher ability. The reason for this was the expectation of classroom participation. They expected all their students to be engaged in the lesson, although as mentioned above, their lesson pace was set at the middle students' level. Questioning higher level and lower level students could give these students some opportunities to talk, and also would keep them busy and make sure that they had a sense of belonging in the class. For example, one teacher claimed:

> *'I have 47 students in my lesson, I cannot tailor my questions to individual students, because that would take too much time. For me, the most important thing is, to get 2/3 of students to understand my lesson and apply into practice. And the rest 1/3, the more able students to get some questions of higher order.'* (Teacher 1)

4.3.3 Sourcing and Preparation of Questions

The findings appeared to show that the Chinese teachers tended to prepare their teaching thoroughly while teachers in England seemed less well prepared for their lessons and questions: whilst all Chinese teachers claimed that they planned their lessons and questions every day, most English mathematics teachers planned their lessons and questions every half term or term, following '*the scheme of work*' for '*the whole year (teacher A)'*. One teacher explained *'within the scheme of work it just says you have to teach multiples, factors and primes (teacher I).*' Further, many Chinese teachers reported that they were required to plan lessons and questions on a daily basis following the teaching manual and their lesson plans would be checked by administrators from the Institute of Education. In contrast, most teachers in England suggested that they did not have to plan their questions and expected to ask these spontaneously depending on the situation and students' understanding. Some teachers explained that they tended to develop their questions based on their students' responses during the lesson. As a teacher in England said:

> *'You often get your question from what a child has said. I mean we've got some what we call question stems up at the board behind there so, you know, if you sort of stuck with your questioning you can just sort of say right, give me another example of, or what's the same and what's different? We use that one quite a lot. Yeah, an open question. But no, you don't tend to have, sometimes you do, sometimes I have odd ones and I tend to put them on here to remind me because they're very specific things, but no. We don't sort of pre-plan the questions.'* (Teacher J)

One reason they gave for this was teaching experience, which gave them the confidence not to prepare questions and allowed them to see opportunities for spontaneous questioning while experiencing the lesson. Many Chinese teachers also saw teaching experience as vital, but they claimed that with more teaching experience they prepared questions based on their predictions of which key mathematical concepts might cause students' misconceptions.

According to the teachers' responses, the sourcing of their questions also seemed to be quite distinct between England and China in terms of the use of the textbooks. All the Chinese teachers explained that textbooks were their main reference for developing questions. They were required to follow their textbooks closely, from which they took questions directly (e.g. the worked examples in the textbooks). They showed me these textbooks. The textbooks explicitly stated how exactly the teachers should teach, which included providing a series of lesson objectives, worked examples, mathematical facts and concepts, and questions following these. All of the Chinese teachers claimed there was '*not much space for them to create their own questions (teacher 3).'*

Additionally, the Chinese teachers mentioned sourcing some questions from students' exercise books and examination papers from previous years. They explained that there were an extensive range of Mathematical questions in examination papers and exercise books; from which they chose typical examples of mathematical questions they believed to be of use for their students. They expected these would help '*students be capable of solving all kinds of questions in making the most use of the lesson and doing less practice (teacher 9).'* These typical mathematical questions tended to be much more difficult to solve than ones written in the textbooks; and if their students got stuck, the teachers addressed them during their lessons for the students to practise together. Another reason they cited for sourcing questions from outside the textbooks was because the questions in the textbook were too easy, so they needed other sources. In order to help their students to compete and get high marks in all examinations, they prepared these questions to get them used to and familiarised with these questions. This was also the reason that all students were given a number of exercise books to practice in outside their school time.

All of the Chinese teachers claimed that lesson targets and objectives were their priority. They revealed the anxiety which they experienced if they fell behind their lesson targets. In schools, all classes were arranged in a hierarchical order based on the average scores of all students in their classes. The classes they taught frequently competed with others during in-school examinations. Following examinations, there would be a new hierarchy allocated to the classes. The in-school examinations took place every two weeks. Students' scores were viewed by them as the only drivers of their questioning, which also determined the sourcing of their questions.

In contrast, all of the teachers in England believed that they had choice and flexibility in creating their own questions or using questions from the textbooks, but they mostly created their own questions, based on the students they had and their level of ability and understanding. For example, one claimed, '*there are some books, but they are very old now, so we do not use them very much. We just tend to make our own flipcharts and get quite a lot of resources of the internet (Teacher J).'*

Another finding was that the Chinese teachers' lessons were more structured compared to those of the English mathematics teachers: all 12 Chinese teachers considered that their questions were mainly prepared centred on the lesson objectives. As one teacher said, '*they are prepared according to the content of the lesson. According to the key mathematical knowledge concepts, what kinds of question can I have here? Then accordingly what kinds of mathematical practice I should have as well (teacher 9).*' Many Chinese teachers felt that there were too many students and *'you cannot look after them all. The mathematical questions and worked examples were already there written in the textbook, so you cannot make these questions to suit students' levels (teacher 12)',* and suggested *'it is unrealistic to prepare questions to suit students' needs (teacher 3).'* The English mathematics teachers, in contrast, suggested to design their questions on the basis of their students' level and ability in the class, since the students in England were already divided into different groups according to ability. For example,

> '*One topic has loads of different levels and different learning objectives, and you choose which one is appropriate for your class…if I teach year 10 set 1, they are all doing by fracturing geometry. Year 10 set 8-7 are doing angles and triangles. so within the scheme of work, it tells you for a year your deadline for your tests, and what topic you should be teaching, Each topic, number A or number B, or Unit 1 or 2, you can open and have all the learning objectives, so you have learning objectives for level 1, level 2, all the way to level 8.'* (Teacher A)

4.3.4 Patterns and Strategies of Questioning

4.3.4.1 Wait Time

Most teachers in the two nations suggested they would wait for students to think before calling anyone to answer. But the length of wait time was vague; some teachers in England claimed to give a few seconds, but many Chinese teachers said they did not know the length, since most of their questions were posed to the entire class, and whoever got the answer simply shouted out their answers.

4.3.4.2 Questioning Distribution strategies

Three methods of questioning distributions were listed: hand-bidding, nomination, and no-hands rule. Most Chinese teachers used all of the distribution methods; whilst most English mathematics teachers used a combination of hand-bidding and nomination in their lessons.

This finding showed that most of the teachers in both countries preferred completely different methods of distribution: no-hands rule was among the most favoured method by all Chinese teachers, whilst the majority of teachers in England preferred a hand-bidding strategy. The no-hands rule, according to the Chinese teachers, was a strategy in which a teacher posed a question to the entire class, expecting all students to shout out their answers without their hands up. It was believed that a teacher should keep all of the students involved. Another reason they gave was that within a lesson time of 40 minutes and a class size of more than 45 students, it was impossible to ask every single student a question, and it was also unfair if only one student was given the chance to talk, but not the others. Therefore with the no-hands rule, they could cover all students in the lesson; which gave them equal opportunity to share their answers. It was also considered by many Chinese teachers a good way to get shy and quiet students involved. Some teachers also claimed that their students preferred to shout out their answers, rather than being put on the spot in the class.

In contrast, most teachers in England said that they preferred their students to raise their hands before being selected to answer questions. Many disliked students shouting out answers without being called, because they believed that it made their students appear ill-mannered and would not make for a pleasant atmosphere in the class. More importantly, they claimed that with so many voices all talking at the same time, students would get confused, and would be unable to hear and understand the answers. They suggested that asking students to put their hands up, in contrast, would mean that '*the entire class could see the hands and the person who spoke, everybody could hear what they said (Teacher D).*' They also believed that some students needed time to build the confidence to raise their hands up. Asking students to put their hands up would prevent a teacher from putting '*anyone on the spot who really would not know what you were asking (teacher F).'*

Another finding was that most of the teachers in the two groups occasionally used nomination to get their students to answer questions. One reason given by both was that all of their students had to be prepared for the fact that any of them could be asked to provide an answer. More than half of English mathematics teachers also explained the need for '*balancing their questions out not only to those students who put their hands up but also to those who did not put their hands up (teacher I)'*. It was also to avoid situations such as having the same children in every lesson raising their hands or having some students answer too many questions in one lesson, instead offering other students a chance. Concern for lower-ability students was the key reason they all gave. Many teachers from both countries thought that most of their questions were answered by more able students, so in order to give lower ability students opportunities to talk they needed to nominate them despite them not putting their hands up. As one said:

> '*It is not that I am not interested in pupils who they think know or the pupils who have been enthusiastic… but I am much more interested in what those pupils who do not have their hands up and are not engaged, and who are weaker to know what they think.'* (Teacher B)

A combination of hands up and nomination was preferred by some teachers in England, because it could *'get the weaker students to participate a bit more without feeling intimidated'* in the class.

Another reason cited was classroom management: many teachers in both groups claimed to nominate students who were off-task or were misbehaving during the lesson as they felt the need to make sure that all students were listening and keeping their attention focused during the process.

A great number of teachers from England and China believed that their questioning distribution strategies varied depending on the context of their questioning: for instance, the lesson topic, the intention of their questions and how the students were doing. Many teachers in England suggested that when they were teaching new topics which appeared to be difficult for their students, they allowed them to have a go when they put their hands up, but when they were reviewing their lesson they preferred to nominate students even when they did not put their hands up. For example, a teacher stated:

> '*If I'm just starting off something and I just want to get a feel of what the class' understanding is, I might pick the people who've got their*

> *hands up. But if I'm trying to check understanding so if we're going through something and so when I did the worked example, I had then two further ones on the board and I want to check specific students or that they have understood, then I will pick them myself. So I'll take the hands up if it's an initial thing at the beginning and I just want to see what the class knows already or as part of the starter. But if I want to check if they've understood then I'm going to pick the students.'* (Teacher K)

Some Chinese teachers, meanwhile, tended to use no-hands rule specifically at the beginning of their lessons because they wanted to review their lesson and to evaluate students' understanding of prior knowledge before moving onto a new topic.

Additionally, most English mathematics teachers held a belief that everybody should get a little bit of their time in the lesson. They tried to ask every single student a question in lesson. One even mentioned noting down who was asked a question and who was not using '*a mentor note'*.

Hands Up for Checking Understanding or the Progression of Their Work

It was also found that both the teachers in China and in England asked students to put their hands up to check their understanding or the progression of their work. They often asked their students to put their hands up when they needed to see the progression of their work, to keep up the pace of the lesson, and to see how well their students had understood what they had just taught. As one Chinese teacher commented '*if 90% of students put their hands up, then I know I can move onto the next section of learning objectives (teacher 7).*' However, seven out of 11 English mathematics teachers felt that asking students to put their hands up to check their understanding was not sufficient, because students could fake and pretend that they understood by putting their hands up. Therefore, they encouraged the use of mini whiteboards. They believed mini whiteboards worked better to find out how well their students had learnt and to make sure that the whole class was understanding. Many of them reported that through mini whiteboards, they can see that '*some people got it right'*, and '*some people had it wrong'* when they put up their boards with their answers up for the teachers to view. Then they could ask questions particularly to those who had got it wrong, *'or if they got it, then they can go on to the extension work (teacher A).'* The use of mini whiteboards also helped to '*find the common* *things that they were wrong.'* Thus, their instructional purpose could be adjusted to fit the students' understanding, in helping to better plan and decide what to teach next, and to direct the instructional pace of their lesson.

4.3.4.3 Questioning Patterns and Strategies

Individualised vs. Collective Questioning

Most teachers in England said that they preferred asking individualised questioning; whilst most Chinese teachers claimed that their questions mostly were asked collectively to their students in expectation of all students answering in unison. In collective questioning, the teachers' questions were shared by the entire class, encouraging as many students as possible to contribute to the question. Maintaining eye contact with all students during questioning was the key, even when questioning individual students. As one Chinese teacher argued '*even though the questions are delivered to and answered by an individual student, my eyes are looking at the entire class, expecting the class to be following the process of thinking step by step (teacher 1).*'

One reason for this, according to these Chinese teachers, was the constraint of large class sizes, and that in order to accomplish lesson objectives in such a short, limited time, it was very hard to ask individualised questions. Class size has always been a challenge for Chinese teachers. This will be discussed in greater detail in Chapter 5. The teachers in England, in contrast, thought that their groups of students were relatively small, and this gave them chance to question students individually within their group. They also explained that the lower the ability of the group was, the smaller the group size would be: a higher ability group tended to be bigger in class size, but no bigger than 30 students.

Another reason why most Chinese teachers adopted collective questioning was for classroom management. Many teachers were not interested in their students' answers to most of their questions but asked them just to keep the lesson going. Along with maintaining eye contact, they could tell whether students were listening and keeping up with the lesson. What is more, some Chinese teachers' collective questioning might be a subconscious behaviour, since many of them believed it to be '*too boring'* if the teachers were '*the only one speaking. '* Additionally, many teachers also believed that some mathematics questions and problems were shared by all students.

Thus, instead of only questioning one individual student, it would be best to ask the entire class, so that everyone could benefit from solving these questions.

In contrast, English mathematics teachers believed individualised questioning worked best for their individual students' needs. They believed their questioning should be centred on their students individually, since each student had their own capacity and pace in learning mathematics. Students should be challenged and extended at their own pace and level of understanding. For example, one teacher expected his questioning to '*challenge students and make sure that at least each one is challenged and at their own capacity (teacher E).'* All students should be questioned to all get to the same level. According to one teacher, *'if they get something, we will move on. If they don't, we will spend longer on it. I am not going to move on if they do not understand it (teacher F).'* The Chinese teachers, on the other hand, could not make sure all students were understanding, but could only make sure that 2/3 of the class was following the lesson. For example, a Chinese teacher said that '*in my 40 minutes lesson time, I spend 30 minutes questioning the entire class to meet the needs of students at the middle level and above (teacher 6).'*

Most Chinese teachers' lesson pace was also fixed, centred on their lesson objectives, and as a consequence, their lesson pace was set at the middle level of their students, which often led to some higher level students and lower level students feeling left out during the lesson. The English mathematics teachers, on the other hand, worked at the pace of their students. When a child fell behind, they would '*increase questioning specifically to that child.'* The reason was that they had relative flexibility in their lesson plan and lesson pace, as one teacher explained:

> *'There is always a little bit of leeway, there are obviously a few lessons where we can catch up on work because I always plan 6-8 weeks at a time when I am doing my planning. So I always know right, I have got three lessons that I can catch up work in if we are falling behind. I have got to catch up time to myself.'* (Teacher H)

Questioning a Series of Students of Different Levels to Check the Understanding of the Entire Class

One distinct strategy mentioned only by Chinese teachers was questioning students of different levels to gain an understanding of the entire class. This questioning behaviour was seen in observations, and later explained in their interviews. The individual students being asked were representatives of students of different levels. They often started by questioning students from lower levels, then gradually moved up to students of higher levels. It was believed that if the first student succeeded in giving correct answers, it meant that the majority of students in the class had understood the lesson, so then the teachers could move on to the next part of the teaching. If the first student failed to provide a correct answer, they could estimate how many of the students would be at the same level as this student and would be likely to fail as well. They then went on to ask another student of higher level than the first. When they had a clear idea of the understanding of the whole class, they would stop and make a decision on whether they should reteach some topics. Many teachers had to reteach the class if there was more than 1/3 of students having problems. For example, one teacher said:

> '*After posing a question, I often call up a lower level student to answer, if they can get them right, then you know they understand the lesson, therefore, I would say the students who are above their level also understand the lesson. If that lower level student did not get the answers right, then I will pick up someone who is a bit higher level over that lower level student, but not too higher level, to answer the same question; if he/she could answer it, then I know the level of students who are above him/her can also do that.'* (Teacher 1)

This was supported by another Chinese teacher, who added *'I often use this questioning strategy at the end of the lesson. You remember I picked up a student at the end, he was at very low level, he said the answer wrong, but my purpose of questioning him was to see the understanding of the entire class (teacher 11).'* Similarly, half of the Chinese teachers also suggested that they would ask more able students to give their answers and their explanations to the entire class, then they would ask a less able student to answer the same question to ensure that students of all levels had understood, particularly when dealing with higher order questions. For example, one teacher explained, *'after a student's explanation, I would ask a student of lower ability to see if they had understood or not. They might still not understand; then you ask them where they did not understand. Following that, you can give some hints or clues to make sure they all understand in the end (teacher 7).'*

No teachers in England ever mentioned using students as representatives to check the understanding of the entire class.

Differentiating Questions or Not

The Chinese teachers explained that all students were given the same questions, because they were incapable of asking different questions to different students, and they had fixed lesson objectives and learning targets for all students in the curriculum.

Most teachers in England meanwhile grouped their students into different coloured groups according to ability, and then provided them with different types of questions, or they used a work sheet consisting of different levels of questions (e.g. as mentioned earlier 'MUST, SHOULD, COULD') then asked their students to choose the level of questions they felt confident to answer. For example, one claimed that '*so like all pupils are going to do this, some people should be able to do this. So it is differentiating. So … giving those questions to the pupils with different abilities so they can answer different sections on the same sheet (teacher B).'* One reason they gave for doing this was that it worked for a class with a mixed ability group of students and could make sure that students of all abilities were challenged to extend their learning. It was also believed that differentiating questions gave more flexibility to the students to follow their own routes through the content. Some teachers were concerned over some students becoming over confident and choosing harder questions they were not yet ready for in the opinion of these teachers.

Questioning for Students' Explanations: through Presentations and Demonstrations on the board vs. through Why Questioning

Most English mathematics teachers' most frequently-used questioning strategy was to ask students whether they were right or wrong using a 'why question'. Some claimed that everybody is able to give an answer, but not everyone can explain this answer. The main reason they asked for students' explanations and justifications was to check and double-check their students' understanding, since some of their students' answers might have been guesses. So by asking them to explain, they were checking their students' understanding. It was believed that during the process, the students would start to think reflectively about what they had done, why they had done it and how they had done it. Moreover, the majority of English mathematics teachers were not teaching them only for understanding, but also for reasoning, to teach them to take responsibility of their own study, and to prepare them for the world of work when they left school. In the outside world, the teachers believed that their students would be less likely to be asked for answers, but more likely to be asked for explanations.

However, for most Chinese teachers, asking students to write their answers on the board and explain to the entire class was their key questioning strategy. Many used this to check students' understanding, as the teachers could only tell if the students were understanding what had just been taught through asking them to write their answers down. For instance, one teacher claimed:

> '*Questioning for me is to ask students to practice on the board, through writing down their answers, you can check whether they have understood what you just taught in the lesson, to check your teaching quality*.*'* (Teacher 2)

Some suggested that asking students to write down their answers on the board, was for classroom management, engaging students in this activity through drawing students' attention to the board and *'to the mathematical questions that they were working on.'* It could also prevent students copying answers from others during questioning. However many Chinese teachers were preparing their students for the examinations in doing this. As mentioned above, the schools, the teachers and students were all under pressure to pass examinations and compete in league tables. It was believed that if the students could not write their answers on the board, then they would not be able to do this in the examinations.

For both teachers in England and in China the effect of asking students to explain was seen to always work better than teachers' own instruction. But the reasons they gave were quite opposing. Most Chinese teachers felt that doing this would create competition amongst students. This encouraged their students to pay more attention to their peers to look for any mistakes, particularly for more able students. According to one teacher:

> *'When a teacher explains, students think you are a teacher that will not make mistakes. So they just listen without thinking. But when their peer is giving explanations, the kids sitting down there would want to find out their peer's mistakes and so they would listen actively and carefully.'* (Teacher 10)

On the other hand, English mathematics teachers believed that their students explained things better than they could themselves, particularly for the age of the students they were teaching, because the students shared the same terminology and language within their age group. More importantly, their students would appreciate their peers more when they were getting help and support from them. As one teacher stated:

> '*Everyone is going to benefit from another pupil's way of speaking, because I might say it, and I might say it already in a messy way they would not work out and quite far from what I am saying, I think they really appreciate how their peers say it… even though they sometimes just repeat what you just said.'* (Teacher D)

Some Chinese teachers also said that it was a learning opportunity and process for the rest of the students, particularly for those who did not know how to solve the question.

Another finding was that, both groups of teachers believed errors or misconceptions might be shared by many other students. The English mathematics teachers expected errors or misconceptions to be exposed when the students encountered. But, in order to highlight possible mistakes or misconceptions in understanding mathematical questions, most Chinese teachers deliberately selected certain students who were highly likely to get answers wrong, which then brought these mistakes to the class to help students to learn from it. For example, one Chinese teacher said:

> '*I set up for this. I knew where some students' misconceptions were, so I set them up before the lesson. During the lesson, I would pick up the students who I knew were going to give wrong answers, so through them, such misconceptions get exposed to the entire class.'* (Teacher 1)

Funnelling and Focusing Questioning Patterns

The findings showed that, both groups of teachers thought that by breaking down big questions into small questions, they were guiding and scaffolding students' thinking. When students appeared not to understand the questions, this meant the question they asked was too difficult. It was necessary for them to ask lower level questions to make sure that they could answer; and then step by step increase the difficulty level of the questions. For example, a teacher said:

> '*I will ask a question here and if they are not understanding my question, then I will know I am asking a question too high up on the ladder for them, so I will ask a question lower down on the ladder to engage them. And then I am like 'ok, dedede…' then I will ask another question. It is a bit higher up; I go 'ok then,' then I go back to the question I asked to them: now they can answer it because then I have dropped that back down and then built it back up again. So it is about me assessing that they are not understanding my question so I need to go more basic to bring it back up to that point.*' (Teacher B)

Teacher Questioning Incorporating Students' Answers into The Entire Class vs. Teachers Questioning Ending in A Mini-lecture

Many Chinese teachers explained why they adopted responsive and evaluative questioning after an individual student's explanations and demonstrations to the entire class: the reason was to stress some key steps of the process and reinforce their learning over some significant knowledge points. For example, a teacher said that '*my main purpose was to reinforce some of the key knowledge and solution steps to make sure that students could remember those key points and steps of demonstration process (teacher 6).*' They also claimed that they monitored students' attention at all time to keep their attention focused. But most English mathematics teachers believed their questioning with the individual student had finished once their demonstration was over, so they moved on to wrap up the conversation in a mini-summary. And then they moved onto another student for questioning.

Teacher Questioning through Worked Examples vs. Teacher Questioning through Problem-solving

The observations revealed that all of the Chinese teachers asked questions based primarily on worked-examples, and in the interviews, they gave some justifications for this technique. The predominant explanation was that the majority of worked examples were provided by the textbooks. As mentioned earlier, they were required to follow closely to the textbooks to ask questions. According to one teacher, '*those worked examples were already written in the textbook, so we have to teach them that. Besides, how can a student learn from nothing? (Teacher 3)'* This seemed to suggest a belief that students could only progress with the help of worked examples. Many also suggested that they made their own worked examples for the students to learn from if there were no worked examples in the textbooks.

Most Chinese teachers were concerned over the quality of students' self-study of worked examples in the textbook, claiming that students simply read through the worked examples without thinking. As a consequence, they had to repeatedly question their students to force them to think about the worked examples and to reinforce the solution steps in order to make sure that they remembered the rigorous mathematical language shown in demonstrations.

In contrast, most English mathematics teachers reported that they very rarely showed their students something without expecting them to work it out first. They expected their students to discover their own learning, and then they adjusted their questions based on how well they learnt. For instance, one teacher said '*as much as they can, they discover it first for themselves (teacher F).'*

Questioning for Peer-Assisted Learning

Both groups of teachers proposed that when the students gave vague answers, said they did not know, or gave incorrect answers, they would ask someone else from their peer group to help and assist in explaining the right answers. Primarily, they suggested not to correct the students directly, because this might result in students feeling embarrassed for getting the answers wrong and then they would just '*give it up at that point, believe that they cannot do it (teacher F).'* More importantly, they believed that students learnt better through a peer's explanations.

Some English mathematics teachers also suggested that it helped students to learn cooperatively. As one teacher stated,

> '*It is getting them used to working together, and as a group as well so it is not just individuals, it is a way of getting them to cooperate with each other.'* (Teacher G)

It was also found that they continuously asked questions to a student who had got something wrong, as observed in lessons. It was because the teachers could find out what the mistakes were and could correct these to make the students come to the right understanding themselves. For example, one said,

> *'You have to know how they got wrong answer and where their misunderstanding lay on. So then you can explain to them why they were wrong, and why their peer's answer was right.'* (Teacher H)

Additionally, they believed many other students might share the same misunderstanding. Thus, asking one individual to explain the answers could challenge their misconceptions and help others self-evaluate their own answers.

Another questioning strategy identified by some teachers in both countries was one in which an individual student gave an answer, and if they were wrong, they would not correct them, instead, they would firstly ask for the number of students who had the same or different answers, and then ask each group to explain how they got their answers. For instance, one teacher said:

> *'If there's an opportunity where a student is doing something in particular that's not quite right…then I'll say … how many of you are getting this kind of answer and how are you getting it and why? And I'm asking them to prove what they're thinking. you've got the answer, you've got the answer there, prove it to me, how did you find that answer, what process did you go through to find it, and get them to draw it out and get everybody else to understand how they did it and then if somebody else says hang on a second that's not quite right, why is it wrong, how can we put it right…and we can draw people in and get them to help each other and think about the process they're going through.'* (Teacher G)

Written vs. Verbal Questioning

It was found that the teachers preferred distinct forms of questioning: English mathematics teachers preferred to ask questions orally and without writing the question out, in contrast all Chinese teachers stressed the need to write the question on the board before putting it to the class. Both groups said their forms of questioning were for classroom management. Most teachers in England thought that if they only asked their questions once by speaking, then the students had to listen actively. They believed this could help all their students to focus on what they said during the lesson. Unlike them, many Chinese teachers believed that while they were writing questions on the board, the physical movement of writing would help to capture their students' attention towards the board.

All of the Chinese teachers also believed that it was impossible to explain and express mathematical language clearly to their students without writing it down in their questions on the board, since there were many symbolic and graphic components in mathematics such as diagrams and graphs. Through writing questions and answers down step by step, the teachers claimed that students would be helped to develop precise mathematics language. It was also believed that their students would not remember anything just by talking. Asking students to write down all their questions and answers at the same time as going through these with them could reinforce the mathematical solution steps to their students and could thus deepen their memory and understanding about these mathematical ideas, in order for their students to develop higher levels of thinking later on.

4.3.5 Teacher Training

In terms of teacher training for questioning, a distinctive difference was found between the two groups of teachers. The majority of Chinese mathematics teachers claimed that they had not received any training specifically on teacher questioning during their preparation in schools or universities. They all reported that their experiences of training were through observations of other teachers' teaching, and some very experienced teachers' teaching practices in particular. However, most English mathematics teachers reported they had received extensive training and support related directly to the use of teacher questioning in their university training pre-service and during their CPD post-qualification. For instance, one said:

> '*That was actually a big part of my teacher training. When we were in the university, they did a whole lot on asking questions, both to see if students are understanding but also to get them thinking.'* (Teacher C)

However, it was found that all Chinese and some English mathematics teachers suggested that questioning '*came a lot from experiences*' in that they started '*making sense of their questioning when practicing and experimenting it with their students* *(teacher J)'* in classrooms. One English mathematics teacher explained her confusion about training for questioning:

'You get sort of training that sort of encourages, they say you know it's good if you can use this type of question, but it's usually quite vague, it's because usually they're doing the teacher training, it's across a broad spectrum, it's to all teachers, so you might not ask questions in the same way in History, as you would in Science, as you would in Art, as you would in…, so each subject you can have your own way of questioning.' (Teacher G)

4.4 Variations between the Beliefs and Practices

Variations between the beliefs and practices of teachers' regarding questioning have been outlined in previous sections following the frequency of questioning, the purposes and types of questioning, wait time and questioning strategies. The Chinese teachers' reports on the frequency of their questions were inconsistent with their actual practices: whilst they reported to ask a very limited number of questions, in fact they asked nearly 2173 questions in total. In contrast, the teachers in England suggested that they asked a lot of questions, which was then reflected in their practices, suggesting a consistency in their reported beliefs and practices.

The purposes for asking questions most commonly mentioned by most teachers in the two nations were checking students' understanding, prompting students' thinking and managing classrooms. All three cited questioning purposes seemed to be broadly consistent with the types of questions they asked in practice. The types of questions asked in the lessons observed were mainly factual, procedural and managerial questioning, which was reported in the interviews, and served the purposes of checking students' understanding of mathematical facts and problem-solving steps, and managing classrooms. More precisely, both groups reported asking questions for classroom management. Of the questions they asked, there were many overlaps between factual, procedural and managerial types of questioning. A great number of factual and procedural questions also fell into the category of managerial questions in particular, which seemed to indicate a very high level of consistency in this perspective of questioning for the purpose of classroom management. What is more, the English mathematics teachers also said that they asked questions to check students' understanding, but they saw checking students' understanding as a stepping stone for extending and deepening students' thinking. Through questioning, they reported that they firstly checked their students' understanding, then based on their students' answers, they claimed to adjust their questioning. Once they understood their students' levels of ability, they would decide what kind of question they would follow up with to develop students' understanding, getting students to discover their own learning, and scaffolding their students' learning. This belief seemed to be reflected in their questioning strategies and patterns in practice since they asked individualised questioning, differentiated types of questions and abilities, and asked questions in neutral manner for the students to explain. Such consistency between beliefs and practices seemed to suggest that teachers in England were well aware of the reasons behind their use of questions.

However, there were some discrepancies. Checking students' understanding was claimed to be the primary purpose of asking questions by the Chinese teachers, but such a claim seemed to contradict the practice of students answering in unison in China, since students answering in unison could only provide answers shared by the entire class. Additionally, English mathematics teachers reported that they preferred to ask open-ended questions, which were often interpreted as requiring a higher level of thinking (Chin 2007). However, in practice, they mostly asked questions with pre-determined answers: factual and procedural questioning which were considered to be closed questions (Denton 2013a). This finding revealed that teachers' beliefs about the types of questioning they used were inconsistent with their actual practices in England. Both groups were aware of the effects of context on their choice of types of questions, including students' different ability levels, classroom activities and mathematics topics.

Regarding wait time, its lengths reported by both groups of teachers were vague, ranging from a few seconds to minutes, which made it impossible to see if there was any consistency between their beliefs and practices. However some Chinese teachers also claimed that most of the time they threw their questions to the entire class, which allowed students to decide how long they would like to take for thinking. This was reflected in their questioning practices. Additionally, in the classrooms observed, both groups of teachers seemed to deliberately give a set amount of time for their students to think before calling up anyone to answer the questions, which was considered another strategy of offering a longer thinking time for students before calling upon them. However, neither the teachers in England nor the teachers in China ever mentioned this in their interviews, suggesting a failure to acknowledge this strategy from both groups.

With regards to the distribution of questions, both groups of teachers demonstrated a high level of consistency between their beliefs and practices. However, most of English mathematics teachers also reported that they tried to distribute questions to every single one of their students in class, which was not reflected in their actual practices. Based on the different questioning distribution methods, individualised and collective questioning were identified as distinct questioning strategies between England and China: the finding indicated their beliefs and practice were consistent.

Regarding questioning for peer support, both groups' beliefs and practices were found to be consistent. Many Chinese teachers also stressed the necessity and significance of the written form of questions and answers. This belief was reflected in their practices of writing questions, together with questioning students for explanations and asking them to present on the board, which indicated a very high level of consistency between Chinese teachers' beliefs and practices.

Concerning frequently used questioning strategies, the English mathematics teachers reported that they preferred to ask their students for explanations using 'why' questions, which may at first appear to be consistent with their practices observed. However, on closely examining their 'why' questioning and their students' responses, an inconsistency was revealed. According to their responses, their intention of posing why questioning was not to look for any correct answers, but to teach the students reasoning skills, which they believed to be vital for the students to fit into the world of work outside schools. However, in practice, based on their students' responses, most of their 'why' questions simply asked for explanations of what they did to get answers in a few words. Although almost all Chinese teachers claimed that they had no questioning strategy, when I asked about it, they started to explain, which indicated some discrepancies between their beliefs and practices. Their practice of questioning a series of students of different abilities to check the understanding of the entire class is one such example of a clear strategy.

From a cross-cultural perspective, the research suggested that the English mathematics teachers were more aware of their use of questioning than their Chinese counterparts, in that more of their reported beliefs about questioning, in terms of the frequency, the purposes of questioning, and their questioning strategies, were consistent with their actual practices. The Chinese mathematics teachers used a variety of skills in their questioning practice that they were not aware of. However, it also revealed that the English mathematics teachers seemed to make claims about their practices which were greater than what took place in reality, such as the types of questions they said to ask and they actually asked in lessons.

4.5 Summary

This Chapter has presented the findings from observations and interviews, regarding teachers' questioning beliefs about questioning, and questioning practices with two groups: one of the Chinese and one of secondary English mathematics teachers. This included the convergences and divergences between beliefs and practices in the two groups. A summary of all findings was provided (Appendix 17). The next chapter will discuss these findings in the light of existing literature.

Chapter Five Discussion

5. 1 Introduction

This discussion chapter consists of two main sections: the first section focuses on how the research questions in this study have been answered, and this will be reviewed in light of the literature. This is then followed by a section that discusses some issues and themes which have emerged from the findings of the study, to reflect upon the study.

This study set out to explore and examine teachers' beliefs and practices with particular reference to questioning in the teaching of mathematics in some secondary classrooms in England and China. The contribution of this research is not only to identify the consistencies and inconsistencies between the beliefs of the two groups of teachers and their actual practices, but also to understand the way these teachers asked questions and how this was potentially impacted by their different cultural and educational systems. Moreover, it has been suggested that more research into teachers' beliefs and behaviours with regards to questioning would help in understanding teachers' use of questions in the context of mathematics (Moyer and Milewicz 2002; Sahin 2002; Shahrill 2013a; Mason 2014). This study therefore had the overarching aim of helping to expand understanding of teachers' current questioning beliefs and practices in mathematics learning in the context of England and China. As it is a comparative study, a social-cultural perspective on teacher questioning will be discussed through comparing the outcomes of the interviews and classroom observations of the two groups of teachers.

A qualitative approach was used in this study, which involved a combination of classroom observations and individual semi-structured interviews with teachers. In the classroom observations, similarities and differences in the teachers' questioning practices were examined across England and China, in terms of the types and levels of questions asked, and the sequences and strategies used, including wait time and the way questions were distributed. Following this, teachers' perspectives on the value and role of questioning, their perceptions of the frequency of their questions and the purposes of their questions, the types and levels of questions they felt appropriate, and the sequences of questions they asked were also explored in order to make a cross comparison between their beliefs and practices.

Findings have suggested social, cultural, and educational differences in the questions that the teachers asked and their beliefs about this. This chapter will address the issues related to the research questions developed earlier:

1. What are the current practices of a group of secondary school teachers in each of England and China in terms of the types and levels of the questions they pose and the strategies they use in asking these questions? What are the similarities and differences between the practices in questioning in England and in China?
2. What are the beliefs of these teachers in each of England and China in terms of their purposes for using questioning in their teaching, sourcing and preparation of questions, the types and levels of the questions they pose and the strategies they use in asking these questions? What are the similarities and differences between the beliefs about questioning held by these teachers in England and in China?
3. Are these teachers' beliefs on questioning consistent with their classroom questioning practices? If not, what are their divergences and convergences?

5.2 Research Question 1: *What are the current practices of a group of secondary school teachers in each of England and China in terms of the types and levels of the questions they pose and the strategies they use in asking these questions? What are the similarities and differences between the practices in questioning in England and in China?*

The summary and discussion of the findings related to this research question is presented in terms of the frequency, types, distribution, sequences and strategies of questions, as well as the wait time allowed between asking a question and receiving an answer. These issues will be discussed in the light of the similarities and differences between participant teachers from the two nations.

5.2.1 Teachers Asked A Large Number of Questions in the Lessons

Findings from observations reveal that all 12 Chinese mathematics teachers together asked a total of 2173 questions, and the average frequency of questioning was four questions per teacher per minute. The English mathematics teachers together asked 818 questions in total, with an average frequency of one question per teacher per minute. The frequency of questioning in both nations has been described in other research as 'pervasive' (see examples from Rowe 1978; Wragg and Brown 2001), and this study is consistent with prior studies of classroom questioning practice (Moyer and Milewicz 2002; Ernst-Slavit and Pratt 2017). The findings of my research reinforce the fact that teacher questioning is the most dominant feature of interaction between teachers and students which has been demonstrated by many previous studies in the literature (Kelly 2014; Ernst-Slavit and Pratt 2017; Dohrn and Dohn 2018), particularly in the context of mathematics classrooms (Sullivan and Lilburn 2002; Franke et al. 2009; Aziza 2018).

Another key finding from comparing the frequency of questions asked by the teachers from the two countries is that, the Chinese mathematics teachers asked many more questions than the English mathematics teachers, and they asked these questions more frequently than their English counterpart. This finding seems to concur with the finding of Leung's (1995) study. He observed teachers' classroom practices in junior secondary mathematics classrooms in 122 lessons from 18 schools in Beijing, Hong Kong and London. He found that students in Beijing were asked more questions by their teachers compared to the students from London. And he also found that whole-class instruction took up 86.3% of the lesson time, and was therefore the predominant mode of instruction. Furthermore, since the number of teachers' questions were counted within the setting of whole-class instruction, this finding may also suggest that the teaching activity in the Chinese classrooms was more dominated by whole-class instruction than in English classrooms. This finding seems to be consistent with Leung's (1995) finding above and other studies (e.g. Ma and Zhao 2015) in Chinese classrooms. The findings of my study extend both the studies of Leung and Ma and Zhao by focusing on questioning in classroom practice. In a whole-class instruction setting, all the students in a class create knowledge together (Alexander 2017). This study has demonstrated that the English mathematics teachers used whole-class instruction far less than their Chinese counterparts. One issue which bears upon this finding and may help to explain it is that of class size, will be discussed in section 5.4.1. It may also be likely that the teachers from the two countries view questioning pedagogy differently: in this study, the English mathematics teachers addressed most of their questions to individual students to encourage one to one participation, and these questions were designed to elicit the thoughts of individual students (Oliveira 2010; Lee and Kinzie 2012; Kawalkar and Vijapurkar 2013). In contrast, the Chinese mathematics teachers in this study directed their questions in a rapid fire way to the entire class in order to foster participation amongst all of the learners.

5.2.2 Teachers Asked Predominantly Lower Level Questions Related to Facts, Routine Procedures and Classroom Management

The findings further reveal that most of the questions asked by both groups were factual questioning, procedural questioning and questioning related to classroom management. More precisely, 31.1% (China) and 19.3% (England) of the questions were classified as factual questioning related to basic mathematical facts and concepts. 39.9% (China) and 73.8% (England) of the questions focused on the routine procedures that involved in solving mathematical questions. The most dominant type of questioning was managerial questioning, 67.7% (China) and 70.2% (England).

Classroom management in this study was characterised as managing students' behaviours and the flow of a lesson, including giving students directions as they were completing group activities or individual seatwork. With nearly 70% of teachers' questions in both groups being classed as managerial questions, it appears that for these teachers classroom management was a significant influence on their teaching behaviours. And it may have been, for some, a source of difficulty, which is congruent with the findings from Martin-Hansen's (2001) study which showed that when teachers adopted student-centred teaching, they saw classroom management as '*one perceived roadblock*'. In the classrooms observed, both groups of teachers gave students warnings many times, when encountering behaviour problems and in order to keep students' attention 'back to the textbook', the teacher and the tasks (Erdogan and Campbell 2008). Studies have also found that teachers ask managerial questions to manage the pace of the lesson (Myhill et al. 2006; Tan 2007). In this study, the observed teachers in both groups spent extensive time asking questions related to activity management, such as '*have you done*?' to manage the instruction related to the textbook, writing and the homework. They also frequently asked questions for students' confirmation or agreements such as *'ok?'* and '*yes?*' The purpose of these questions was to ensure that the lesson could keep moving, through checking on when students were completing assignments, or through investigating where the students were in terms of their understanding of certain mathematical concepts or mathematical problem-solving. These questions thus were recognised as not directly relevant to instruction but as being intended to control classroom behaviours (Morgan and Saxton 1991; Kerry 2002; Myhill and Dunkin 2005; Massey et al. 2008; Carlsen et al. 2010). What is more, the findings also suggest that there was a big overlap between questions aimed at classroom management and other categories of questioning. Such overlap may be due to the fact that functionally most of the teachers' questions serve the function of for communication, which may have fallen into the classroom management category (Mercer 2012).

In this study, both teachers' factual and procedural questioning seemed to be questions that required largely recall of facts and concepts; and the reproduction of routine procedures and rules, which are considered to be lower level questions leading to lower-order thinking (Denton 2017). This finding corroborates the results from extensive previous studies (Ho 2005; Myhill 2006; Tan 2007; Almeida 2010; McNeil and Pimentel 2010; Lee and Kinzie 2012; Banilower et al. 2013; Drageset 2014; Tavakoli and Davoudi 2016), from which it appears that teachers asked predominantly lower level questions in practice. For example, in a research study (Lee and Kinzie 2012) examining the use of open- and closed-ended questions of three pre-kindergarten teachers in science instruction, they found that teachers used more closed-ended questions than open-ended questions. But these findings seem to differ from the results of Ernst-Slavit and Pratt (2017) who examined one individual teacher teaching a fourth-grade class and found that this teacher asked more higher-order questions than lower-order questions. This study, however, only examined one single teacher's questioning practice and its divergence from the more usual research findings as mentioned above. My study was conducted in a wide range of class sizes ranging from 8 to 53 students, and the type of instructional activities observed varied from reviewing a lesson to learning new topics. However the class size and the type of instructional activity taking place did not seem to affect the types of questions that teachers asked. This seems somewhat to the point of departure between my study and the previous study: previous findings have revealed that teachers' use of questions are usually related to contextual features of a classroom such as the type of instructional activity taking place or the size of the group in which children and teachers are interacting (Girolametto et al. 2000; Turnbull et al. 2009). In a study conducted by Girolametto et al. (2000), they found that teachers tended to use more directive questions in book-reading activities but they asked more open-ended and prompting questions in play. Turnbull et al.'s (2009) study found that when the class size was small (1-5 students), teachers' open-ended questions occurred more frequently and were more student-centred.

The type of questions asked by the teacher can either '*open up the space of learning by encouraging students to explore possible answers and to formulate their own answers, or reduce the space of learning by confining students to only a restricted* *number of possibilities and even encouraging them to engage in guesswork'* (Tsui et al. 2004: 130). From the observations, most of the questions asked by all teachers appeared to collect answers from the students where teachers already knew the answers: the purpose of the questions was to find out if the students knew the answers (Mason 2000). In the Chinese classrooms in particular, many of the questions asked students to '*fill in the blank or the details of the definitions'* (Graesser and Person 1994: 110). Those questions were asked in rapid-fire pace to collect the correct answers and move on, in effect short-circuiting students' cognitive thinking (Banilower et al. 2013). The answers from students in this study were mostly short, consisting of a few words. The teachers from both groups also demonstrated their authority through asserting knowledge in the expectation that students would accept this without debate (van Zee and Minstrell 1997): an 'authoritative discourse' (Scott et al. 2006). All of these findings seem to echo the characteristics of lower order questions that constrain students' answers into short, brief and simple preconceived responses and inhabit true classroom dialogue (Lemke 1990; Khan and Inamullah 2011; Gokbel and Boston 2015). However, the closed lower-level questions in this study also appear to provide some valuable information for the teachers in deciding what to teach next: whether they should move on or reteach definitions, and whether they should initiate a discussion depending on how well students had answered (Hodgen and Wiliam 2006; Koizumi 2013). The reason for this might be the prioritising of lesson or content of teaching over students' learning or understanding. The teachers could be under pressure to cover curriculum objectives sufficiently to achieve the specified goals for their lessons, which may have led to the factual and procedural questions they mainly asked.

Although both groups of teachers' questions were lower-level, the difference between factual and procedural questioning in the two nations seems to show an important difference. Factual questioning in the Chinese classrooms seemed to be twice as prevalent as factual questioning in English classrooms, whilst procedural questioning in English classrooms appeared to be twice that in the Chinese classrooms. Procedural questions refer to questions that demand answers following routine procedures or using procedures, and factual questions refers to questions requiring facts, concepts and definitions (Andrew et al. 2005; Purdum-Cassidy et al. 2015). Such a significant difference could indicate that mathematical knowledge in the eyes of teachers in England and in China have different priorities in that the Chinese teachers seemed to encourage the factual development of their students, whereas the English mathematics teachers seemed to encourage the procedural development of their students. The Chinese teachers observed asked questions mostly involving extensive mathematical terminology, key words and phrases, which appears to encourage the factual development of their students (Ibid). Students were often expected to recall mathematical facts and predetermined principles to support their statements, which in a way verified the superior status of memorisation in Chinese education (Shi 2015; Guo-Brennan 2016; Ross 2017). In English classrooms, the teachers seemed to emphasise the acquisition of skills, mathematical procedures, techniques or mathematical algorithms, involving procedures or steps of problem-solving. This finding could provide an explanation of the different ways teachers perceived mathematical learning, which corroborates Leung's (1995) study that Chinese mathematics teachers saw mathematics as a fixed product whilst English mathematics teachers saw mathematics as a process.

5.2.3 Teachers Did not Wait More Than Three Seconds after Posing Questions and Before A Student Started Speaking

Before discussing the findings regarding wait time in the light of the literature, it is necessary to establish again the particular meaning of wait time in this research context. This study has focused on examining the length of what has been referred to in previous research as wait time. This refers to the pause that occurs between the teacher finishing speaking and a student starting to speak (Ingram and Elliot 2016), which is a simple definition of wait time, but has been explored by most of the previous studies in this area. There are technically two types of wait time in operation, each starting with the teacher speaking (in this study teacher questioning), one ending with students speaking, and the other ending with the teacher speaking again according to Ingram and Elliot (2014). The second type of wait time was not examined in this study, since it was observed that after a teacher's question, if they took the next turn, this usually involved them repeating their own questions, rephrasing their own questions or redirecting their questions to specific students. This type of wait time was considered as 'no response' from the students. Therefore, this study only examined wait time as that between a teacher finishing speaking and a student starting speaking.

Although the literature reviewed above came to an inclusive decision about extended wait time beyond three seconds, most scholars and educational professionals (DfES 2004) have advocated to increase a teacher's wait time beyond three seconds. The finding in this study indicates that most the teachers observed did not allow more than three seconds for students' thinking time, which corresponds with many previous studies, in that teachers naturally tend to wait less than three seconds in practice (Rowe 1986; Macbeth 2004; Seedhouse 2004; Jarvis 2006). Rowe (1978) analysed eight hundred tape recordings of lessons and found that teachers asked between three-five questions per minute, but allowed only a second or less for a child to respond before asking someone else, answering the question themselves, or rephrasing the question. In this study, the majority of Chinese and English mathematics teachers' wait time in length was found to be shorter than two seconds. There might be some possible reasons underlying the brevity of wait time. Firstly, this could be linked to the nature of conversations, since in a daily conversation, pauses tend to be less than a second (Jefferson 1989). Extended wait time of more than three seconds might make teachers feel uncomfortable and embarrassed. When a teacher treats the silence as trouble, they might start talking or interrupting before the students have the opportunity to speak. This might explain why in this study, a great number of 'no responses' from students were found after the teachers asked a question. It was also shown that teachers started to repeat, rephrase, or even redirect their questions to the next student when the students failed to offer an answer within the gap of three seconds, something which is similar to suggestions from previous studies (Liebscher and Dailey-O'Cain 2003; Maroni et al. 2008; Yaqubi and Rokni 2012; Yataganbaba and Yildirim 2016).

Secondly, it may also be that different types of questions affect the length of wait time (Kirton et al. 2007). As mentioned in the literature, factual questions tend to need a shorter wait time compared to higher order questions (Brophy and Good 1986). My findings reveal that most of the questions asked by the two groups were lower-level questions, which merely demanded recall of facts and routine procedures. This might explain why the Chinese and English mathematics teachers in the study asked questions with less than three seconds' wait time.

Thirdly, an explanation could be that teachers and students have different interpretations of how long the answer to a question needs to be waited for, taking into account the fact that teachers already know the answers to their questions (Ernst-Slavit and Pratt 2017). In the teachers' interpretation, they might think a question only requires two seconds to be answered by students, whereas in the student's interpretation of the question posed, they might need more than four seconds to answer. Such different interpretations and expectations might result in the failure of extending the wait time to more than three seconds. This could also explain the large number of ‘no responses’ from the students after the teachers’ questions in the Chinese classrooms in this study.

Most importantly, it is also worth noting the cultural contexts and structure of question-answer exchanges in the two countries. The concept of wait time in the Chinese classrooms was observed to be very different from the concept of wait time in English classroom setting. In the Chinese mathematics classroom setting, as observed, the teachers tended to pose their questions to the entire class, and whoever had the answers was free to shout their answers to the teacher. Even in cases where there was one nominated student answering teacher’s questions, other students were still welcome to respond to the contribution of this individual student. In these circumstances, it was not entirely up to the teacher to choose who would answer and when, but up to the students to decide as they answered the questions. This structure of interaction was considered by Ingram and Elliot (2016) to be closer to ordinary conversations. Because of students’ self-selection and competition, the pause between teachers and students has become naturally shorter and shorter, which could explain why most of lengths of the Chinese teachers’ wait time tended to be significantly shorter than three seconds, shorter than their English counterparts. Such short lengths of wait time were not simply due to the teachers cutting the students’ thinking time short, but were the result of students’ self-selection and competition when answering questions. In other words, wait time here has become the time that the students take for themselves rather that the time being given by the teachers to students to think. Wait time is usually defined differently to this, as the time given by the teachers to students to think before speaking out their answers (Rowe 1986) reinforces asymmetric relationships between the teacher and students. ‘*It is only structurally built in interaction where there is tight control over who can speak when*’ (Ingram and Elliot 2016: 48). This was observed in English classrooms in this study. The English mathematics teachers posed their questions, and then through asking students to put their hands up to bid, they selected certain students to answer. Such a tight structure of interaction gives the teacher the power and control (Cazden 2001; Edwards-Groves et al. 2014; Ingram and Elliot 2014, 2016) to decide how long they wanted to give the students to think, in contrast with the wait time in the Chinese classrooms. However, in the Chinese classrooms where students were encouraged to shout out responses, the concept of wait time may no longer be relevant.

This cross-cultural comparison seems to suggest that, the length of wait time is not just what teachers allow for, considering the exception to this seen in the Chinese classrooms. It is more likely to be the product of particular teaching strategies, as the Chinese teachers' questioning strategy was to throw their questions to the entire class in expectation of students to give answers freely, whereas the English mathematics teachers' questioning strategy was to ask students to put their hands up to bid for answering the questions. In this case, the Chinese questioning strategy may be more influential, in that it has shifted the norms and structures of classroom interaction where a teacher has control over who can speak and when, into a new structure of interaction which gives students more opportunities to self-select to answer questions (Ingram and Elliot 2016; Smith and King 2017).

Another important finding was that other strategies were employed by both groups in order to give the thinking time benefits of wait time. The teachers deliberately gave students a set period of time to work out a series of mathematical questions individually and allowed them to write down answers in their homework when they were reviewing their lessons. This seems to indicate that the length of wait time is associated with the intention of the teaching (Dalton et al. 2006). This finding also corroborates with DfES' (2004) idea of allowing time for collaboration before answering.

5.2.4 Hands Up vs. No-hands Rule

How teachers' questions are distributed to students has been found to be strongly associated with classroom management (Black et al. 2004; Tan 2007; Denton 2017; McDonald 2013). As found in the types of questions asked previously, managerial questions comprised most of the teachers' questions in England and China. So here, I will now present the questioning distribution strategies employed by teachers in both countries and discuss them in the light of the literature on this topic.

The findings reveal that teachers in the two nations demonstrated very distinctive questioning distribution strategies. The English mathematics teachers predominantly used hand-bidding. As mentioned earlier, this illustrates a strategy of directed questioning (Wragg and Brown 2001), which seems to make it possible to regulate and control the classroom. However, as observed, most of their questions were directed to the students with their hands up, which then had the effect of losing the rest of the students' attention and class control. In the English classrooms, one student was picked upon at a time to answer the teacher's questions. This may leave the rest of students feeling disengaged from and limit who was included (DfES 2004; Lee 2017) in the process. Moreover, once some students put their hands up, the rest may stop thinking about the answers, since the teachers preferred to pick up the ones with their hands up, which made them to believe it was safe not thinking (Lee 2017). Even the ones with their hands up might end in not thinking neither, because they might be trying to remember what they wanted to say instead of listening to other's answers and being reflective about their own. Therefore, hands up could limit students' thinking in the classroom (Ibid) and is not supportive in developing a classroom climate where students can actually think and discuss their answers together until they understand. In contrast, the Chinese teachers used no-hands rule throughout their entire lessons. This no-hands rule is slightly different from what we normally think it is as nominating students individually without asking them to put their hands up (Ibid). As observed, most of the Chinese teachers' questions were directed to the entire class, with students who had the answers shouting out loud to the teachers without putting their hands up. This no-hands rule involved more than just one individual student. This method is seen as undirected questioning (Wragg and Brown 2001). Undirected questioning has been criticised by researchers such as Wragg and Brown (2001) and Tan (2007) leading to classes full of chorus answers and a lack of control. But this strategy seems to establish a classroom culture which expects and encourages all students to contribute to the questions (Hodegen and Wiliam 2006), which may help avoid the same high-achieving students making the majority of contributions. It was found in this study that the no-hands rule appeared to have involved as many students as possible in the process. In the Chinese classrooms, it also seemed to have created a competitive culture amongst all students in the class (Tan 2007).

There are some possible reasons underlying such different questioning distribution strategies. The primary reason may have been the class size, which will be discussed in section 5.4.1. The different cultures might also contribute to the difference practices in questioning distribution strategies. A classroom culture is often defined and shaped by the culture of schools and society (Ma 2010; Leung 2014). The Confucian Heritage Culture has always been deep rooted in Chinese society, and is reflected in a classroom culture through the principal of the collective (Alexander 2000). Collective in this context means that '*teachers and students address tasks and activities together, whether as a group or a class*' (Alexander 2017: 38). In the Chinese classrooms, the teachers posed their questions to the whole class, expecting all students to give answers together. When the Chinese teachers asked their questions to the entire group, they also shouted out and echoed their students' answers many times. Moreover, studies have indicated that Chinese schools are heavily affected by the culture of examinations, whether in-school or public examinations (Leung 2014). In this study, students' seat positions were arranged accordingly based on their examinations, which took place every two weeks in schools, and the public examinations called Zhongkao (Wu 2015). As a consequence, the teachers in schools were most likely facing the pressure of meeting the targets or requirements of these examinations. In this context, as long as most of the students were shouting out their answers loudly and correctly, the teachers could keep moving to the next section of what should be taught. As reflected in this study, throwing their questions to the entire class without expecting individual students to put their hands up became the most predominant form of distributing questions. Such examination stress may also have led to the competition between students (Wong 2004), which may also explain why students in the Chinese classrooms appeared to be so competitive in answering their teachers' questions. They had to prove to the teacher that they knew the answers or solution-steps, and therefore shouted out. In this study, most of these Chinese teachers' no-hands questions tended to be quick-fire with the simple aim of obtaining an answer from students, which may suggest that these teachers were more concerned with whether or not the students grasped the mathematical content of knowledge, rather than their process of mathematical thinking. This seems to echo what other researchers (Ma 2010; Kaiser and Biomeke 2014; Leung 2014; Cai and Xie 2018) have found in East Asian mathematics classrooms, where mathematics teaching tends to focus on the transmission of knowledge from teachers to students.

In a western culture which puts a lot emphasis on independence and individualised learning (Alexander 2017), the hand-bidding strategy may best work for teachers and students in England as it addresses the question-'who is the teacher's question for': a one-to-one questioning strategy. In English classrooms, many teachers devoted their questions to one individual student until they arrived at the correct understanding of one mathematical question. The process of questioning often involved a proper process and development of mathematical thinking, which is in line with previous findings about the process of doing mathematics in western classrooms (Leung 2001; Kaiser and Yang 2017). In this study, the English mathematics teachers mainly called upon one single student to answer at a time. Distributing their questions mostly to the students with their hands up and not to those without their hands up also seems to suggest that they were concerned about embarrassing the students who did not put their hands up, since those students did not know the answers. This questioning strategy has received much criticism from studies (DfES 2004; Hodgen and Wiliam 2006; McDonald 2013) since it may discourage a supportive and inclusive classroom culture.

Findings from my study further reveal that the teachers in both nations adopted a nomination strategy. According to DfES (2004), nominating students by their names gives the teachers the authority to direct their questions to the people they want and to pitch their questions at the level of the individual students who are being asked. In English classrooms, the teachers occasionally nominated those students who did not put their hands, which suggests that they were aware of students who did not put their hands up and they asked questions to them because they wanted to include these students in the questioning process as well. Posing questions to those who did not put their hands up may indicate that teachers were interested in balancing out their questions. As observed, despite the fact that most of the questions were answered by the students who put their hands up, teachers in England also directed questions to students without their hands up. It could also be that, by nominating students who did not put their hands up, the teachers aimed to get those students involved in the classroom activities and keep their attention on the tasks (DfES 2004; Rahmah and Adnan 2017).

My observation revealed further a questioning strategy used by both the teachers in China and in England: asking students to put up their hands to check the progression of their work, which seemed to help them in keeping up with the pace of the lesson. The Chinese mathematics teachers also asked students to put their hands up to check the understanding of the whole class. However, the English mathematics teachers demonstrated an alternative informal assessment tool- the use of mini whiteboards, which seems to be particularly popular in mathematics classrooms (Preciado-Babb et al. 2015) in providing the teachers formative and ‘continuous’ feedback (Watson and Mason 1999; Andersson and Palm 2017). Checking answers with the use of mini whiteboards is interpreted as a ‘show me’ question (Denton 2013b), which seems to be more effective than simply asking students to put their hands up as was seen in the Chinese classrooms in this study, because some students might put their hands up even though they do not know the answers to the questions (Lee 2017). The use of mini whiteboards may also help to promote students’ mathematical writing skills (Martin 2007), since all students were required to write down their answers on the boards. Also, asking students to put their hands up to check understanding does not provide information on how individual students are responding to the teachers' questions, and it can only give a rough idea of how well the class has answered the questions. Showing their answers on mini whiteboards, on the other hand, is an '*all-response system*' (Andersson and Palm 2017: 114) that gives the teachers information about every student's learning so the teachers know exactly how well every individual student has performed. In this study, the English mathematics teachers consistently used mini whiteboards to assess their students in-the-moment. The continuous assessment of 'show me' questions also seems to create and support interactivity between the teachers and students (Miller et al. 2005; Morgan 2010; Preciado-Babb et al. 2015; Lee 2017).

5.2.5 Questioning Patterns and Strategies

Individualised Vs. Collective Questioning

The findings reveal that the Chinese mathematics teachers preferred to ask questions collectively involving the entire class, whereas the English mathematics teachers were in favour of asking individualised questions. The Chinese questioning pattern has been described by Alexander (2017: 28) as '*teachers and children address learning tasks together, whether as a group or as a class, rather than in isolation.*' In this study, the Chinese teachers and students were facing each other during the whole lesson, and maintained eye contact as much as was possible between one adult and a class of more than 45 students. The Chinese teachers and students indicated an orientation towards learning together; also called social or collective orientation (Leung 1995, 2001; Wong et al. 2012; Kaiser and Blömeke 2014; Kaiser and Yang 2017), and the questioning pattern in the Chinese classrooms became a rather collective form of questioning. This collective questioning has been found in other studies investigating Chinese classrooms (Huang et al. 2004; Rao et al. 2010; Ma and Zhao 2015). Additionally, the Chinese teachers' questions seemed to follow a set agenda that usually took priority over any unanticipated responses from any individual students (Chin 2006). This suggests the influences of social harmony and the '*obligation of the individual to fit into the social structure*' (Leung 2001: 44). In contrast, the English mathematics teachers asked their questions mostly at individual level; keeping eye contact with the individual student until they had finished the questions or the students had come to the right understanding. This demonstrates an orientation towards independent or individualised learning described as individual orientation (Leung 2001), illustrating a relatively individualised questioning pattern.

They firstly started questioning with a task-driven purpose, but soon followed this conversation with individual students and assessed how well they answered the questions. Their follow-up questions were frequently modified to accommodate the individual student's response, in a way a more student-centred approach, which fits the description of western culture seeing the individual as being of prime importance (Leung 2001; Kaiser and Yang 2017). The difference in the two groups of teachers' questioning patterns is in line with Hofstede (1986) and Alexander's (2017) conclusions of collectivism- individualism in terms of students' joint identity and culture in the western and eastern countries. The more detailed exploration of this will be discussed in section 5.4.2. Another potential reason for this difference in approach could be class size, as discussed in section 5.4.1.

Check the Understanding of the Entire Class through Student Representatives

This distinct Chinese questioning pattern was identified through both interviews and classroom observations. It was believed by the Chinese teachers that choosing a series of students that represent different levels of all of the students to question could give them a rough idea of the understanding of the entire class. This strategy may have been a product of the collective culture, which will be discussed in greater detail in section 5.4.2. It also seems to illustrate that the teachers knew the students well in terms of their levels of ability; as otherwise, it would be impossible to get an idea about the understanding of the entire class through a group of only 4-5 students out of a class of 46-53 students. The class size could be a major reason behind such Chinese questioning pattern, which will be discussed in detail in section 5.4.1.

Differentiating Questions or Not

The finding suggests that all of the English mathematics teachers divided their questions into different levels based on estimated students' abilities. This finding seems to suggest a high level of pedagogical knowledge amongst those teachers about types of thinking, which is similar to Bloom's taxonomy for classifying students' cognitive behaviours (Bloom et al. 1956). In contrast, there was no such pedagogical knowledge found among the Chinese teachers, since in the Chinese classrooms, all of the Chinese students were given exactly the same kind of questions at the same time. With regards to the philosophy of teaching, it could be that teachers in England were prepared and encouraged in adapting this theoretical framework of student-centred learning in their teaching and questioning from their training, whereas the Chinese teachers might not have had access to this theoretical pedagogy knowledge in their training, which will be discussed later in section 5.3.7. It may also suggest that the teachers in the two nations view the nature of learning differently. The former seemed to take a constructivist or social constructivist view of learning as knowledge construction for students through active participation in the process of learning (Piaget 1971; Vygotsky 1978; Bruner 1986), a perspective which places students at the centre of learning. The latter, on the other hand, seemed to take a Behaviourist view of learning as a passive process, with knowledge construction being transmitted from the teacher to the students, a perspective which sets the teacher at the heart of learning (Zhao 2016; Cai and Xie 2018).

What is more, the different class sizes between the two countries could be an important factor, as discussed in section 5.4.1. A further factor could be that the teachers had different expectations of their students. Given that students were allowed to work at their own level of questions in the observations in English classrooms, the English mathematics teachers might expect their students to reach target levels at their own capacity and at their own pace. The Chinese teachers might have opposite perspectives, expecting all of their students to achieve at the same level of ability and understanding. The English mathematics teachers' questioning strategy here may indicate that they were aware of the diversity of students' abilities and therefore tailored their questions to meet different levels of students' understanding or learning competences (Chin 2006, 2007), This suggests that they tended to prioritise students' individualised or personal needs in their teaching (Leung 2001); which is consistent with many of the characteristic features of individualism and independence stressed in western culture (Alexander 2000; Leung 2001; Kaiser and Yang 2017). This individualism will be discussed more in 5.4.2. The Chinese teachers' questioning strategy in this study did not use differentiation, something which might be explained by the Confucian Heritage Culture, in which effort is valued over ability, with the belief that all students can achieve at the same level with their best effort, regardless of their ability (Tweed and Lehman 2002). These parallels are indicative of culturally-based pedagogy within the teachers' questioning practices in England and in China.

Questioning for Students' Explanations: through Presentations and Demonstrations on the board vs. through Why Questioning

Questioning by asking students for explanation is the primary means of eliciting more information from students (Bailey et al. 2015; McCarthy et al. 2016; Andrew et al. 2016; Johnny et al. 2017; Ingram et al. 2018). Questioning and explaining are considered as having the potential to ascertain '*the nature and extent of students' knowledge about a particular domain by identifying the relevant conceptions he or she holds and the perceived relationships among those conceptions'* (Ashlock 2002: 195). In this study, teachers in the two nations demonstrated different questioning strategies to get explanations from students, regardless of whether the answer was right or wrong. The Chinese teachers frequently asked their students to come to the front to write their answers down and simultaneously explain loudly and clearly to the entire class how they solved the mathematical question step by step, expecting all students to check this against their own answers. This is consistent with findings from Alexander (2017), who observed some lessons in Russia, and described lessons as being similar to the Chinese lessons observed for this research. Alexander also described this style of lesson as collective. In a collective culture like China, learning is expected to be a shared experience, as observed through the individual students sharing their learning and demonstration process, including their step by step solutions together with their peers (Leung 2001; Wong et al. 2012).

This pattern also seems to give the individual students the authority to lecture on the board like their teachers, since these individual students were writing down the solution steps and explaining to their peers at the same time, acting like their teachers. Meanwhile, their peers asked questions to them in the process. In doing this, the lesson turned into student-student interactions which could create a level of collaborative learning (Jacobs et al. 2016). However, this type of peer interaction took place at an instructional level, under the strict supervision of the teacher, and in which, the teachers' questions here served to monitor the flow of the lesson, keep the rest of the class' attention on the individual student's explanations; and check the rest of the class' understanding by asking '*do you understand?' or* '*do you agree?*'(Chin 2006). In a way, the students were not explaining to the teacher how they arrived at their answers but to their peers. The students' thoughts are likely to be closer together in understanding, and therefore this approach can help in comprehending mathematical solution steps (Jacobs et al. 2016). Such student-student interactions in a whole class setting were encouraged by the Chinese teachers observed. These students acted as cognitive models for their peers, by explaining and demonstrating their problem solving strategies, the rest of class observed and duplicated successful strategies demonstrated by their peers, which relates to social cognitive theory (Bandura 2001; Chapin and Anderson 2003). This in turn facilitated the development of similar problem-solving strategies for these students (Smart and Marshall 2013). Even when students demonstrated and explained incorrectly on the board, they were still treated as '*stepping-stones to understanding'* and '*intrinsic to learning'* (Alexander 2017: 20). Such findings correspond with other studies investigating Chinese teachers' responses to students' mistakes or errors (Stevenson and Stigler 1992; Wang and Murphy 2004; Schleppenbach et al. 2007). Such an approach also seems to facilitate an inclusive classroom climate for all students: in this study, the rest of class besides the student who was presenting demonstrated a high level of willingness to participate in this process and ask questions to the student presenting. This indicates that the students feel more at ease interacting with their peers than with their teachers, who are highly regarded as high authority in a Confucian heritage culture (Zhao et al. 2011; Kaiser and Yang 2017).

In contrast, the English mathematics teachers' 'why questions' in the observation served to invite students to express their thinking, and to justify and generalise their understanding (Martino and Maher 1999; Webb et al. 2009, Webb et al. 2014). This questioning pattern seems to be consistent with a culture which places greater emphasis more on independence and independent learning, as is the case in England. Students are expected to learn independently, and thus they are asked to explain their answers individually.

Another possible explanation could be social environment. Questionings asking for justifications and explanations of students' answers are seen as effective in prompting students' learning and reasoning skills and are encouraged across English schools (DfES 2004, 2013) by the UK government. Teachers in England in this study developed their questions to accommodate their students individually, to get more information from their students and to build upon their understanding of important mathematics (Drageset 2015; Gerstein 2017; Ingram et al. 2018), or to challenge students to advance their understanding (Mercer 2008; Vijayakumar et al. 2015). However in the Chinese classrooms, the teachers' approach to asking questions did not seem to carry much significance on its own in a mathematics teaching context (Li 2010; Li and Ni 2011). Rather, teachers' questions observed in this study were not utilised in order to get more out of the students, but to manage classroom behaviour and to make sure that the mathematical content was transmitted from the teachers to the learners.

Different cultural values may also contribute to the differences in the questioning patterns of the two groups. In this study, the Chinese teachers appeared to be more concerned with asking their students to put their answers down in writing, rather than explain them out loud. This might come from a deep-rooted traditional belief that it is better to put things down in writing rather than to rely on memory alone, which comes from an ancient Chinese proverb (好记性不如烂笔头 Hao ji xing bu ru lan bi tou). In the lessons observed in this study, a great number of students were asked to write their answers on the boards whether they were going to explain to the rest of the class or not. This also could be due to the heavily examination-based environment (Wong et al. 2012), which emphasises the written form of answers above verbal answers. This is evident in my study as the Chinese teachers not only asked individual students to write their answers on the board but also asked the rest of the class to write their answers down in their homework. In western culture, thinking abilities such as reasoning and critical thinking are the priority (Chen and Bennett 2012; Chen 2014), together with an emphasis upon spoken language. In England, the government has focused its educational approach on the development of communicative expression related to intellectual abilities, which has led to the integration of speaking and listening skills. In other words, more attention is paid by teachers to prompting and developing students' oral skills—referred to as oracy (Wilkinson 1965; Jones 2017; Mercer et al. 2017) due to recent changes in the national curriculum. Students' self-expression is considered an important way of improving oracy and promoting students' learning and intellectual development (Hewitt and Inghilleri 1993). One way of encouraging students' self-expression, as demonstrated in this study, is through teachers asking for students' explorations and explanations of their thinking verbally.

The mathematical focus of the teachers could also be a factor which leads to the different questioning patterns, a notion which is consistent with the proposition made by Leung (1995) that Chinese teachers focus more on the conformity and a rigorous mathematical language, which might not be a priority for teachers in England at this stage. In the Chinese classrooms, the teachers were observed to ask their students to follow fixed steps to solve problems whilst also requiring students to present their solution format by writing this down on the board in order to check whether their students had followed their criteria of solving mathematical problems. All these observed questioning behaviours of Chinese mathematics teachers seemed to exhibit a conservative, abstract and rigorous approach to mathematics teaching (Tang and Hsieh 2014; Zhao 2016). This finding corresponds with studies into Chinese mathematics teaching (Leung et al. 2006; Schleppenbach et al. 2007) which showed that Chinese teachers urged students to express mathematical ideas precisely and formally (Leung et al. 2006) and discouraged their students from expressing these ideas informally (Schleppenbach et al. 2007). This is indicative of Chinese teachers' belief that '*learning works best through memorisation or other non-time summing ways'* (Ibid: 231). In contrast, the English mathematics teachers seemed to see the nature of mathematics as open and creative (Tang and Hsieh 2014), emphasising the importance of students figuring out their own solutions regardless of the time taken for this, something demonstrated in the lessons observed.

Funnelling and Focusing Questioning Patterns

The findings from the observations reveal that both groups of teachers broke down open-ended questions into a series of closed questions to try to ensure that the students could eventually answer without any difficulty. This questioning pattern happened mostly when students got stuck. This finding seems to corroborate those from previous studies, which have suggested that teachers tend to simplify their questions when students struggle to respond to open-ended questions (Lee and Kinzie 2012). Both groups of teachers demonstrated a frequent and almost dominant use of this questioning pattern, which supports the findings from a report (Conner et al. 2017) examining 84 elementary preservice teachers in their second of two method courses at a university in the Midwestern United States. In their study, teachers were found to exhibit consistent patterns in selecting questions with certain features, in this case, funnelling questioning pattern.

In this study, the teachers also seemed to be directing their students to 'a desired end' following a particular sequence of thinking, and expected a particular response (Davis 1996) from students in the process. This finding is consistent with what many previous studies have shown (Wood 1998; Mason 2000; Fernandes 2012; Conner et al. 2017). This approach to questioning is referred to as 'funnelling questioning' (Wood 1998) since it funnels '*students attention more and more narrowly, becoming simpler and simpler'* (Mason 2014: 515). It often occurs when teachers ask a series of direct or indirect questions that consist of heavy clues to guide the students' thinking towards 'correct' answers (Groth et al. 2016). In this study, teachers in England and in China asked the students a sequence of ever more precise and focused questions that eventually all students could answer. Research have criticised 'the funnelling effect' of this questioning pattern (Mason 2000, 2014), since it is the teacher who ends up doing much of the cognitive work and the students merely answer with the expected answers (Herbel-Eisenmann and Breyfogle 2005; Franke et al. 2009). Mason (2014: 515) also described this funnelling pattern as 'asking as telling', because teachers do not genuinely experience the mathematical problem-solving process, as they subconsciously shift into an instruction, expecting students to be '*attending the way the teacher is attending'*. In this study, the teachers did not seem to be very interested in what the students were saying and doing. Instead, they were most interested in was to how to get students to arrive at the right answers, through breaking down the questions into a sequence of small questions. During the process, they did not follow the students' thinking, but simply tried to solve the problem following their own sequence of thinking, and expected their students to follow that thinking as well. However, the teachers' thought processes might not have been accessible to the students (Herbel-Eisenmann and Breyfogle 2005; Mason 2014). Thus, those questions limited and minimised students' opportunities to '*exhibit their mathematical thinking'* (Groth et al. 2016: 54), which might have had the effect of inhibiting the learning of the students overall.

In this study, it was also found that the English mathematics teachers occasionally used another questioning pattern, which is opposite to 'funnelling': that of 'focusing questions' (Wood 1998). In the focusing questions demonstrated in this study, the teachers were not interested in solving the problem, but were more interested in what their students said and listened actively to it; Davis (1996) referring this as 'teaching by listening'. This questioning pattern is also considered to be responsive questioning, or 'focusing and zooming' (Chin 2007). The teachers were focusing on students' responses, and adjusted their follow-up questions carefully according to the response: intending to build upon it to help students progressively construct their own ideas. This questioning pattern has been suggested by several studies (Herbel-Eisenmann and Breyfogle 2005; Mason 2014; Groth et al. 2016) to be a good way to get students to elaborate, probe, and extend on their own thinking. Based on this, the teachers could ask questions which progressively help students to construct '*an integrated framework of ideas'* (Chin 2007: 832). In the observation, the teachers asked some focusing questions which enabled the students to see their misconceptions for themselves. However, not all of the English mathematics teachers used this questioning pattern, and even the ones who used this, did so only 10 times combined in total in their lessons.

The reason that both groups of teachers' questioning patterns were dominated by funnelling questioning could be due to their assumptions about the capabilities of their students. As revealed in the interviews, when facing a challenging task, and when the students indicated that they were not able to give an answer immediately, the teachers claimed that they had to bring the difficulty level of their questions down to suit students' level of understanding. This belief is strongly associated with the concept of the 'zone of proximal development' (ZPD) developed by Vygotsky (1978: 86), '*the distance between the actual developmental level as determined by independent problem-solving and the level of potential problem solving as determined through problem solving under adult guidance or in collaboration with more able peers.'* The concept claim that, with the help of the teachers, the students can answer the questions. However, in the observations, the teachers offered lower level questions that students could do without any effort, which to some extent, indicates a failure to challenge, and thus a lack of resilience and resourcefulness on the part of the students (Claxton 2002). This could also demonstrate to the students a lack of belief in their ability to solve a challenging question, which may send a message to them that they should stay away from failure and refuse even relatively simple challenges (Dweck 2000).

Teacher Questioning Incorporating Student's Answers into The Entire Class vs. Teacher Questioning Ending in A Mini-lecture

How a teacher responds to a student answer can be a very crucial part of the learning environment (Swaffield 2008; Ulleberg and Solem 2018). In this study, we saw very different questioning strategies in responding to students' answers in the two groups. In the Chinese classrooms, the teachers frequently incorporated students' words to the entire class after the student had answered. This questioning pattern works to convey enthusiasm and generate interest, (Wragg and Brown 2001) as it brings student knowledge into public view (Nathan and Kim 2009; Kawalkar and Vijapurkar 2013). The Chinese teachers illustrated two ways of conveying interest. The first one was called reflective questioning: '*catching the meaning of students' response and 'throwing' responsibility for thinking back to the entire class'* (van Zee et al. 2001: 178). This seems to corroborate van Zee and Minstrell's (1997) study, in which an experienced high school physics teacher used questions to guide students' thinking during discussions, and a particular sequence of teachers' questions was identified and referred metaphorically to 'reflective toss'. A reflective toss happens when a teacher uses questions to try to give students responsibility for thinking. In this case, the Chinese teachers reflected and addressed the thinking of one individual student to the entire class. This way of questioning seems to contradict the traditional image of teacher questioning, where the teacher asserts their authority to judge the correctness of students' answers (Lemke 1990; Chen et al. 2017). The Chinese teachers observed did not make any judgements about the individual students' answers, rather they consistently shifted their authority to evaluate answers from themselves to the students. By acknowledging students' contributions in a neutral manner, the teachers created a reflective and supportive environment in which the rest of the students had to listen closely to each other, try to make sense out of what their peers were saying, and then comment publicly on it (Kawalkar and Vijapurkar 2013). This also seemed to force the students to monitor their own understanding of their peers' thinking (van Zee and Minstrell 1997; Beatty et al. 2006). In the observations, the Chinese teachers repeatedly asked the rest of the class whether they had understood and accepted the argument made by their peers. This kind of questioning may also suggest that the teachers were aiming to get the rest of the students to participate to the questioning in the process by encouraging them to evaluate answers made by their peers. It also seems to allow for a level of flexibility in teachers' questioning, which could transform the nature of questioning into what has been called reflective discourse (van Zee and Minstrell 1997) or mathematising discourse (Cobb et al. 1997) which can help students clarify their own meanings, consider various points of views and monitor their own thinking, as demonstrated in this study. The Chinese teachers also demonstrated another form of questioning to convey and generate interest for the entire class: responsive questioning. Responsive questioning, refers to a focusing and zooming questioning strategy (Chin 2007). In this study, the teacher adjusted their questions to an individual's response, with each subsequent question building upon the previous ones to help the rest of the class to progressively construct integrated ideas. Those questions progressively zoomed in and out, alternating between a big, broad question and more specially focused questions (Ibid). However, the interviews reveal that the Chinese teachers justified their responsive and reflective questioning in terms of reinforcing and deepening students' memory of the solution steps and key mathematical concepts, alluding to the superiority of memorisation and rote learning in Chinese culture (Leung 2006; Wong et al. 2012; Shi 2015). Additionally, it also reveals teachers' beliefs in continuously monitoring students to ensure that the class was following, which seems to be related to be the control of a large class, as discussed in section 5.4.1.

Conversely, in English classrooms, the teachers appeared to conclude their questions in a mini summary to the individual students who had been questioned, demonstrating no further interest in incorporating or building upon students' thoughts for the class. This questioning pattern might be a result of individualism, the significance of which will be discussed in section 5.4.2.

Example-based vs. Inquiry-based Questioning

Another difference between the two groups of teachers lay in how questions were brought up to front during the lesson. The observations reveal that the majority of questions Chinese teachers chose to focus on were brought up through a series of worked examples. Learning from worked-examples relates to a theory of example-based learning or cognitive load theory (CLT) (Sweller 2011), which is very common in the context of teaching mathematics skills (Schwonke et al. 2009; Renkl 2017) and studies have suggested that example-based learning can be productively implemented inside classrooms (Booth et al. 2015; Barbieri and Booth 2016; McLaren et al. 2016). This is particularly found to be the case in the beginning of the acquisition of cognitive skills, when learners benefit more from the study of worked examples in comparison to solving problems (Atkinson et al. 2000; Renkl and Atkinson 2003; Renkl 2014, 2017). In this study, students were given a period of time to self-study each worked example, then the teachers followed up with a series of questions to assess their self-study by getting them to explain their solution steps by writing on the board or by speaking through them aloud (Glogger-Frey et al. 2017). Asking questions for students' explanations has been considered by researchers (Renkl 2017; Rittle-Johnson et al. 2017) to be crucial and powerful in realising the potential of learning from worked-examples and for students to gain a profound understanding of the topic (Nokes et al. 2011).

In contrast, the findings from the observations show that the English mathematics teachers asked questions based on how well students solved mathematical problems without any worked examples. This kind of learning relates to a theory of inquiry-based learning (Chin 2006, 2007) which has become increasingly popular with the support of learning theorists and psychologists (e.g. Piaget's Constructivism, Bruner 1966 and Vygotsky 1978 Social Constructivism). As observed, the teachers' questions served as an explorative tool to find out what students knew and did not know through their problem solving (Mason 2014). These questions aimed to reveal students' thinking (Ibid), drawing out their students' experiences and prior knowledge to build up the students' cognitive skills and so they could construct their mathematical thinking themselves (Chin 2006; Oliveria 2010). Teachers' questions here seemed to assist the students' own learning. Mason (2014: 515) further claimed that it was much more engaging to work on problems posed in the lesson than on '*well-worked-over problems'* (in this case, worked-examples) in a standard text.

The completely different approaches to questioning in England and China could be reflective of different 'assumptions about students as human beings' (Mason 2014). The findings from the interviews reveal that the teachers from the two countries saw their students' capabilities and engagement differently. Asking students to give answers to the problems without worked examples can be described as 'deep end' or complexity-oriented (Ibid), because the English students did not have a worked-example at hand showing all the solution steps. They were exposed to rich concepts, and had to relate and apply their prior knowledge flexibly and carefully to make sense of the problems at hand, demonstrating '*the power necessary to tackle complexity, to make sense of mathematics, and as willing to preserve in the use those powers when challenged, frequently 'folding back'* (Peirie and Kieren 1994 in Mason 2014: 514) in a spiral of frequent returns to the same idea in increasingly complex ways (Bruner 1966). In contrast, the Chinese teachers interviewed showed concerns about their students' capability to addressing mathematical problems, and even to face worked-examples. This was reflected in their practices: their questions were asked in a careful, simple manner to develop their students' learning through worked examples, involving a series of simple steps and procedures in order to build up to complexity. The students had to have their hands held as they negotiated these steps, based on a 'staircase' theory (Mason 2014). This is consistent with the pragmatic philosophy which lies at the heart of the Chinese culture (Shusterman 2004; Leung 2006; Park and Leung 2006; Cai and Xie 2018).

Another possible explanation of questioning for the differences in the learning theories underpinning questioning strategies in both nations could be the social and cultural reasons. In Chinese classrooms, which are significantly influenced by Confucius, learning comes from 'exemplars' who hold the truth (Tweed and Lehman 2002) and possess profound subject-matter knowledge (Leung 2001). In this study, the worked examples can be seen as the role models with profound subject-matter knowledge from which the students must learn. It is likely that example-based learning has been built into the teaching of mathematics in China for a long time, since all Chinese teachers claimed that they could not think of how a student can learn without worked examples. On the other hand, in UK culture and under the influence of Socrates, one should search individually for truth (Tweed and Lehman 2002). This is reflected in my study as the English students were expected to discover answers themselves first through problem-solving individually, rather than being shown through worked examples.

A third reason behind the differences could be related to the way of approaching mathematics for the two groups of teachers. The teachers in the Chinese mathematics classrooms tended to emphasise learning the mathematics content itself (Leung 2006; Cai and Xie 2018). In order to help students acquire this content, Chinese teachers in this study adopted example-based learning and claimed to repeatedly question the students to ensure that they remembered the solution steps and procedures, which seems to confirm the superior status of memorisation (Wong et al. 2012) in Chinese culture. In contrast, under the influence of a constructivist view of knowledge, which sees learning as an active process, English classrooms in this study focused more on classroom activities such as problem-solving and investigations (Leung 2001).

Questioning for Peer-Assisted Learning

Previous studies have suggested that teachers should allow their students to seek help from their peers when they do not know the answers or give incorrect answers (DfES 2004; Hodgen and Wiliam 2006; Ingram et al. 2015; Denton 2017; Dong et al. 2018). In this study, teachers from both groups demonstrated redirecting questions from one student to their peers, who were able to answer when individual students failed to give right answers. However, there was one difference; before turning to asking students' peers for help, the teachers in England asked individual students to firstly explain themselves. This gave these students an opportunity to justify their answers and stimulate further thoughts about their problem solutions, which have the potential to lead to the reorganization of their own solutions or developing new solutions (Ilaria 2009; Mueller et al. 2014; Ingram et al. 2015). Such finding supports Ingram et al.'s (2015) study of repair after a students' error where teacher's questioning was firstly asked for students' self-corrections before redirecting their peers to help. Our study further collaborates with their finding that peer corrections are more common than teachers' correction or self-correction of wrong answers in mathematics classrooms. The Chinese teachers, on the other hand, tended to ask the rest of the class to evaluate first as discussed above.

The observations also reveal that both groups of teachers employed another questioning strategy. That is, when students gave an answer, the teacher asked how many of them agreed or disagreed with the answer which had been offered, then chose one from each group to explain. In doing so, the teachers would gain a general idea of how well the students understood the lesson. Such a strategy provided students with an opportunity to hear explanations of other students' answers which were different from their own. This enabled students to focus and consider the ideas of others (Denton 2017), which could challenge their learning experience, and extend and broaden their present knowledge (Martino and Maher 1999; Lee 2017). This coincides with the belief of Watson and Barton (2011: 77) that questioning should draw upon the '*mathematical knowledge and experience we have, and on the ways we have individually encapsulated it*.' It also supports the idea that '*through exploring and unpacking mathematics, students can begin to see for themselves what they know and they well know it'* (Hodgen and Wiliam 2006: 5). In the observations, the teachers' questions to peers for support and their requests to students to consider ideas from others both allowed their students to reflect on their own ideas, and opened doors for students to become more aware of each other's ideas, which could lead to students' re-examining their understanding to offer more adequate explanations and justifications. This questioning strategy allowed students to play more active roles in their own and each other's learning through sharing their ideas and understanding with one another, and thus build a classroom community inviting active participation, confidence and further learning.

Written vs. Verbal Questioning

The findings of my classroom observations indicate that the Chinese teachers preferred to write their own questions, taking students' answers on the board, whereas the English mathematics teachers were more interested in asking questions verbally. This finding from the English classroom observations seems to be consistent with previous studies which have suggested that very limited writing takes place in secondary school mathematics classrooms (Morgan 2017). The Chinese teachers in the observations meanwhile seemed to place significant emphasis on writing mathematically. Through writing demonstration steps down on the board, students could refer back to these steps when solving a mathematical problem, particularly when students were practicing these strategies in the demonstrations during seat work. This appears that the teachers were trying to make mathematics accessible to the students by helping them visualise solution steps from the boards. This also seems to suggest that the Chinese teachers placed a lot of emphasis on mathematical solution steps or demonstration procedures, which is found to be consistent with Leung's (1995) study of teachers' classroom practice in Beijing, Hong Kong and London. This finding could be explained by that mathematics is different to other subjects in that it requires a systematic and logical flow to process thinking (Leung 1995; Mason 2002). Writing down questions and answers on the board might be seen by the Chinese teachers as helping students to process the thinking in their head.

But on the other hand, such emphasis over mathematical concepts or content could lead students into conformity in expressing mathematics. Students could also become dependent on their teachers writing answers down on the board, leading to reluctance of students to listen attentively to teachers' verbal questions of instruction, as this would ultimately be written on the board. The writing of the teachers' questions and answers helped the Chinese teachers in drawing all students' attention to the questions on the board, and to the tasks to which they were attending. The stress of the Chinese teachers over writing down the questions and answers could also reinforce the superior role of 'memorisation' (Dahlin and Watkins 2000; Wong 2004; Wong et al. 2012; Leung 2014). In the observations in Chinese classrooms, after teachers wrote on the board, the students were expected to memorise the procedures demonstrated and then put them into practice. It was also observed that the Chinese teachers did not only write solutions down but also explained these repeatedly, something indicative of 'repetitive learning' (Biggs 1996; Chiu 2016). This repetitive learning has been criticised in the western education system, which does not see repetition as true learning but *'a route to understanding'* (Biggs 1996). Conversely, the teachers in England may expect all students to listen actively and attentively, since they are given limited chances to hear their teachers' questions. Such a difference in the format of English and Chinese mathematics teachers' questioning seems to correspond with Leung's (1995) explanation of a different underlying definition of mathematics education in the two nations. For the Chinese teachers, mathematics is a product: a fixed body of knowledge imparted by the teachers to the students. This was reflected in this study as the teachers wrote down solution steps so that the students could follow those steps systematically by copying the same procedures and fixed format of solutions. In contrast, the teachers in England saw mathematics as a process, which students learned through doing it: in this study, they did not necessarily write down their questions and steps to solutions, but responded flexibly to the students. Another key reason for Chinese teachers placing emphasis upon writing down mathematical steps could be the high-stakes examination environment. Writing mathematically and talking mathematically appear to be different skills (Morgan 2005, 2017). In Chinese mathematics classrooms facing the pressure of public and in-school examinations, the students were expected to produce lengthy pieces of writing to report their work on mathematical tasks. Teachers' emphasis on writing mathematically might be caused by the need to achieve this. As observed in the Chinese classrooms, the teachers wrote almost everything down, with the expectation that students would also write everything down throughout the lesson.

5.3 Research Question 2. *What are the beliefs of the group of secondary school teachers in each of* England *and China in terms of their purposes for using questioning in their teaching, the types and levels of the questions they pose, the sourcing and preparation of questions and the strategies they use in asking these questions? What are the similarities and differences between the beliefs about questioning held by these teachers in* England *and in China?*

An answer to this research question will be attempted using data arising largely from the interviews with the teachers, and will be presented based the values which these teachers appeared to hold concerning: the role of questioning in teaching, the frequency and purposes of teacher questioning, the sourcing and preparation of questions, the types and levels of questions they felt were appropriate, and appropriate strategies and sequences of teacher questioning including wait time and question distribution strategies.

5.3.1 Teachers' Perspectives Concerning the Role and Frequency of Questioning in Their Mathematics Teaching

It seems that the English mathematics teachers valued the process of teacher questioning more highly than their Chinese counterparts. Such different values may stem from the different cultural and historical contexts underlying the use of questions in teaching (Alexander 2000; Skott 2009; Cai and Wang 2010; Seah et al. 2017). In England, questioning has been deeply rooted in western education: it can be traced back to the classic Athenian philosopher Socrates (469-399 BCE) who tended to repeatedly question himself and others, giving rise to what has become known as socratic questioning or the socratic method. The significance of questioning in western educational thinking has been long and widely documented (Dillion 1984, 1988, 1990; Mercer 1995; Walsh and Sattes 2016; Webel and Conner 2017). This is in contrast to the Confucian Heritage Culture in China, in which '*learning is not focused on questioning, learning is instead mainly from the collective, from individuals whom the collective recognises as exemplars and from the ancients who the collective recognizes as even greater exemplars'* (Tweed and Lehman 2002: 92). The philosophy of Confucius (551-479 B.C.E.) has profoundly affected Chinese education. The value of teacher questioning has been well built into the national curriculum (DfES 2004), and teaching pedagogy and practice for a relatively long time in English classrooms. Together with extensive research (Mercer 2012; Edwards and Mercer 2013; Alexander 2017) exploring practice in teacher questioning, teachers in England appear to be theoretically much more aware of their use of questions and their importance to mathematics teaching and learning than their Chinese counterparts.

The difference in valuing questions could also be explained through examining the social and cultural contexts. Culturally, mathematics teaching in China has the unique and typical feature of placing a great deal of attention upon practice, holding the belief that 'practice makes perfect' and students should have sufficient exercises in order to consolidate the learned knowledge' (Wong 2004; Zhang et al. 2004; Li 2006; Ma 2010; Ma and Zhao 2015). That might explain why the Chinese teachers interviewed claimed that questioning was time-consuming, since they might prefer to give time to students to review and reinforce what they had just learnt through practical applications. In contrast, in the context of western education, especially in England, and under the influence of social cultural theory (Vygotsky 1978), learning is not seen to take place in isolation, but through dialogue and social interaction with others in classroom activities (Lee and Kinzie 2012; Littleton and Mercer 2013). This theory suggests that there are particular frameworks which underpin the function of teachers' questions and their importance in the process of knowledge construction in students, which explains why English mathematics teachers who were interviewed highly valued the role of questioning and claimed to ask a lot of questions. The difference in the cultures of teaching and learning between the two nations may explain why the two groups of teachers held such different opinions on the value of questions.

A further reason behind such differences might be the influence of the different educational environments for the two national groups. All the Chinese teachers mentioned that they were constrained by the fact that they had to make sure that students were ultimately able to get good marks in the tests which were held every few weeks. At secondary school level, they needed to prepare students to get used to tests and eventually compete at the national college entrance examinations. Therefore, these teachers and their students spent a lot of time doing exercises following the textbooks and other exercise books combined with the textbooks. This finding is consistent with extensive studies (Wong et al. 2012; Leung 2014; Zhou and Wang 2016) exploring the examination-based environment. This type of environment with its inherent competition, may have put a lot of pressure on the Chinese teachers and have led them to prioritise ensuring students complete a large quantity of exercises over their own pedagogical performance. For the Chinese teachers in this study, pedagogy was not an issue of significance. That could explain why they did not pay attention to their use of questioning. The English mathematics teachers may have felt less pressure from the prospect of examinations. This less pressured environment might have the effect of offering them greater opportunities to focus on pedagogy practice. Understanding the effects of different educational environments could help to explain why the Chinese teachers did not place as much value upon their pedagogical skills as their English counterparts.

Such different values were clearly reflected in teachers' self-reports on the frequency of their questions: all of the teachers in England believed they continuously asked a lot of questions throughout their lessons. In contrast, most Chinese teachers claimed they asked very few questions, consistent with previous studies which have claimed that teachers tend to underestimate the number of questions they ask in the lesson (Wragg and Brown 2001). The difference between China and England in teachers' reports on the frequency of the questions they ask during lessons seems to suggest that the English mathematics teachers have a better understanding of their own practice in questioning than the Chinese teachers in this study.

5.3.2 Purpose of Questioning

The findings suggest that checking students' understanding, prompting students' learning, managing classrooms and getting students engaged were among the most frequently mentioned purposes of questioning by both groups of teachers, which seems to be in line with previous literature (Wragg and Brown 2001; Harris 2014;

Walsh and Sattes 2016; Muijs and Reynolds 2017). Checking students' understanding of both the current and previous knowledge was the primary purpose mentioned by all the teachers. This relates to the pedagogical concept of informal formative assessment (Black and William 1998; Ruiz-Primo and Furtak 2007; Heritage and Heritage 2013; Jiang 2014; Powley 2018). The teachers checked students' prior knowledge through reviewing what they had learnt from previous lessons at the beginning of their lessons. Through the feedback provided by this review, they believed to gain a better idea of their students' current understanding and expected to use this to plan and organize further for their teaching to follow. Some teachers interviewed also claimed that prior knowledge also revealed their students' thinking. Based on students' responses, some of the teachers from both groups believed they could uncover their students' understanding and misunderstandings. Through establishing students' prior knowledge and understanding, the teachers would be able to '*develop their learning and understanding of new information and concepts effectively*' (Myhill and Brackley 2004: 273). However, this claim of aiming to conduct formative assessment seems to contradict the practice of students answering in unison in China, which will be discussed in section 5.4.1.

Promoting students' learning was the second most mentioned questioning purpose. It was believed that questioning would probe students' thinking. The Chinese mathematics teachers did not offer any more explanations beyond this. However the English mathematics teachers elaborated further, explaining that their questions were structured to 'scaffold' students beyond their current thinking. This may be with the concept of scaffolding (Wood et al. 1976) which leads to students' construction of their mathematical knowledge. One of the characteristics of 'scaffolding' relevant to questioning is '*contingency,*' which is '*responsive, differentiated, or adjusted support*' (van de Pol et al. 2010: 275). Based on students' responses, teachers' questioning operates as a scaffolding strategy which provides and adjusts contingent support, through firstly determining and then responding to the level of students' understanding (Lee and Kinzie 2012). The English mathematics teachers also expected their students to reflect and discover things while learning. This finding is consistent with the concept of '*learning by doing*' in western culture (Leung 2006) or ''the *pragmatic culture of mathematics*' (Cai and Wang 2006, 2010), and is also consistent with the notion of '*talk for learning*' (Edwards and Westgate 1994; Bakker et al. 2015; Alexander 2017; Mercer et al. 2017). Researchers have suggested that teachers' questions may be used to foster the learners' learning by both extended and reflective talk, which is characterised as dialogic talk (Alexander 2008) or exploratory talk (Mercer and Hodgkinson 2008). This also corresponds with the recent emphasis upon the significant role of talk or classroom dialogue in England (DfES 2013; Rabel and Wooldridge 2013; Edwards-Groves et al. 2014; Díaz 2018).

Classroom management was another purpose of questioning mentioned by most teachers interviewed. This finding confirms previous research that has suggested that teacher questioning has always been strongly associated with classroom management (Wragg and Brown 2001). However, this finding also revealed a variation between teachers in how to bring the questions to the attention of students with behavioural issues. This may be due to different teachers' preferences in their manners of asking questions. The different attitudes in whether or not asking questions to embarrass students with behavioural issues could also indicate that the emotional and social development of young students at this stage is an issue (Bennett 2014).

Maintaining interactivity within the lesson was also found to be important to the Chinese teachers, since they emphasised the necessity of hearing from their students in whole class teaching, which seems to be in line with the notion that questions invite a response and are thus a type of interaction (Myhill and Dunkin 2005). In this case, questioning for interactivity seemed to be principally concerned with classroom management, as the teachers expected to involve as many students as possible in taking the position of 'listening' in this process. This might have been constrained by the large class size, which will be discussed in more depth in section 5.4.1.

In conclusion, formative assessment and classroom management were the two major purposes of questioning in both countries. The main difference between the two groups was that the English mathematics teachers were more concerned with students' individual learning. Whereas, the Chinese mathematics teachers were more worried about classroom interactivity, continuously monitoring students, and imposing a traditional and authoritative image of mathematics teaching (Scott et al. 2006). The English mathematics teachers, on the other hand, expected to use questions to get their students to think, to justify, to explain, to speculate, and to discover their own thinking for themselves, which seemed to encourage 'exploratory talk' (Mercer 2012; Rabel and Wooldridge 2013), 'learning by doing', and 'scaffolding' learning, all of which embrace the concept of social-cultural theory

(Vygotsky 1978). These findings fit with inquiry or constructivist teaching (Smart and Marshall 2012; Ong 2015). The different priorities of the purposes of questions for the teachers in the countries could be explained by the respective collective and individualised cultures of the two countries; and their beliefs about mathematics and mathematics education which will be discussed in more detail later in section 5.4.2.

5.3.3 Content Focus and Types of Questions

Findings from this current study seem to suggest that most Chinese teachers who took part did not have any explicit theoretical knowledge about the types of questions they intended to ask. This may be due to the teachers' educational backgrounds since only one Chinese teacher was aware of Bloom's taxonomy.

Half of the Chinese teachers interviewed reported that they preferred to ask questions with more than one correct solution to their students. Many mathematical questions consist of more than one correct solution, and can considered as 'open-ended' questions (Lampert 2001; Lee et al. 2012). These types of questions created opportunities for the teachers and students to communicate and discuss possible answers and solution methods together, which was claimed by the teachers to attract their students' curiosity and interest in engaging in the process of mathematical thinking. Such a claim is consistent with previous studies that have found students' high enjoyment and lower boredom (Pekrun 2006; Schukajlow and Rakoczy 2016; Schukajlow and Achmetli 2017). All students were encouraged to provide different methods for one single mathematical question, which then could extend all of the learners' learning and thinking. This may be due to the fact that it encourages the learners to express and justify their own thinking, and meanwhile considering other possible answers provided by others, thus similarities and difficulties between the different answers can be considered (Martino and Maher 1999). This could function to broaden the students' knowledge (Martino and Maher 1999; Leikin and Berman 2015; Zaidi et al. 2018).

Rather than explaining questioning typologies and theoretical frameworks, the Chinese teachers focused on the content of their questions in the interviews. The Chinese teachers were found to emphasise the mathematical terminology, definitions, facts and procedural fluency, which, to some extent, were considered to be basic factual and procedural knowledge in mathematics. Prioritising factual and procedural knowledge seems to confirm Chinese teachers' emphasis upon the 'two basics': the basic skills and the basic knowledge, something which has been found by previous studies on Chinese mathematics teaching (Zhang et al. 2004; Ma 2010). It could also be due to the teachers' lack of confidence in their learners. In the interviews, the Chinese teachers reported their concerns over students encountering problems in later problem solving using basic facts, definitions and terms if they did not have a full understanding of these beforehand.

The emphasis upon factual and procedural knowledge could also suggest that secondary education in China is foundation education: establishing a good foundation is the main task of mathematical education (Zhang et al 2004), as without a solid foundation, it is impossible to progress students in their learning. Many Chinese teachers claimed that they spent more than half of their lessons establishing foundation knowledge with their students. Only one English mathematics teacher mentioned that it was important to draw out students' understanding of mathematical knowledge and the symbolism of mathematics before they could apply these in practice, revealing the different effects of the National Curriculums in England and China, as mentioned in the literature (Ministry of Education 2012; DfES 2013).

However, all of the teachers in England were fully aware of different types of questions from theoretical perspectives: they reported that they were encouraged to use open-ended questions or open questions when they trained to become teachers. The details of teacher training can be seen in section 5.3.7. Many also referred to Bloom's taxonomy when classifying questions. As mentioned earlier, Bloom's taxonomy is considered to be one of the most popular classifications (Bloom et al. 1956) and researchers have continuously used and revised this framework (Mullis and Martin 2013; Walsh and Sattes 2016; Diab and Sartawi 2017). As mentioned in the literature review, Bloom's taxonomy consists of six domains which follow a hierarchy of cognitive levels: remember, understand, apply, analyse, evaluate and create. However, researchers have criticised the hierarchy of Bloom's taxonomy in classifying teacher questions (Zaidi et al. 2018), and the findings in my study seem to support the critique that Bloom's taxonomy does not fit mathematics. Mathematics questions was seen to have a different order to that of the Bloom's taxonomy: whilst *create* is placed at the top of Bloom's taxonomy, in mathematics a student could create a question without necessarily fully understanding it. This reinforces literature which have argued that mathematics understanding is not necessarily a linear progression (Sfard 1991; Watson 2007). Being able to explain and understand how to do something in mathematics was argued to be a much higher skill than being able to create a question. This echoes Watson's (2007) claim that Bloom's categories of *remember* and *understand* in mathematics could be interpreted at different levels of mathematics. With all of this in consideration, they suggested to adopt Bloom's taxonomy but then developed this into their own types of questions for their mathematics teaching.

The results of the study further reveal that contexts such as classroom activities and lesson topics could affect the types of questions asked, which is consistent with the previous literature (Young 1992; Myhill and Dunkin 2005; Smith and Higgins 2006; Phillips 2013). The types of questions asked would be different when reviewing previous knowledge compared to those asked when working on something new. Similarly, the types of questions asked would be different when giving a lesson on probability statistics to a lesson on algebra (Mason 2000). This suggests that the teachers acknowledged the variety of ways in which questions could be developed and modified according to the circumstances.

The interviews also reveal that students' ability had significant impact over the types and levels of questions teachers asked within class, which is consistent with previous literature (Pham and Hamid 2012; Dong 2017; Caleon et al. 2018). All of the teachers in England emphasised the need to cater to students' individual differences, which aligns with the concept of individualised and student-centred learning (Leung 2001; Kaiser and Yang 2017) in western culture. They suggested that they could not ask a question which appeared to be inaccessible for the students in terms of understanding. However, such catering for individual difference may result in teachers' questions being asked at a lower level, which could limit students' development of higher level mathematical thinking (Mason 2014). On the other hand, the Chinese teachers explained their struggle to adjust their questions to suit students individually. Instead, they claimed to choose students accordingly based on the difficulty level of questions, by posing easy and simple questions to lower level students and difficult questions to students of higher ability. It appears that the Chinese teachers expected to create a culture of participation to get students motivated in the process of questioning, strengthening their self-efficacy (Pajares 2005) and establishing classroom norms that would foster a sense of community for their students (Bennett 2014). This belief also seems to embrace the social harmony perspective of collectivism (Hofstede et al. 2010). It was also reported by the Chinese teachers that the lesson objectives took priority over the students since they had fixed tasks and goals for all students across the class. This finding is indicative of the unified curriculum in this collective culture (Cui 2009; Wong et al. 2012), which will be discussed further in section 5.4.2. Another reason the Chinese teachers gave was class size, which will be discussed further in section 5.4.1.

5.3.4 Sourcing and Preparation of Teacher Questions

The findings on this topic of sourcing questions are presented and discussed from two perspectives: teachers' reported preparations of questions and their reported sourcing of questions. Lesson plans and preparation of questions are important to deliver an effective lesson (Swan 2008; Cai et al. 2014; Jones and Edwards 2017). As reviewed previously, teachers' question preparation can have the potential to affect the level of the questions they ask in lesson; particularly in cases where teachers have to prepare their higher cognitive questions before asking these in practice (Denton 2013b). The results reveal that the Chinese teachers prepared lessons and questions on a daily basis, consistent with other studies of Chinese teachers' lesson plan (Huang and Leung 2004); whereas the English mathematics teachers planned their questions every half term or full term, referring to a practice called 'medium-term planning' (Jones and Edwards 2017). Such planning is significantly influenced by the KS3 Framework for Teaching mathematics, which is designed to provide guidance on meeting the national curriculum requirements for mathematics for children aged between 11 and 14. It sets out yearly teaching programmes showing how objectives for teaching mathematics can be planned using medium-term planning. The medium-term planning is then specified within a scheme of work, which helps teachers to interpret the key Stage 3 framework for teaching mathematics (Pimm 2014). This scheme of work is particularly common in lower secondary school mathematics in England. Many English mathematics teachers mentioned planning their questions and lessons according to the scheme of work and their yearly teaching programme from the mathematics department.

This results of this research suggest that the Chinese teachers tended to prepare their teaching thoroughly (Yang and Ricks 2012; Cai et al. 2014; Chen and Leung 2015), whilst the English mathematics teachers seemed to be less well prepared for their lessons and questions, instead expecting their questions to come spontaneously depending on the situations and student understanding. One reason given for this was teaching experience. Teaching experience was believed to allow the English mathematics teachers to see opportunities for spontaneous questioning while conducting the lesson. On the other hand, the Chinese teachers saw teaching experiences to be helpful in predicting the points at which questions would arise, including where the students' common misconceptions might be. They then incorporated these questions into their lesson preparation. This belief corresponds with the idea that common misconceptions or errors should be the focus while designing tasks before lessons (Borasi 1996; Swan 2008; Ingram et al. 2015). It also seems that the Chinese teachers' lessons were more structured (Cai and Wang 2006, 2007) compared to those of the teachers in England. Such structured preparation for lessons and questions may also be indicative of a feeling of incompetence on the part of Chinese teachers (Leung 1995), or it could be the result of a tradition of what is expected of a teacher in China, since many Chinese teachers reported that their lesson plans and questions were regularly checked by the authorities.

The findings of teachers' sourcing of questions reveal that the textbooks were the main reference in China. Textbooks are an important resource for teachers' questions in teaching mathematics at schools (Jones and Edwards 2017). The dominant role played by the textbook in Chinese teachers' sourcing questions seems to corroborate the claim that '*teachers and students regard the textbook as a 'Bible''* (Park and Leung 2006: 130). It also indicates that sourcing questions is quite constrained by the textbook (Ma 2010). This could be a result of the centralised curriculum and assessment systems (Leung and Li 2010; Usiskin and Willmore 2008), as the mathematics textbook is developed in alignment with the nation-wide unified curriculum standards (Li et al. 2009; Ministry of Education 2012). The significant role of the textbook could also be reflective of Chinese collective culture or collectivism (Mercer and Hodgkinson 2008) will be explained in section 5.4.2. With such emphasis on the uniformity of teaching contents from the textbooks, this could result in a lack of individual development among students (Wong 1998; Cai and Wang 2007).

The study reveals that the Chinese teachers also sourced their questions from students' exercise books and examination papers from previous years. One reason for this was the achievement-orientated examination culture (Leung 2006; Wong et al. 2012; Feniger and Lefstein 2014; Tan 2017a). On the top of this, Chinese parents place great emphasis on the academic achievements of their children (referring to 望子成龙 Wang zi cheng long) and there is a tradition of expecting children to meet the needs of their parents (referring to 报父母恩 bao fu mu en) (Cai 2003; Chiu

2014). These traditions may have contributed to the development of the examination culture (Leung 2014), since it allows '*an individual, regardless of their family background, to climb up the social ladder by striving to pass a hierarchy of examinations'* (Wong 2004: 513). To some extent, the examination culture has a far greater impact on education in China than Confucianism. This cultural tradition may well explain why the Chinese teachers felt compelled to set questions that enabled students to compete in examinations as the priority, doing this by selecting numerous typical and representative questions outside the textbooks from examination papers and exercise books. This also seems to confirm the significant role of rote of learning in China (Leung 2001, 2014). In contrast, the teachers in England preferred to create their own questions based on the students' level of abilities and understandings, with the availability of textbooks. This indicates a great deal of flexibility and diversity in their method of sourcing questions. It may be that the national curriculum in England allows for such flexibility and diversity (DfES 2013). Their approach to sourcing questions also seems to be strongly associated with the student-centred culture (Kaiser and Yang 2017) and a culture of individualism (Leung 2001).

Findings from the interviews also reveal that the Chinese teachers' questions were mainly prepared centred upon the lesson objectives, whilst students were placed at the centre in the sourcing and preparation of questions in England. This could also be indicative of collectivism–individualism, which will be discussed in section 5.4.2. It could also be a result of institutional policies. As the Chinese government required all teachers teaching to follow closely to their standardised textbook curriculum, this may have left no space for them to design their own questions which could be centred upon their students. In contrast, the department of education in England has currently been promoting oracy education and spoken language (Mercer et al. 2017; DfES 2013) across England (i.e. the UK's National Oracy Project (Norman 1992), which may have encouraged the teachers to prepare questions focused on their students in order to get them talking more in class. Furthermore, the highly competitive environment in schools in China could be a contributing factor. In the interviews, all of the Chinese teachers claimed that students were allocated in a hierarchy of examination marks, which again reinforces the achievement-oriented classroom culture (Wong et al. 2012). The competitive examination-based environment, could explain the Chinese teachers' anxiety and their priority of lesson objectives. This prioritised questioning could come at the expense of their students' understanding and needs (Wang and Murphy 2004; Chin 2006; Cai and Wang 2007).

5.3.5 Questioning Distribution Strategies

Questioning distribution strategy often involves two questioning strategies: directed questions to students and undirected questions to students (Wragg and Brown 2001). Directing questions to students consists of hand-bidding and nominations. The findings reveal that no-hands rule was among the most favoured method of distributing questions for the Chinese teachers, whilst the majority of English mathematics teachers preferred hand-bidding strategy. No-hands rule, according to the Chinese teachers, was where a teacher posed a question to the entire class, expecting students to answer without their hands up. This method has been criticised for failing to prompt students' understanding and learning (Alexander 2017). However, it seems that the Chinese teachers used the no-hands rule to establish social equity within the questioning environment (McDonald 2013). In such an environment, everyone is welcome to make a contribution to answer their teachers' questions, which may explain why the Chinese teachers claimed that this strategy could involve as many students as possible, rather than just one student. By failing to nominate any individual students in particular, all students would have to listen carefully to their teachers' questions and to be prepared to answer (Rahmah and Adnan 2017); to some extent this serves to involve all of the students (Leahy et al. 2005). No-hands rule was claimed to indicate that all students had to contribute to the question, which would give opportunities to all students to talk, including lower level students (Watson 2007). Students' preferences may also contribute to the use of the no-hands rule. Students may be not willing to putting their hands up to bid to answer, because they might not want to be put on the spot in class. In consideration of the young students' social and emotional feelings towards hand-bidding and nomination, the no-hands rule seems to work well for both the Chinese teachers and their students. With so many voices answering the same question, the students who are not willing to respond or who are shy might be encouraged to speak out their answers (Ma 2010).

In contrast, hand-bidding was the English mathematics teachers' favourite method. This distribution strategy might be expected to create a classroom culture that is respectful and regulated for both teachers and students, so that everyone can hear each other in the process of questioning (Hodgen and Webb 2008). Another explanation for using the hand-bidding method was that it did not put anyone on the spot who really did not know the answers. It was believed that some students needed time to build their confidence to raise their hands. However, this belief may be problematic, since some students may know the answer but might be too shy to put their hands up, thus they would probably never get a chance to speak in class, or have the opportunity to develop their skills of mathematical reasoning and thinking (Morgan 2017).

The results from this study also reveal that nomination was a choice for both groups of teachers. The reason given by the teachers in England for using this method was to balance their questions out not only to those students who put up their hands, but also to those who did not put their hands up, which supports suggestions from several previous studies (DfES 2004; Watson 2007; Alexander 2017). It may be that the teachers used a combination of bidding and nomination to keep all students focused, particularly those who were off-task or misbehaved (Kelly 2002; Tan 2007). Both groups of teachers suggested that all their students had to be prepared that anybody could be asked for an answer. It may also be that the teachers expected to involve and support all students when they asked questions, whether they put their hands up or not, and particularly those less able students. Doing this could avoid having the same group of students always putting their hands up to provide answers.

The findings further reveal that the context in which the questioning took place, including the lesson topic, the intention of their questioning and how the students were doing, could potentially affect teachers' distribution methods. Context, according to Young (1992), is very important since the complexity of classroom life creates difficulties for teachers to implement their questioning distribution strategies. A no-hands rule might be used at the beginning and the end of the lesson to evaluate students' understanding of previous and current knowledge. Nevertheless, the English mathematics teachers stressed the need to question every single student once in the lesson. This belief is consistent with a culture of individualism, however, in the interest of maximising the number of students taking part, interactions with individual students might end up being '*briefer, more random and scattered*' (Alexander 2017: 20).

Hands-up to Check Understanding or the Progression of Work

The finding of the study further reveals the need for teachers to see progression of work, to keep up the pace of their lesson, and to see how well their students understood what had been taught. This was done by asking students to put their hands up. Many teachers in England advocated for using mini whiteboards because students could fake their levels of understanding by putting their hands up. In that case, mini whiteboards were believed to work for the teachers in helping them to find out how well their students understood as they provide them with information about every students' learning during a lesson, solving the problem of the difficulty of acquiring information about every single student in a class (Andresson and Palm 2017). Functioning as a formative assessment tool, it was reported that mini whiteboards could help them to interpret their students' thinking and the skills underlying the students' responses. Based on this, they could identify their students' learning needs, then could ask more specific, student-centred questions to better meet these needs, confirming its effective integration into questioning practice (Denton 2017; Andresson and Palm 2017).

5.3.6 Questioning Patterns and Strategies

Individualised vs. Collective Questioning

The research reveals that the Chinese teachers preferred to ask questions collectively whereas the English mathematics teachers were in favour of individualised questioning. Collective questioning is where teachers ask questions to the entire class, in expectation of students answering in unison, whilst maintaining eye contact with all students. One reason given for the use of this approach in China was class size and the effect of this will be discussed further in section 5.4.1. It was also suggested that collective questioning helped for classroom management, since it seems to help teachers to keep everyone focused and enable them to communicate with all students constantly (Wragg and Brown 2001). It was also believed that the mathematical queries were shared by all students, so instead of questioning one or two, it was best to question students collectively as a whole. Such a belief is closely associated with the culture of collectivism discussed in section 5.4.2. Such collective questioning behaviour could also be a subconscious teaching habit, as some Chinese teachers claimed to be too boring to have themselves talking only during the entire lessons.

In contrast, individualised questioning was believed by the teachers in England to work best for individual students: since students had their own unique capacity and pace of learning mathematics, they should be challenged at their own pace and level of understanding. From this perspective, the pace of students can be defined as the '*interactive pace and cognitive pace or the speed of thinking and learning*' (Alexander 2017: 20). They set their lesson pace flexibly, centred on the students, which suggests that the teachers aimed to extend classroom talk (Mercer and Hodgkinson 2008). In contrast, the Chinese teachers had a relatively fixed pace for their lessons, set at the level of the majority of students (Li and Ni 2011) and centred upon their lesson objectives: this tended to lead to the abbreviation of classroom talk. Underlying the two different beliefs could be the different cultures of individualism and collectivism (Leung 2001, 2014), which will be discussed in section 5.4.2.

Differentiating Questions in England

The English mathematics teachers explained that they grouped their students of different abilities into different coloured groups and they then provided them with different types of questions, or they used a worksheet consisting of different levels of questions (e.g. MUST, SHOULD, COULD as mentioned earlier). And then they asked their students to choose the level of questions they felt comfortable to answer. It allowed all students of different abilities to answer different levels of questions at the same time. One reason they gave for this was that it covered all levels of students in class and could make sure all students were challenged to further their learning. Such beliefs are strongly associated with student-centred and individualised questioning (Chin 2007), in viewing students as the centre of learning, in a constructivist philosophy of learning (Vygotsky 1978). Again, this belief is in line with individualism, which puts the individual as the primary focus (Hofstede et al. 2010; Kaiser and Yang 2017) in a society. This culture of individualism will be discussed later in section 5.4.2.

Many teachers claimed that students gained confidence and self-esteem from accomplishing questions. Students' self-esteem has been found to be strongly associated with students' perceived self-concept and motivation in learning mathematics (Roykenes 2016). Differentiating questions were claimed to give more flexibility to students to move on following their own routes through the content. However, some teachers claimed that students could be over confident about themselves and chose harder questions than they could manage. There seems to be a conflict in the beliefs of teachers and students about students' capacities, in that students were more willing to tackle a challenge but teachers were frightened because they believed their students would be unable to address these. Such beliefs might result in the students' '*lack of challenge, and hence lack of resilience and resourcefulness'* (Mason 2014: 514).

Questioning for Students' Explanations: through Presentations and Demonstrations on the board vs. through Why Questioning

The study reveals that the favourite questioning strategy of the English mathematics teachers was asking students 'why questions' verbally, whereas the Chinese teachers favoured was asking students to give answers and presentations written on the board. These strategies were claimed by both groups to be primarily for the purpose of checking the understanding of individual students. Such different beliefs over verbal and written expressions of students' thoughts may reveal the different cultural assumptions. The English mathematics teachers seem to see talking as '*a positive act'* that can '*create, change, and signify'* (Kim 2002: 828) thinking, through which, individual students explain their ideas. This is a reflective of the '*core value of western culture –individuality*.' In contrast, in Chinese cultural tradition context, the assumption about talking and thinking is absent (Ibid).

It could also be that the teachers in England and in China emphasised different mathematical ability and skills, since talking mathematically and writing mathematically are different skills (Morgan 2017). Writing mathematically demands '*greater completeness and explicitness than is generally used for oral communication'* (Ibid: 157). Writing mathematically requires students to think about what words to use and how to express their ideas precisely. Even students who were very good at mathematics may experience difficulty in mathematical writing. This statement is strongly supported by the Chinese teachers in their interviews, who prioritised written answers. They felt that one reason for this was the pressure of examination competition (Tan 2017b). However, this is opposed to the western view of learning, which sees examination pressure as harmful to learning (Leung 2006).

The teachers in England, meanwhile, initially aimed to force students to think and to be clear with their understanding, expecting students to develop the ability to communicate mathematical ideas verbally. It seems that learning to talk mathematically and reason mathematically are very important skills to them. They also expected students to take responsibility for their own study, and aimed to prepare them for the world outside school where the students would be more likely to be asked for explanations than answers. Reasoning and speculation have always played an important role in questioning (Lithner 2015; Alexander 2017), through which teachers can develop students' critical thinking (Ingram et al. 2017; Chikiwa and Schafer 2018), students' creativity (Nathan and Kim 2009) and promote students' ownership of learning (Patahuddin et al. 2018). Critical thinking is reflective and reasonable thinking that focuses on deciding what to do or to believe (Aizikovitsh-Udi and Cheng 2015).

The study also reveals that the effect of getting students to explain worked better for students' learning than the effect of their own teaching claimed by both groups of teachers. However, the reasons given by the two groups of teachers for this were quite opposing. The Chinese teachers claimed to aim to create competition between all students, which would encourage students to listen actively and attentively to their peers' explanations to identify potential mistakes. This corresponds with the concept of peer assessment (Adediwura 2015). Peer assessment allows students to play an active part in the assessment process, and provides more opportunities for students to think and explain (Ibid). In contrast, the teachers in England believed that their students would appreciate how their peers explained answers. They found that their students explained things better than they did, particularly for the age of the students they were teaching, because students used the terminology and language of their age group. This finding seems to confirm the notion of 'peer language socialisation' or the role of the 'peer group' in studies of language between students (Duranti et al. 2012; McGuire et al. 2015). Western-influenced notions of 'peer groups' have conceptualised children's groups as consisting of same-age peers who are not related to one another (Ibid). Under the influence of social identity development (Nesdale 2004), studies have examined the language and identity amongst peer groups. In the study, the groups consisted of Year 7 to Year 9 students.

Additionally, asking students to provide explanations was believed by some Chinese teachers to be a learning opportunity and process for the rest of the students, particularly for those who did not know how to solve the question. The Chinese teachers saw these students who gave presentations on the board as functioning as 'role models' for their less able students to observe and learn from, something which relates to the concept of the 'role model effect' (Krapp 1992; Gaspard et al. 2015). Studies of identity-based motivation (Oyserman and Destin 2010) have suggested that students can benefit from positive role models. This belief may also be a reflection of the Confucian values of learning from 'exemplars' collectively (Yang 2014).

Another reason the Chinese teachers gave for the use of student demonstrations was to help with classroom management, engaging students in the classroom activity through drawing their attention to one student's demonstration and presentations on the board. A further reason was to avoid students copying answers from others. The need for classroom management may be directly related to the large class sizes, discussed in section 5.4.1.

The finding further reveals that both groups of teachers believed that the errors and misconceptions might had been shared by many other students in lessons. But the way they brought these up were quite different in whether or not to deliberately reveal or expose errors of students' misconceptions. This division may be due to the different culture attitudes towards errors. The Chinese teachers' deliberate move for revealing students' errors is in line with research that focuses on designing tasks in order to expose students' errors to the students themselves (Zaslavsky 2005; Swan 2008; Bray 2013). It seems that the Chinese teachers embraced such errors or misconceptions as opportunities for learning (Bray 2013; Steuer et al. 2013; Brodie 2014) and were not concerned about how the individual students would feel when they made such an error; their focus was on the errors or misconceptions themselves (Wang and Murphy 2004; Schleppenbach et al. 2007). As they claimed, these students selected were representatives for all the students who might be making the same mistakes, and through which all students could learn from to prevent the same errors or misconceptions from happening in later their own practice. This belief is consistent with the culture of collectivism discussed in section 5.4.2.

Questioning for Peer-Assisted Learning

My findings reveal that both groups of teachers claimed to see students' errors in questioning as opportunities for learning, which is contradicted to the findings of some studies that many teachers avoid revealing or exploring errors or misconceptions in mathematics lessons (Heinze and Reiss 2007; Bray 2013). When the students could not give a correct answer, both groups of teachers claimed to ask someone else from their peer group to assist in explaining the right answers. This strategy is positively connected with peer-assisted learning (Leslie 2017: 246), which encourages cooperative learning between students, and suggests that learning outcome can be maximised through '*learners talking to each other that [lead] to increased interest and positive emotions*' in peer interactions. This belief was supported by teachers in England in the interviews, who thought that students learnt better through their peer interactions (Philp et al. 2014). However, they also emphasised the need to continuously question the students for explanations before turning to help from their peers. This finding coincides with prior studies (Ashlock 2002; Morgan 2005; Ingram et al. 2018) which have shown that questioning and explaining have been used as an important means of diagnosing students' misconceptions and error patterns in mathematics. They believed that students might be sharing the same incorrect answers among others, therefore, through asking an individual student such misconceptions could be challenged to help the rest of the students to self-evaluate their own answers.

The results of this study further reveal that when a student gave an incorrect answer, both groups of teachers would firstly ask for the number of students who had the same or different answers, then would ask each group to explain how they got their answers. Such questioning strategy also seems to allow students time for self-exploration and self-reinvention in the process (Martino and Maher 1999; Morgan 2005). Both groups were asked for explanations and justification for their claims, which would draw out a sense of these students' understanding and whilst helping the rest of the class to understand the solution steps and think about the process they were going through. The resulting student-student interaction then provided an opportunity to test, consolidate or modify the ideas of all students (Martino and Maher 1999; Lee 2017; Ulleberg and Solem 2018).

Written vs. Verbal Questioning

The forms of written and verbal questioning correspond with the questioning pattern of asking students to present and write answers on the board, and asking students to explain verbally. Through oral questions, the students were expected to listen actively and attentively. By using written questions, on the other hand, the students were able to visually see the questions, together with the solution steps, which could keep them focused. The cultural tradition of the written form in China and the oral tradition of UK culture can be seen to have shaped the communication of questions (Kim 2002; Goucher et al. 2004). Chinese culture has traditionally placed emphasis on the written texts of '*keeping records'*, whilst western culture has historically paid greater attention to '*oral traditions'* (Goucher et al 2004: 14).

The written form of questioning could be linked to the nature of mathematics language. '*The form of language needs to construct a concise and precise mathematical definition or a rigorous justification of a result, which are quite different from those required in everyday or in other subjects*' (Morgan 2017: 158).

This is supported by the Chinese teachers' claims that mathematics was a special language that involved many symbols and graphs: without writing this down, it was believed to be impossible to express their questions clearly to the students. Such emphasis over the written form of questions and answers seems to support the conventions of the system in mathematics (Ibid).

Another reason the Chinese teachers gave for their use of the written form was the need to reinforce correct mathematical language and solution steps in their students' memory. Writing questions and answers was believed to help students develop a deep memory of the key mathematical knowledge, and thereby further develop higher order mathematical thinking. This finding corresponds with the superior status of memorisations in Confucian Heritage Culture (Leung 2014). Memorisations is an important part of mathematics education in China (Leung 2014; Chiu 2016). The potentials underlying such superior status of memorisations could be associated with the nature of mathematics in the perceptions of the Chinese teachers: they seems to see mathematics content, procedures and the skills to deal with the content essentially as products (Leung 2006). This is in line with the pragmatic philosophy of mathematics from ancient China (Cai and Xie 2018).

5.3.7 Teacher Training

The findings reveal that the majority of Chinese teachers had not received any training specifically on teacher questioning during their time at schools or at universities. However, most English mathematics teachers reported that they had received extensive training and support related directly to their use of questions, both in their university training pre-service and during their CPD post-qualification. The pre-service training received by teachers in England, called PGCE, short for Postgraduate Certificate of Education is run alongside university faculties of teacher education, preparing postgraduate trainee teachers to teach in English secondary schools. This seems to suggest that an academic education is traditionally prized over practical training in England (Stephens et al. 2004), which may raise some practical concerns that too much time is devoted to academic study and too little time is devoted to the practice.

The difference in training about questioning specifically may be related to the perceived social and cultural expectations of the professional competencies of mathematics teachers in the two nations. Many Chinese teachers interviewed focused more on their mathematical content knowledge, which seems to exemplify the image of the mathematics teacher in Confucian culture, which presents teachers as scholars and role models with profound subject-matter knowledge (An 2004; Ma 2010; Burghes 2011; Kaiser and Yang 2017). Competence in subject matter knowledge is essential to '*knowing what questions to ask next based on the unpacked learning goals and concepts, and students' thinking'* (Schwartz 2015: 34). This does not necessarily mean that the Chinese teachers did not see pedagogy as important but the way they approached questioning was differently. In this study, all of the Chinese teachers claimed they had received training, but through watching the demonstrations of teaching of other teachers and those with more experience to advance their own teaching pedagogy including questioning, which was also found in Burghes' (2011) study of Chinese teacher training. The identification and analysis of expert teachers' teaching characteristics including questioning are vital for training teachers in China (Yang 2014; Kaiser and Li 2011; Kaiser and Blömeke 2014). This type of training accords with the deep-rooted Confucian cultural practice of learning from 'experts' (Tweed and Lehman 2002). The teacher training with a focus on teacher questioning received by the teachers in England might be an indication that teachers are expected to possess profound pedagogical, rather than knowledge-based competencies (Leung 2001, 2006) in the western education.

Most of the English mathematics teachers in my study supported the claim made by previous studies that training for their use of questioning was very important (Wilen 1991; Cotton 2001; Chen et al. 2017). They claimed that they became more aware of the role of questioning and used this to help them to develop their questioning skills for students to learn and think in class. Their approach to questioning as a pedagogical practice seems to rest on a theoretical basis.

However, one teacher also explained her confusion over her training on the use of different types of questions, since the types of questions in the training were not specific to the subject of mathematics. She believed that each subject should have its own way of questioning. This issue has also been raised by other studies, which claim that teacher training regarding questioning has little to say about methods of questioning within the contexts of specific subjects (for example, how to ask question in History), instead concentrating on general pedagogical principles (for example, asking open questions) (DfES 2004). This also seems to indicate that teacher training on questioning alone may not be sufficient to improve teachers' pedagogical questioning practices. This reinforces a belief held by most of the

Chinese teachers and more than half of English mathematics teachers that teaching experience was more important than training for their use of questioning. This claim echoes other research (Wilen 1991; Heritage and Heritage 2013; Wang et al. 2017) showing that teachers with more teaching experience have been found to be more flexible in their questioning practices and more likely to ask higher level questions than inexperienced teachers. Many of the teachers claimed that they started to make sense of their own questioning only when practising and experimenting with their students in classrooms.

5.4 Emerging Factors: Contextual, Social and Cultural factors based on England and Chinese Contexts

As found in this study, there are several factors that influence teachers' classroom questioning in terms of their perceptions and the actual behaviours they demonstrated, which can be attributed to the contextual factors (Young 1992; Fang 1996; Sahin et al. 2002). The contextual and cultural factors discussed in this section are class size and collectivism-individualism. Class size is identified as one contextual factor in particular (Finn et al. 2003; Cao and Philp 2006) since different aspects of the class environment can exert distinct pressures on teachers and their students.

5.4.1 Class Size

Class size, by definition, is the number of students in a class with one teacher. In this study, the class size in England and China ranged from eight to 53 students. In England, according to 'the class size and education in England' (DfES 2011), since the introduction of 'school standards and framework 1998' which later became a law in 2001, class size in Key Stage 1 has been limited to 30 students. This to some extent, has an effect over the number of students in class at secondary school level, Key Stage 3, for example, remains around 30 students per class. Therefore, the figure of 30 students or more is seen as constitutive of a large class for the purpose of this study, since this helped to distinguish the class size between England and China. In this study, class sizes in England, ranging from 8-30 students, are considered small, whereas the Chinese classrooms, consisting of 46-53 students, are interpreted as relatively large. It seems to be a significant factor affecting teachers' use of questioning. The impact of class size is discussed in relation to teachers' questioning practices and their own perspectives on how class size affects their approach to questioning, in terms of teachers' classroom instruction choices, and individual attention and support.

Questioning Practice and Class Size

Class size has a significant influence over teaching practice (Taylor and Lelliott 2015; Blatchford et al. 2016), and as questioning plays a key part in teaching practice, it is thus affected by class size as well. Class size seems to affect teachers' choices about classroom instructions. In this study, the Chinese teachers tended to adopt whole-class instruction, since it gave more control to the teacher (Galton and Pell 2012a), in terms of managing a large number of students and distributing the teachers' time most effectively (Stigler and Stevenson 2005; Song 2015). However, in English classrooms, the teachers demonstrated many other teaching activities including small group discussion, pair work, and sustained periods of individual interaction with students. Small class sizes may have allowed the teachers in England to adopt more group work and pair work (Wang and Finn 2000), and more individualised instruction (Alexander 2004; Harfitt 2013b).

Consistent findings concerning class size effects on classroom processes show that small class size is strongly related to the individualisation of teaching (Blatchford et al. 2003; Blatchford et al. 2011; Galton and Pell 2012a; Harfitt 2013b), whilst large class size is associated with classroom management and classroom control (Huang and Leung 2004; Zhang et al. 2004; Blatchford et al. 2011). Firstly, class size seems to alter the proportion of time spent questioning the whole class, or with individuals. In the Chinese classrooms, contributions were rarely made by one sole individual, but were mostly a joint contribution from all students in the process of questioning, since most students were welcome to contribute even during one to one questioning time. Only a small proportion of students were selected as student representatives to contribute orally or by writing on the board in the process of questioning for explanations and justifications. In this study, the Chinese teachers incorporated their students' answers into their own instruction, or restated their students' answers to the entire class after the individual students had provided these answers, which probably was done to ensure all of the class could hear. The Chinese teachers may also have felt the need to keep monitoring and controlling the rest of the students in the process of questioning individuals. This also seems to suggest that the Chinese teachers were concerned with students' active engagement in a large class size, which is aligned with the findings of other studies (Finn et al. 2003; Lan et al. 2009; Blatchford et al. 2011; Hattie 2016).

In contrast, many English mathematics teachers devoted their time to asking a great number of their individual students to provide individual contributions (Mercer and Hodgkinson 2008). In this study, the Chinese teachers observed demonstrated collective questioning by asking most of their questions to the entire class, rather than to individual students. However, the English mathematics teachers asked more questions to individual students rather than posing questions to the entire class. The Chinese class size was very large, with a lesson time of 40 minutes and structured lesson objectives, so Chinese teachers' collective questioning pattern may be adopted in the interest of maximising participation by as many children as possible (Alexander 2012), expecting and encouraging all students as a whole to contribute to the answers as shown in this study. This is consistent with the results from previous research into Chinese classrooms (Song 2015; Li and Ni 2011; Tan 2007; Hattie 2016). In the smaller class sizes of English classrooms, the teachers may be able to offer more personalised, one to one questioning to their students (Anderson 2000; Konstantopoulos and Sun 2014) who were more often the focus of the teachers' attention (Blatchford et al. 2003; Blatchford et al. 2005). The findings of this study show that in a lesson of 60 minutes, the teachers and individual students were often engaged in a sequence of several question-answer exchanges. This may suggest that small class size can sustain teacher-student interactions, whereas large class size tends to cut teacher-student interaction short.

Furthermore, class size also seems to alter the types of questions teachers pose in terms of the degree of sensitivity to individuals' particular needs. In this study, the Chinese teachers posed the same questions to all of their students, whereas the English mathematics teachers differentiated their questions, using different types of questions to allow their students to choose the appropriate level for them. This seems to reveal that larger class size may lead to a difficulty in differentiating questions to suit individual students' needs (Brabo 2014). In a class of 45 or more, it might be difficult for the Chinese teachers to monitor the progress of all the students if they were doing different tasks and proceeding at different paces. Small class size may have allowed teachers in England to accommodate the students in their questions (Blatchford et al. 2011; Galton and Pell 2012b).

Teaching a large class may limit teachers' flexibility to use particular questioning techniques for co-constructing meaning (Jordan 2009; MacNaughton and Williams 2009), such as '*hypothesising, building understanding and encouraging pupils' thinking'*. English mathematics teachers demonstrated that they spent time listening to students' initial answers, and then followed up with more questions in to probe their students' thinking, through explanations and justifications of their answers. In this way they would encourage their students to re-consider, clarify and deepen their understanding. In contrast, the Chinese teachers selected very few student representatives (less than five students in the observations) to explain aloud regardless of right or wrong answers, in the expectation that everyone could listen, look and learn from their peers' experience. As the English mathematics teachers may be less stressed by the number of students, they asked a great number of questions for multiple explanations from students, offering numerous opportunities for individual students to talk (Galton and Pell 2012a).

Questioning Belief and Class Size

It is interesting to see that; both the teachers in China and in England interviewed reveals an almost '*uniform sense of professional comfort'* about the idea of working with small classes, although none of the Chinese teachers had ever had experience of small class teaching. This is consistent with previous studies (Pedder 2006; Galton and Pell 2010) which have shown that teachers indicate a strong preference for teaching small class sizes. This could be an important factor in the effectiveness of teachers' pedagogies and the learning outcomes in the classroom (Harfitt 2013a).

According to the Chinese teachers' responses, large class sizes had a negative effect on their questioning. The class size also seems to affect the teachers' purposes for the questions they asked. Most Chinese teachers reported that they asked questions to get students to participate and to keep control over the classroom. The majority of the English mathematics teachers, on the other hand, used questions to support their individual students' learning. Although teachers in both groups were aware of students' different abilities and levels of understanding in their lessons, the English mathematics teachers could adjust their types of questions to accommodate their individual students' abilities in class. The Chinese teachers, however, claimed that it was impossible to tailor their questions to suit students individually, instead had to select a few students accordingly, based on their questions. Because the Chinese teachers' lessons were content-focused teaching (Cai and Xie 2018), their questions targeted the middle range of students, otherwise they could not possibly '*keep up with the pace and meet objectives'* (Burns and Myhill 2004: 39). In other words, the purpose was to get two thirds of their students to understand their lesson properly and be able to apply this in practice, whilst the remaining third of their students, including the least able students, were potentially left out. In contrast, all of the English mathematics teachers suggested that they tried to ask questions to help every single student in their class, and made sure that all students were questioned at their own levels of understanding and capacity of learning. They intended to work at the pace of their students, which is consistent with the concept of student-centred teaching (Galton and Pell 2012a).

Class size also seems to affect teachers' questioning strategies to their students and the support given to students. According to the Chinese teachers, with a class size of more than 45 students in a lesson of only 40 minutes, in order to accomplish the structured lesson objectives, they could not cover every single student in their questioning. Therefore, their questions to the students tended be brief, which could have the effect of creating passive behaviour of simply listening to teachers amongst students (Harfitt 2013b). Constrained by the large class size, the Chinese teachers believed it would not be fair to question one student but not another. In consideration of fairness to all of the students in their lessons, the Chinese teachers suggested that it was best to ask them altogether and for students to answer together in unison: collective questioning. Whereas, the teachers in England thought of their group of students as small, giving them a chance to ask individualised questions in their classes. They also explained that the lower ability a student's group was, the smaller the group size would be. In other words, the higher ability groups tend to bigger in class size, but no more than 30. This seems to suggest that students' abilities are strongly linked to the size of a class (DfES 2011). This could be due to the fact that studies have found that small class size can benefit the lowest attaining and disadvantaged students (Blatchford et al. 2011).

5.4.2 Collectivism-Individualism

Culture is defined as the '*shared motives, values, beliefs, identities, and interpretations or meanings of significant events that result from common experiences of members of collectives that are transmitted across generations'* (House et al. 2004: 15). Culture has always had profound impact over teachers' beliefs about, and practices of questioning. Previous studies have identified two cultures, individualism and collectivism when comparing the western and eastern education. This study is consistent with this, and these two cultures appear to be particularly relevant in explaining differences between English and Chinese mathematics teachers' beliefs and practices in questioning. The collectivism-individualism concept refers *to 'the extent to which the individuals of a society are perceived as autonomous'* (Kaiser and Blömeke 2014: 406). It was initially developed by Hofstede (1986). According to Alexander (2003 in Bearne et al. 2003: 25), collectivism emphasises '*human interdependence, caring for others, and sharing and collaborating, but only in as it serves the larger needs of society, or the state, as a whole*.' Individualism as its counterpoint, puts '*the self above others and personal rights before collective responsibilities*.' This may create different joint identities for students and teachers, which may then explain their classroom questioning behaviours. In the observed classrooms, the English mathematics teachers' questions were mostly answered by individual students. Their questions were divided into different types to allow individual students to choose the level they were capable of: relating to an emphasis over the individual and independence in an individualist culture (Kaiser and Yang 2017). This also explains why the teachers in England tended to close their questioning with individual students in a mini-summary. However, in the Chinese classrooms, most of the teachers' questions were answered by all students in unison, echoing the notion of social harmony within this collectivist culture (Leung 2001; Jin and Cortazzi 2008). This also seems to suggest the value of group decisions over individual opinions. Most of the time, the Chinese teachers questioned students as a group, rarely as isolated individuals, as they emphasised learning common mathematical knowledge together rather than in isolation, following a single curriculum for all. This collective culture was also reflected by the way in that the Chinese teachers frequently asked a group of students to answer the same question to check the understanding of the entire class, choosing a few students to represent the different abilities of all students.

The individualism-collectivism concept was also evident in the teachers' beliefs in this study. Most teachers in England tended to create their own questions and expected their questions to come spontaneously, since they believed in their students learning at their own pace, and were prepared to differentiate their questions accordingly to challenge and extend their students' thinking at their own pace and understanding. This seems to view '*knowledge as being personal and unique*', embracing '*individual intellectual differentiation and divergent learning outcomes*' (Alexander 2009: 936). In contrast, the Chinese teachers believed that their questions were shared by all students, expecting all of their students to learn and share the uniform learning outcomes. They believed knowledge could be imposed upon their students, though they were aware of that their students had different abilities. This belief is in line with teacher-centred learning under the influence of behaviourism (Cai and Xie 2018). The Chinese teachers claimed that they would select some student representatives to explain their answers explicitly to the entire class, which was a form of 'sharing': sharing their knowledge with their peers, which indicated that the teachers and students shared a common language collectively.

5.5 Research Question 3: *Are these teachers' beliefs on questioning consistent with their classroom questioning practices? If not, what are their divergences and convergences?*

Beliefs and values have a profound influence over teachers' teaching practice (Campbell et al. 2014; Caleon et al. 2018). In the context of teaching mathematics, there has been a growing interest over the last 30 years in how affective factors such as beliefs (Philipp 2007; Francis 2015) influence classroom practice, especially with reference to teacher questioning (Sahin 2002; Pham and Hamid 2012). Studies have asserted that questioning behaviour is a result of belief (Pajares 1992). A number of other studies have suggested that teachers' classroom behaviours in practice are more complex than their self-reported beliefs account for in questioning (Sahin 2002). Therefore, this study aimed to examine what the teachers said about questioning, in order to compare this with their actual practices in classrooms to see if there were any consistencies and inconsistencies between their self-reported and actual behaviour of questioning. As expected, the relationship between teachers' beliefs and their actual practices was complex, and did not fall into a fixed pattern. At a broad level, there were congruencies between the teachers' views and what they did in terms of frequency, purposes, types of questions, wait time, questioning distribution strategies, and questioning strategies overall. However, a closer examination of each of these features revealed significant discrepancies.

5.5.1 Variations between Beliefs and Practices

The findings reveal that at an intra-country level, both divergences and convergences were found in England and in China; whereas at a cross-country level, the English mathematics teachers seem to be more aware of and more reflective about their questioning than their Chinese counterparts. More precisely, the Chinese teachers' inconsistency in their beliefs and practices regarding the frequency of the questions they asked seems to coincide with the claim made by other studies that, when asked, teachers often underestimate the number of their questions (Wragg and Brown 2001). However this claim contradicts to the findings of this research with regards to the English mathematics teachers, as their self-reported beliefs and practices of frequency of questioning were consistent.

When examining the purpose of questioning, it is also revealed that in a Chinese context, the function of asking questions to check understanding should be redefined as checking the understanding of the entire class, taking into account the way in which teachers' questions were answered, that is students answering in unison. This questioning might not be considered an effective assessment tool anymore since it could not provide any valuable information about the understanding of individual students (Cheewaviriyanon 2016). In terms of asking questions to prompt learning, the Chinese teachers claimed to do this, but failed to explain this further. Conversely many of the claims made by the English mathematics teachers were explained further and reflected in their actual questioning practice.

However, there also seems to be a gap between what the teachers in England intended to do and what they ended up doing, with regard to the types of questions they asked and their strategies. They claimed to ask every single student at least one question, but in practice they did not manage to ask everyone one question. One reason for this could be that they subconsciously posed their questions to the same group of students who put their hands up (Wragg and Brown 2001). Another potential reason could be that they spent too much time on questioning one individual at a time, which left no time to question them all. Another claim to ask open questions (Oliveira 2010) in order to scaffold students' thinking through ZPD (Vygotsky 1978) was different in practice: they asked mostly factual, procedural and managerial questions that are regarded as closed questions (Chin 2007). They in fact broke open-ended questions into a sequences of narrow and focused questions that eventually funnelled students' thinking into a narrow path. All of these discrepancies could be due to the complexity of classroom environment. As Young (1992) indicated, depending on context, questions could be relatively 'open' or 'closed'. Sahin et al. (2002) claimed that a lack of awareness of contextual factors such as students' level of ability led to inconsistency between teachers' beliefs and practices about questioning. Contrary to Sahin et al.'s (Ibid) claim, my research reveals that the teachers in England seemed to acknowledge the variety of ways in which types of questions were developed and modified according to the circumstances. This suggests that there are many other contextual factors contributing to divergences between beliefs and practices, since classroom life is full of complexities, which creates difficulties for teachers to implement what they believe (Ng and Farrell 2003; Farrell and Bennis 2013; Tamimy 2015).

What is more, regarding their favourite questioning strategy - asking students 'why questions' to explain, the English mathematics teachers demonstrated a mismatch: claiming that this was to develop students' reasoning skills and to prepare them for the world outside, but eventually it was in fact asking them to give expected answers in practice. This inconsistency may be due to the nature of mathematics, in that a mathematical problem naturally requires an answer to its solution, which may constrain the nature of students' responses and thinking. Furthermore, the way teachers respond to their students' answers might be a contributing factor. In practice, the teachers in England indicated a tendency to say 'almost', or 'close' in response to their students, which may suggest to the students that their teachers were more interested in getting correct answers for solutions from them than finding out what they thought about a particular idea. This pattern of questioning is called 'evaluative' questioning, providing evaluative feedback on students' explanations (Evans and Dawson 2017). Such discrepancy may suggest that question-asking is always contextualized, it is not just the question's '*semantic content or linguistic structure'* that could determine how it might be interpreted by students (Ulleberg and Solem 2018: 16). When a classroom culture is not encouraging '*curiosity and open thinking,'* a question asking for explanations might limit students from explorations and ruin dialogue (Ibid: 16).

Questioning is '*dynamic and context-dependent rather than static'* (Young 1992: 123). If a particular context was provided, both groups of the teachers were able to describe the way they approached questioning comprehensively, which led to a series of potential explanations. For the first, it may be that the teachers experienced challenges in recognising their implicit beliefs. Pajares (1992: 312) suggested that '*beliefs are created through a process of enculturation and social construction*'. Thus, the assimilation of learning processes and cultural norms is significant, such as the incidental interactions students and teachers engaged in, the students' abilities, and the classroom climate they experienced. The existing literature has suggested that classroom behaviours are an outcome of beliefs being filtered by experience (Wilen 1991; Heritage and Heritage 2013; Tamimy 2015), but not all the teachers were aware of this. Subsequently, the English mathematics teachers' beliefs about questioning did not always show what they actually did in classroom practice. Teachers' unawareness of the impact of their cultural experience was also evident in the fact that neither the teachers in China nor teachers in England critically analysed their own practices and experiences. Therefore, *'making implicit belief systems explicit*[4] *and developing language for talking and reflective thinking'* about their practice is vital for teachers' professional development in questioning (Freeman 1993, quoted in Sahin et al. 2002: 382). Alternatively, it could be that the teachers were not fully aware of the importance of context that influenced the way they asked questions or how this influence operates (Sahin et al. 2002). Extensive studies have suggested that context has vital influence upon questioning in classrooms (Hallam and Ireson 1999; Phipps and Borg 2009; Levin 2014; Borg 2015; Wang et al. 2017). In other words, questioning is embedded in the activity of the particular environment in which it takes place.

This study further reveals that even if a particular context was given, the Chinese teachers' questioning practices were still richer and more diverse than what they claimed. For example, the Chinese teachers explained their purpose for asking questions that incorporated students' answers to the entire class was only to reinforce and deepen students' memories over some important solution steps and key mathematical concepts. However, in practice, their questioning proved to be much richer. Their responsive and reflective questioning encouraged the students to take responsibility for making judgements and justifications for their thinking, and further extended their thinking, leading to the con-construction of mathematical knowledge, which clearly went beyond mere memorisation. This suggests that questioning is a complex process not only affected by contextual factors, but also a variety of other factors including learning objectives, learning environment, student abilities, social-cultural backgrounds of both learners and teachers, expectations from parents and students, and teachers' access to curricular materials and resources (Borg 2003; Herbel-Eisenmann et al. 2006; Phipps and Borg 2009; Savasci and Berlin 2012; Zhu and Geelan 2013; Yim and Cho 2016).

Overall, the research reveals an inconsistency between the teachers' beliefs and practices in questioning. In other words, both groups of teachers showed a lack of awareness of their questioning. The Chinese teachers' questioning practices were

[4]Teachers' implicit and explicit beliefs are distinctive, in which implicit beliefs are '*held unconsciously and can only be inferred'* from their practices, whereas *'explicit beliefs are those which'* teachers *'are aware of and can readily articulate'* (Basturkmen 2012: 283).

richer and more diverse than what they claimed, and whereas the English mathematics teachers were more aware of their approaches to questioning than their Chinese counterparts. It is also revealed that their beliefs did not automatically translate into practice. The findings from the Chinese teachers seem to contradict to most previous research about teachers' beliefs and practices which has suggested that teachers do less than they claim. Some of the findings from the English mathematics teachers is consistent with this claim, however. The findings of this research were mixed is due to the fact that they were more reflective compared to the Chinese teachers, though what they claimed was not always reflected in their questioning practices. It may be that questioning is seen as a distinct teaching pedagogy and the teachers in England had been receiving constant support for developing their approach to questioning from university and in-school training, whereas questioning in China is not considered as a separate teaching pedagogy and skill, but a tool to balance out the relationship between the teacher, the students, and the mathematical knowledge required (Leung 1995, 2006). More importantly, no training had been given to the Chinese teachers to develop their questioning skills, which may explain why they were not aware of many of their questioning strategies. This examination of beliefs and practices in teachers' questioning in England and China will hopefully contribute towards enhancing their consciousness of their approach to teacher questioning, which should provide them with opportunities to reflect upon, articulate and give meaning to their practices. This should eventually contribute to improving the effectiveness of their use of questioning. Previous studies have indicated that teaching experience plays a major role in the consistency and inconsistency between teachers' beliefs and practice (Levitt 2002; Lim and Chai 2008; Sandholtz 2011; Pham and Hamid 2012; Belo et al. 2014; Wang et al. 2017; Caleon et al. 2018). However, in this current study, no evidence can be found to support this. It may be due to the fact that my study aimed to find the commonly shared beliefs and practices of a group of teacher participants in questioning in England and in China, which may neglect the factor of teaching experience between the teachers that with a wide variety of teaching experiences ranging from one year to forty years.

5.6 Summary

This chapter has discussed the findings of observations and interviews in terms of teacher beliefs and practice in questioning in England and in China, in the light of the existing literature. The limitations and implications of this study will be presented in the following chapter.

Chapter Six Conclusion

6.1 Introduction

This research has provided a picture of a group of teachers' beliefs and behaviours with regard to asking questions when teaching mathematics in China and in England. The findings of this research have explained social-cultural differences through the examination of questioning in the two nations, as well as the understanding of the relationship between beliefs and practices with a focus on questioning in the two nations. This chapter will outline the significance of this study, together with some limitations. It will also propose some recommendations for future studies.

6.2 Contributions and Implementation

This study has a few contributions to make to the existing research in the area.

Concerning the political status of mathematics, recent studies have focused on international comparison of education systems (Zhang et al. 2016; Son et al. 2017; Nortvedt 2018; Pons 2017; Zhou and Wang 2016; Cai et al. 2016). Given the pervasiveness of teacher questioning in classrooms, this study contributes to the growing literature on the nature of questioning in mathematics in England and China.

Concerning the teachers' questioning practices, another contribution is that it confirms extensive studies which show that teacher questioning is still 'pervasive', inside both mathematics classrooms in England and China. It also confirms that classrooms are still dominated by lower order questions that require the recall of facts, and routine procedures. The responses from students were short, generally less than one or two sentences in length.

What is more, this study contributes to a better understanding of teachers' current questioning practices in the two nations by showing how questioning was woven holistically into everyday lessons; how questions influenced subsequent student responses; how questions were differentiated to accommodate different students' levels of understanding; how some patterns and sequences of questioning could stimulate students' productive thinking and encourage participation; and how questions were responded to students' errors. The classroom lessons showed a conflicted picture of questioning in the two groups which was neither traditional nor constructivist. The teachers in England and China exhibited similarities and differences in their approaches to questioning. On the whole, however, the Chinese teachers demonstrated a rather traditional perspective on questioning practices, seeing its purpose as evaluating what students knew, and viewing the nature of learning as a transfer -of- knowledge from the teachers to students. The students' role was seen as being to carefully listen, receive, and follow the rules and procedures of mathematics which were explained by the teachers (Li and Ni 2011; Zhao et al. 2016). In contrast, the English mathematics teachers' approach to questioning was more constructivist or inquiry-based: viewing the purpose of questioning as being to elicit what students knew and viewing the nature of learning as students actively constructing knowledge. The Chinese classrooms showed teachers and students working together to solve problems, adopting a collective questioning for the entire class and expecting all students to answer in unison. These teachers illustrated a teacher-centred questioning, where lesson objectives took the priority over students, and questions were limited to 'asking by telling' at a quick fire pace, with students' answers constrained to a series of predetermined responses or 'filling the gap'. Contrary to such authoritative questioning, they also demonstrated the ability to give up their power to the students to explain and present answers on the board, forming an explorative student-dominated form of questioning. Alternatively, they frequently shifted the authority to evaluate answers themselves to all students in the class; or focused and zoomed in on the students' responses. These explorative, reflective and responsive questioning patterns expanded the traditional IRF (teacher initiation-student response- teacher feedback) questioning structure into a chain of IRFRF (Mortimer and Scott 2003) or reflective toss (van Zee and Minstrell 1997), where students' further thoughts were articulated, supporting a relatively dialogic teaching (Jones and Hammond 2016) or explorative classroom talk (Mercer 2012). In the English classrooms, the teachers and students addressed the problems individually, and teachers adopted an individualised form of questioning which was directed towards individual students. Students were expected to hand-bid for answers, creating a restrictive power relationship. The teachers demonstrated student-centred questioning, in which lesson pace and the design of tasks were primarily based on the needs of individual students; opening up the potential for questions to be '*asking for enquiring*' and differentiating types of questions to accommodate to their individual student's learning capacity and understanding. Questioning for explanations and speculation was frequently adopted to diagnose and extend students' ideas, and scaffold students' learning. However, the teachers in England also asked questions that funnelled students' thinking down into a narrow path, since they modified their questions based on their perceptions of the students' learning needs and abilities. Such a questioning approach was close to student-oriented questioning rather than student-centred (Caleon et al. 2018). Bear in mind that this study was undertaken in the context of a whole-class setting, which can be one of the limitations discussed in section 6.2.

Following this, this research also contributes to a culturally-based understanding of wait time in the questioning process. Although the lengths of wait time in both groups were found to be shorter than three seconds; wait time in Chinese classrooms was ultimately a different concept because of the structure of turn-taking. Wait time is generally understood to be the thinking time that is given by the teachers to the students after asking a question and before students start speaking. However in the context of Chinese classrooms, with students all shouting out answers without requiring the permission from the teachers, wait time was re-defined as the time that students allowed themselves to think; contrary to its original definition where the teachers control who talks and when. This new student-driven structure has shifted the Chinese classroom interactions out of the IRF/E pattern into more naturally flowing conversations (Smith and King 2017). This phenomenon of all students shouting out answers to their teachers challenges the western traditional image of Chinese students, who are often seen as passive listeners waiting to be called up before answering any questions (Wu 1993).

Another contribution made by the research is the further development of an understanding of teachers' beliefs towards their approach to questioning in England and in China. The findings suggested some possible explanations for these differences were that the English mathematics teachers possessed more in-depth pedagogical knowledge about questioning and more diverse and dynamic views about their roles compared to their Chinese counterparts. They espoused social constructivist pedagogical beliefs, seeing themselves as facilitators, and asking open-ended and scaffolded questions centred to students' learning of mathematics. In contrast, the Chinese teachers held strong mathematical content knowledge but had a lack of explicit pedagogical knowledge about their questioning. They were more stressed about in school and public examinations. Textbooks were considered to be one of the main constraints, and sources for their thorough and structured preparation and sourcing of questions. Their questions were constantly used as an informal formative assessment tool to check students' understanding. For example, they asked questions to students who could be representatives of all students with different levels to check their understanding, through which they subsequently obtained a rough picture of the understanding of the entire class. The teachers in England, on the other hand, were more concerned about the diversity of abilities amongst their students, in order to question the students to challenge and extend their current levels of thinking. They claimed that they had relative flexibility in creating their own questions, pitching and differentiating their questions to the level of their students' understanding and pace. Through exploring teachers' perceptions and beliefs about questioning, we can gain a better understanding of factors such as examinations; the curriculum and textbooks; students' abilities; class size and lesson topics could affect, and to what extent these factors might affect teachers' approach to questioning.

A further contribution made by this research to this field of enquiry is that it contributes to a mutual understanding of social-cultural and historical differences that are embedded in common behaviours and beliefs in the two nations. The concepts of collectivism and individualism were identified (Hofstede et al. 2010) as significant: whilst Chinese culture values collective interests over individual interests, British culture sets the individual's interest as the prime focus and values the independence and individuality within learning. The intra-relationship between pedagogy and teacher questioning was also identified across the two countries. The English mathematics teachers saw questioning alone as an effective teaching pedagogy and saw themselves as facilitators with profound pedagogical competencies in the way they asked questions. The Chinese teachers, in contrast, saw themselves as role models or scholars possessing profound mathematical knowledge. Instead of viewing questioning as a 'stand-alone' pedagogy, it was integrated holistically into the teacher, the students and the subject matter together as a whole (Li and Kaiser 2011), reflecting the '*social harmony'* of collectivism (Li and Huang 2013).

The distinct attitudes towards questioning the teachers displayed derived from two different cultural values: the Confucian Heritage Culture was embedded deeply in Chinese classrooms which values learning collectively from 'experts' who possess knowledge. The culture of questioning, in contrast, is deeply rooted in England can be traced back to 'socratic questioning' from the ancient philosopher Socrates (Kaiser and Blömeke 2014). Social-cultural beliefs also contribute to the understanding of what mathematics is and the process of teaching mathematics. The repetitive questioning pattern in China that focuses on memorisation and rote learning reinforces the findings of many Chinese studies which have shown that

Chinese teachers view mathematics as a product. Rote learning and the emphasis over the application of mathematics can be seen to be embedded in ancient Chinese mathematical beliefs and Chinese agriculture. '*Mathematics was regarded as a tool to solve practical problems, a kind of skill'* (Cai and Xie 2018: 6). The ancient '*Nine Chapters on Mathematics Procedures and Euclid's Elements of Geometry'* also proposed application as one of the main features of traditional Chinese mathematics (Liu 2005). The English mathematics teachers seemed to focus on the process of learning by doing in mathematics, and asked questions to develop reasoning and critical thinking. Additionally, the two different preferences for verbal or written formats to communicate questions is indicative of different traditions of communication in England and China. The written form reinforces the Chinese belief that 'practice makes perfect,' as well as the deep-rooted belief that it is better to put things down in writing rather than relying on memory alone.

Furthermore, a contribution that this study makes is to expand present research investigating the relationship between beliefs and practices with regards to purposes and types of questions alone to include the questioning strategies, though it is sometimes a challenge for teachers to reflect upon questioning strategies. Teachers are compelled to think reflectively not just about questions but also about how questions were related strategically in order to work towards teaching goals.

A final contribution that it makes is towards a recognition of the significance of training for teacher questioning, which has shown to have had profound effect in improving the teachers' awareness and reflectiveness of their own questioning behaviours. A comparison of the two groups revealed that the English mathematics teachers were more aware and reflective about their questioning than their Chinese counterparts. This is illustrative of the fact that the Chinese teachers had not received training for questioning, whereas the English mathematics had been supported by pre-service training and in-service professional development, which may explain their greater awareness of their use of questioning. As Wilen (1991) pointed out, teachers' decisions about questioning in the classroom were mostly 'intuitive' and based on their experiences. However, effective teaching reflects the informed decision making which is rooted in knowing what theory and research can offer, and realising research should inform practice.

6.3 Limitations

The limitations of this study were based around the analysis and interpretation of data, the scope of this study, and the setting of this study.

This study adopted a qualitative approach using classroom observations and individual interviews. The analysis and interpretation of the data collected from the two methods had some limitations. One limitation lies in the ability to generalise from individual students' responses to the rest of students. All of the data derived from conversations was derived in whole-class settings. But at any particular moment, only one student could be allowed to respond to the teachers, except in the case of chorus answers that mostly happened in the Chinese classrooms. Thus, the analysis and interpretation of classroom data was on the basis of the responses of individual students who involved in question-answer exchanges, and was collectively extended to the rest of the class as a whole. Here lies an assumption; whatever applied to individual students also applied to other students in the class. However, such assumption has its own limitations, since '*the process of internalisation does not simply involve direct transfer from social to personal planes and it is not possible to know for sure, the extent to which individual students [are] able to internalise and make sense of the concepts addressed (Chin 2007: 838).*'

A second limitation is that, the analysis and interpretation of classroom discourse and interviews is predominantly based on the verbal accounts of participants, and is thus referential. To some extent, it is impossible to make any generalisations from such data.

A third limitation is the scope of this study. This study was conducted involving a wide range of lessons from revision lessons to lessons on new topics; and a variety of mathematics topics were covered from teaching decimals to teaching congruence triangles. The variety of contexts may have resulted in different purposes, types and patterns of questioning. To address this issue, future research could focus on a specific context to enhance the validity and reliability of the findings, such as teaching a new lesson on decimals.

A fourth limitation of this study pertains to the omission of questions asked in small groups and one -to- one conversation during individual seatwork. The questioning examined predominantly took place within the context of whole class teaching. As demonstrated in the literature review chapter, there has been a shift in learning theory and pedagogy from teacher-centred monologue teaching, where learning is transferred from teacher to student towards student-centred inquiry based teaching, where students actively participate in the process of knowledge construction. Taking account of this shift, further study could be carried out to examine teacher questioning in other settings, such as in group discussion, peer work, or individual seat work, since the existing literature has suggested that teachers have struggled with their strategies to approach questioning since the move towards inquiry based learning.

6.4 Recommendations

This study also can suggest a few recommendations for research, for teachers and educators, and for policy makers.

6.4.1 Recommendations for research

Firstly, as mentioned earlier in the literature, there has been a lack of comparative studies of pedagogy in the UK context. It is hoped that this research can bring the value of comparative study of pedagogy into focus, and more research is needed for international studies especially within the context of England and China. Additionally, this explorative study was designed to give social and cultural explanations for the differences and similarities in the two groups of teachers' beliefs and practices with a focus on their use of questioning. As a way forward, future research is recommended to be carried out in the effectiveness of teacher questioning across the two nations.

Secondly, this research also reinforces the value of comparing practice to the literature, to the study of wait time in particular. Although the lengths of wait time in both groups were found to be shorter than 3 seconds; wait time in Chinese classrooms was ultimately a different concept because of the structure of turn-taking. According to the literature, wait time is generally understood as the thinking time that is given by the teachers to the students after asking a question and before students start speaking. It is structurally built into classroom conversation, where teachers have the control over who can talk when. However, in practice, in the context of Chinese classrooms, the teachers threw their questions to the entire class, and whichever students had the answers were free to shout their answers. There was not such a tight control over who can speak and when, replaced by students' self-selection and competition. This new structure has shifted the Chinese classroom interactions out of IRF/E pattern into more naturally flowing conversations (Smith and King 2017). Wait time here could be re-defined as the time that students allowed themselves to think; contrary to its original definition where the teachers control who talks and when. This is something new and different to what the literature mainly has found. More research can be carried out to examine wait time in a context where there is no asymmetric relationships between the teacher and students. Therefore, it is recommended that teachers should be aware of the options available to them, and the consequences of each of these two options, when they want to adopt one or the other. This metacognitive awareness could allow them to decide which norms of conversation they want to achieve and which strategies may be effective in doing so.

6.4.2 Recommendations for practice

First, when facing students' errors in answers, different questioning strategies were adapted by teachers in the two nations. Although the teachers all redirected their questions to the other students, the English mathematics teachers asked for their explanations first before turning to get others to help. Rather than correcting students' errors, they challenged the students with considering the reasonableness of solutions. They were offered the opportunity to defend and/or modify their arguments, to take ownership of their own solutions. The literature has acknowledged the significance of student building and defending their arguments to problems (Maher and Martino 1996; Mueller et al. 2014), and the crucial role of teacher questioning in drawing out elaborate form of reasoning and deeper understanding. Whereas the Chinese teachers frequently asked the rest of the class to evaluate the answers first before asking any individual students for help. Their questioning approach was to bring students' answers public and to throw the responsibility of evaluating answers to the students. A result was that the students became comfortable judging their own solutions and those of their peers, and learned that they could determine the validity of a mathematical argument. This created a reflective and inclusive environment that forced the students to monitor their own understanding of their peers' thinking. Both strategies are considered as effective teacher interventions to the establishment of social norms of listening, sharing, and prompting student justifications. Hence, the results of this study could be used in preparing future and practising teachers of secondary mathematics in both England and China. Teachers in England could be made aware of the benefits of making students' answers or solutions public, and ready to adapt when there are opportunities to do so. Meanwhile, the Chinese teachers need to react responsively in their questioning and to be aware of the interventions that could facilitate the building of their students' mathematical reasoning and justifications, in particular when it comes to face students' incorrect or incomplete answers.

Secondly, this study also highlights the different preferences in terms of the organization of students' errors and misconceptions, which has been a recent focus in mathematics education (Ingram et al. 2013, 2015). Although both the teachers in England and China embraced students' mistakes or misconceptions as opportunities for learning and allowed their peers to help them, this study revealed culturally different questioning strategies. The Chinese teachers focused on designing these common misconceptions or errors in their initiations (Swan 2008) and employed a strategic questioning approach to reveal these during lessons for students to learn so as to prevent them from happening later in mathematics. Rather differently, the English mathematics teachers expected students' misconceptions and mistakes to be exposed during doing mathematics. This study hopes to raise an awareness of different ways of approaching students' errors or misconceptions. By making teachers aware of this, they can then begin to make conscious choices in their future questioning practices.

Thirdly, '*teacher questioning is a function of the teacher's cognition*' (Wang et al. 2017: 28). Thus, before teachers are able to change their professional teaching behaviours, they must firstly become aware of what they are doing and why they are doing it. This necessitates an awareness of not only behaviours, but also of the beliefs, values and attitudes that prompt these behaviours. Therefore, this study contributes to a better understanding of the relationship between beliefs and practices in questioning in order to improve teachers' awareness about their own questioning practices. In general, the research has contradicted previous studies which have claimed that teachers do less than they claim; the findings of this research reveal that both groups did more than they claimed, although some of the claims made by the English mathematics teachers differed in practice. Contextual factors and the nature of mathematics may have contributed to the gap between what the English mathematics teachers intended to do and what they actually did, such as the specific learning and teaching environments they were in, the teachers' content knowledge, the students' abilities and so on. This study contributes to the current understanding of the significance of contexts where questioning was set, in the hope of that teachers could later design and implement their questions taking contexts into considerations.

Fourthly, the findings from this study have the potential to offer practical advice for future teacher training in England: a combination of empirical and theoretical approaches to questioning, because the English mathematics teachers had experienced difficulty in transferring their pedagogical knowledge of questioning into practice. Similar to a suggestion made by Dong (2017), this study suggests that designers of programmes focused on the professional development of teachers should take into account the value of observing and experiencing the practice of more -experienced teachers, especially for those pre-service or novice teachers. This could be done through close examination of how expert teachers ask questions according to the demands of the particular lesson, and how they structure and sequence their questions to prompt students' learning and participation. Although teaching may be regarded as a private practice in the west (Kaiser and Vollstedt 2007), less experienced teachers can use such observations to make comparisons with their own questioning behaviours and to use these to improve their practices in future teaching. Such training for learning from excerpts is very common in the Asian context (Kaiser and Blömeke 2014). Meanwhile, more experienced teachers could also observe pre-service and in-service teachers' questioning practice, to evaluate this and help them to be reflective. It is hoped that by putting this empirical perspective of questioning into practice, teachers would be able to become more reflective about their questioning and build their own understanding of effective questioning strategies and skills to suit their students. It would be also worth introducing mathematics-specific training for questioning into training programmes, as the teachers in England indicated their concerns over the use of questioning in the context of mathematics and there is currently lack of subject-specific training for questioning (Myhill and Dunkin 2005). For the professional education and development of teachers in China, it is recommended to implement some training programmes specifically designed for questioning, including effective questioning types and skills. It is clear that the Chinese teacher participants all held some implicit theories about their questioning behaviours, training would hopefully help them to make these explicit. Knowing what theories can offer, they can make more sense of their own questioning and be reflective, which then helps to ask effective questions in classrooms.

Finally, as mentioned above, the Department of Education in England aimed to copy the Shanghai style of teaching through a mathematics teacher exchange programme (2014-extended to 2020). This study suggests that cultural appropriateness is important. Questioning is a cultural activity, and therefore it is recommended for the policy makers to be openly looking at other education systems, while taking care to assume these can be simply adopted in a very different culture.

6.5 Summary

This chapter has concluded the thesis by explaining the contributions and possible implementations of this study. The limitations and potential recommendations are also presented, in the hope that future studies will build upon this research.

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Appendix

Appendix 1 Classroom Observation Protocol

Descriptive field-notes typically consist of some essential elements such as the place (the setting, activities) and the time. In my study, the descriptive field notes were as follows:

- The physical setting of the classroom, including the time and length of classroom observation, the number of students
- A description of classroom activities which the participants were engaging in at different stages of the entire lesson
- Teachers' whole classroom questioning behaviours
- Students' responding behaviours to teachers' questions
- Teachers and students non-verbal behaviours, particularly teachers' body language. The conversation was observed not only for what was being said but also how it was being said e.g. teacher's movement (walking down from podium to somebody or to a group, gesture)

Field Notes

Date of Observation: _ Grade/ Year group: _Name of Teacher: _

Class size: _ Lesson topic: _ Lengths of the lesson: _ Physical setting: _

Teachers' questions	Students' answers	Teacher's non-verbal behaviours (Hands up, nomination, movements)

Appendix 2 Semi-structured Individual In-depth Interview Schedule

A Comparative Study of Current Beliefs and Practices of Teacher Questioning in England and China

Purpose

This interview aims to collect information about personal beliefs and self-reported practices about questioning from mathematics teachers teaching at Key Stage 3 in England and at Year 7 and Year 8 in China to draw a cross-cultural comparison of teachers' beliefs about and use of questioning in teaching and learning.

Procedures

The interview questions have five sections and are estimated to take around 20-30 minutes to complete. The questions are designed to collect teachers' personal social and educational background information and to elicit teachers' views on the role of questioning and their beliefs about asking questions in class.

Participation

Participation in this interview is entirely voluntary. All participants can withdraw at any point and they do not have answer every single question asked by the researcher.

Structure

The first section will consist of a series of demographic questions, including gender, education, years of experience etc. Following this, sections (2-5) will ask questions to teachers about their perception of the value of questioning, their purposes in asking questions, their content focus related to their ways of sourcing questions, the cognitive levels of the questions they ask, their language and manner in questioning, and their perceptions of student ability and how their questioning might vary. It is anticipated that by asking those open-ended questions, teachers' underlying beliefs will be articulated. This second section is designed to explore individual perceptions of the importance of questioning in teaching. The next set of questions asks about the teachers' frequency and purposes of asking questions to students. The third section seeks to investigate teachers' sourcing and preparation of questions.

Questions will include: *Do you have lesson plans? Do you plan your questions beforehand or spontaneously? Where do you source your questions from?* The fourth section will be drawing on teachers' questions - content focus, and the cognitive levels of the questions they ask. The content focus and cognitive level of teacher questions are developed from the *revised Bloom's taxonomy* (Anderson et al. 2001). The fifth section addresses the perceptions of teachers towards their language and manner in posing and distributing questions. The final section is to ask if they ever had any training about questioning and their further comments.

Opening statement: Thank you for taking part in this research and for agreeing to be interviewed. The interview will last about half an hour. The purpose of this interview is to obtain some information about your educational background, and to understand your views about the role of questioning in classroom practices. Please remember that there are no right or wrong answers. The validity of this investigation depends on the extent to which your responses are open and frank, so please answer honestly and in as much detail as possible. Your responses will be used for research purposes only, and will remain confidential. I would like to record the interview, with your consent.

Before we proceed, are there any questions you would like to ask me?

(*Allow time for any questions and begin recording)*

Part 1: Demographic Information (Participants' backgrounds)

- Highest Education (academic qualifications)
- Years of teaching experience
- Years of teaching Mathematics
- Grade that currently teach
- Number of students in current class

Part 2: Personal Value of Questioning and Purposes of Questioning

- Do you use questions during your lessons?
- How often do you ask questions in class?
- How important is the use of questioning in your teaching?
- What are your normal reasons for asking questions? (Purpose of questioning)

- Why do you ask questions for those reasons?
- How do you think the instructional objectives of the institution and the course are affecting your purposes of questioning?
- Any other constraints that may affect your purpose in posing questions?

Part 3: Preparation or Sourcing of Questions

- Do you have lesson plans? Do you plan your questions?
- How do you prepare questions (in advance or spontaneously)?
- Where do you source your questions (where do your questions come from?)? What are materials or resources do you use to generate questions? (Textbooks, magazines etc.)
- What factors do you take into account while preparing your questions? E.g. purpose, student cognitive level you aim to develop, content focus etc.

Part 4: Questioning Types (Content focus and cognitive level of questions)

- What sort of questions do you usually ask?
- Do you ask different kinds of questions at different times in your lesson? How do you decide on the levels and types of questions to ask to your students? (Levels and types of questions)? Are you aware of different levels and types of questioning?
- What content do you prioritize by asking questions? (factual knowledge, conceptual knowledge and procedural knowledge, meta-cognitive knowledge)
- Which helps you to decide the content to focus on? Syllabus? Progression of questions?
- What kinds of questions do you feel you ask the most to the students? For example, Questions requiring them to remember information, understand concepts, or apply or evaluate these?
- Do you ask questions that support higher order thinking? How would you make it happen?

Part 5: Language and Manner of posing questions

- How do you pose questions to students? Do you pose the questions at random or do you pose to volunteers or to children you select? (Distribution of questions)

- Do you wait after posing a question to the class? How long you do usually wait? (Wait-time 1)
- How do individual students' differences (e.g. Age, grade, learning behaviour, learning abilities, achievement level, and cultural backgrounds) affect the way you formulate or pose questions? (other factors that influence teachers' questioning)

Part 6: Training and Suggestion for teacher questioning

- Have you ever experienced any training for the use of questioning in your teaching?
- If you were given a choice, how would you improve your way of questioning?
- Thanks for your time. Is there anything else you would like to suggest to add about questioning?

Additional questions:

- Do you often use questioning strategies in your lessons? How do you sequence/ask your questions in any particular way? (Questioning strategies)
- Why do you ask questions the way you do? (Questioning strategies), for what purpose?
- Do students always answer your questions? What if they do not answer, what will you do? Will you rephrase your questions before asking it again?
- Do you correct your students' incorrect/incomplete responses? If so when and how?
- To what extent, do you encourage students to ask questions? Or how do you encourage your students to raise their own questions? (Student questioning)
- Do you try to find alternatives to questions? What are they?

Prompts:

- Why?
- How?
- Can you explain?
- Can you give some examples?

Appendix 3 Chinese Version of Semi-structured individual in-depth Interview Schedule

中西方初中数学老师课堂提问对比采访纲要

目的

此采访是为了收集中英数学老师课堂提问的看法， 来做中英老师课堂提问比较和对比。

流程

采访的问题包含 5 个部分，采访时间大约需要 20-30 分钟完成。问题主要集中在了解老师个人教育背景，老师个人对课堂提问的看法。

参与

所有参与的此采访的老师都是自愿的。老师可以选择在任何时候退出此采访，也可以选择不回答一些问题。

结构

第一部分是关于老师的个人信息，包括性别，所受教育，教学年龄等等。老师的社会信息是和他们的文化价值。

接下来的 2-5 部分是关于老师对提问的价值，提问的目的，提问的类型，提问的内容， 问题的语言与态度，以及他们对学生能力对提问的影响的看法。这些采访问题希望能够针对老师对课堂提问的看法做个全面的了解。

开场陈述：谢谢参与到此课题的采访。采访将持续 30 分钟左右。目的是希望能够获得老师对课堂提问的一些看法。请记住问题没有对错。希望能够诚实作答， 并且尽可能多的给出具体信息。您的回答只会用于此论文， 所有信息都是机密的。希望您不介意被录音。

在开始之前，有什么想问的问题吗？

第一部分：社会信息

教育背景

教龄

数学教龄

所带年级

学生人数

第二部分：个人对提问的价值和提问目的的看法

你在课堂上提问吗？

你经常提问？多长时间提问一次？

提问对你来说重要吗？

你提问的目的是什么？

你为什么因为这些目的提问？

你认为教学目标会怎么样影响你的提问目的？

有没有哪些因素会影响你的提问目的？

第三部分：问题的来源和准备

你备课吗？在备课当中，你准备问题吗？

你都如何准备问题？是在上课之前准备还是随着课堂展开？

你的问题都是从哪里来的？课本？网上?

在准备问题的时候，有什么需要特别注意的吗？ 比如说课堂目标，提问目的，你希望学生发展的学生能力。

第四部分：提问类型

你通常都提什么类型的问题？

你在课上都会提不同类型的问题吗？你怎么决定问题的类型和水平？你了解不同类型的问题吗？

什么提问内容你会优先提问？

哪些会帮助你觉得提问内容？教学大纲？问题进程？

你通常什么问题问得最多？比如说让学生记住的问题，让学生明白的问题，让学生锻炼的问题, 让学生分析的问题？

你会问那些让学生发展高阶思维的问题吗？怎么实现？

第五部分：提问语言和方式

你通常怎么向学生提问？ 举手回答还是点名？

你问完问题会等待一下吗？会等待多久？

不同学生会影响你提问题的方式吗？比如学生的学习习惯，学习能力，文化背景，成绩高低等等

第六部分：提问培训

有没有受到过针对课堂提问相关的提问？

如果可以，您愿意怎么样提高提问？

谢谢您的时间！您有其他的关于课堂提问的建议要提出吗？

其他问题：

你有经常用的提问策略吗？怎么用的？ 你为什么那么用？ 目的是什么？

学生总能回答您的问题吗？如果他们不能给出合适的答案，您会怎么做？ 您会改写自己的问题吗？

你会纠正学生的错误回答吗？怎么做？

你会鼓励学生提问吗？怎么做？

你会用其他方式代替提问吗？

提示：

为什么？

怎么做？

你可以解释一下吗？

你可以举个例子吗？

Appendix 4 The Data Collection Structure

The researcher made a structure for conducting observation and interviews. It was planned to conduct classroom observation on one day, and the individual in-depth interview on the same day or the following day. This was to allow some time for the researcher to reflect deeply about teacher questioning through field notes and repeatedly playing back of the audio recorder.

On the day	Classroom observation	Interview
The following day	Interview	

Table The Data Collection Structure

Appendix 5 Participant Teachers' Portfolios

The profiles of all 23 participant teachers are presented including their general information about their educational backgrounds and years of teaching experience. All participants are given pseudonyms. The summary of these profiles can be seen in table below.

Teacher	School	Gender	Education	Teaching Years	Teaching Years in maths	Classes	Class Size	Year group	Class /Set	Lesson Topics
Teacher 1	School 1	F	MA	9	9	2	45	Year 7	Class 5	'Equation with algebraic fraction'
Teacher 2		M	MA	3	3	2	47	Year 7	Class 3	
Teacher 3		F	MA	4	4	2	46	Year 7	Class 10	'Equation with algebraic fraction' in solving real life mathematical problems'
Teacher 4		F	MA	4	4	2	47	Year 7	Class 2	
Teacher 5		F	MA	9	9	2	46	Year 7	Class 8	'Collection and collation of Data'
Teacher 6		M	MA	10	10	2	49	Year 7	Class 12	
Teacher 7		F	MA	1	1	2	50	Year 8	Class 5	'Inverse proportionality'
Teacher 8	School 2	M	BA	44	44	2	53	Year 8	Class A (6)	' the graph of function'
Teacher 9		F	BA	17	17	1	50	Year 7	Class B(5)	'Internal angles of a triangle'
Teacher 10		F	BA	33	33	1	52	Year 7	Class B(3)	'Polygon'
Teacher 11		F	BA	6	6	1	47	Year 7	Class A (5)	'Angle Bisector'
Teacher 12		M	BA	11	11	2	49	Year 7	Class A (3)	'Triangles congruent'
Teacher A	School 3	F	MA	1	1	5	11	Year 7	Class A (7)	'Multiplying decimals'
Teacher B		F	MA	7	7	5	24	Year 9	Class B (5)	'San, Cos, Tan'
Teacher C		F	MA	1	1	5	8	Year 8	Class c (1	'Rounding numbers'
Teacher D		F	MA	4	4	5	15	Year 7	Class D (6)	'Angle measurement'
Teacher E		M	MA	30	30	6	31	Year 9	Class E(2)	'Midpoint'
Teacher F		F	MA	1	1	5	24	Year 7	Class F(H)	'Division'
Teacher G		M	MA	15	14	5	30	Year 7	Class G (8)	'Calculation'
Teacher H		M	MA	13	13	5	10	Year 7	Class H (8)	'H T O (x timing 10,100...)'
Teacher I		F	MA	12	12	5	20	Year 8	Class I (5)	'Multiples'
Teacher J	School 4	F	MA	27	27	7	21	Year 7	Class J	'Rectangle, Square, Stick'
Teacher K		F	MA	3	3	4	24	Year 7	Class K	'Factor of a number, the highest common factors, and the lowest common multiples'

Table Participant Teacher Profiles

Teacher 1

Teacher 1 was a very experienced mathematics teacher. She taught two classes and undertook 40 hours of teaching per week. According to her, she was appointed to teach students in Class 5 and Class 6 which are considered as lower level students (Class 5, Class 6). She was the homeroom teacher of Class 6. Class 5 was selected by her to be my observation class because she believed that there were less classroom management issues in Class 6 than those in Class 5.

Teacher 2

Teacher 2 was in his late 20s. He used to teach mathematics in another lower secondary school for two years. After that, he jointed School 1 a year ago. Similar to Teacher 1, she taught two classes (Class 3 and Class 4) and spent 45 hours on teaching per week as well. He selected Class 4 to be my observation target but because Class 4's lesson was reviewing the previous lessons which did not suit my observation purpose, I then observed his Class 3 instead.

Teacher 3

Teacher 3 was pregnant for 5 months at the time when I was conducting my research there in school 1. She was on her fifth year of teaching mathematics, but she only started teaching in this school one year ago. In School 1, she also taught two classes - Class 9 and Class 10. They were considered as the higher ability groups of students compared to the classes taught by Teacher 2 and Teacher 1. She had to spend over 30 hours teaching per week.

Teacher 4

Teacher 4 was on her fifth year of teaching mathematics in School 1. At that time, she taught two classes and undertook 40 teaching hours per week. Class 2 was selected to be observed by the researcher.

Teacher 5

Teacher 5 was the wife of teacher 6, who had been teaching for nearly nine years of mathematics. She was also teaching two classes at that time, and spending more than 40 hours on teaching per week.

Teacher 6

Teacher 6 was the head teacher of Year 7 in school 1. He had been working in school 1 longer than anyone else participated in this study, and he had been teaching in the school 1 for nearly 7 years. Prior to joining school 1, he used to teach in a senior secondary school for 3 years. At the time of my study, he was also the mathematics teacher of Year 7 students, teaching two classes and spent 50 hours teaching per week. He was also the homeroom teacher of class 12 (see the detailed descriptions of participant classes in later sections).

Teacher 7

Teacher 7 was in her early 20s. She just received her Master's degree from a Normal University. Sooner after her graduation, she started teaching mathematics to Year 7 in School 1; this had been her second year of teaching. At the time of the study, the group of year 8 students I observed were the same group of students she taught last year, so she had been teaching them for two years from Year 7 to year 8. Like other teachers 1-6, she also taught two classes and undertook 40 hours of teaching every week.

Teacher 8

Teacher 8 was the most experienced teacher across all my participant teachers in both countries, he had taught for 3 years in School 2 during the Cultural Revolution. After that, he went back to university for a Bachelor's degree, and returned to School 2 to teach Mathematics after his graduation. In total, he had been teaching for 44 years. He was also teaching 2 classes at the time of my study and spent over 40 hours per week on teaching.

Teacher 9

Teacher 9 was in her 30s. She had been teaching in School 2 for nearly 17 years in School 2, and was rewarded ‘teaching excellence’ during the year 2015-2016. She only taught one class during my visit, and undertook 30 hours of teaching every week.

Teacher 10

Teacher 10 was in her earlier 60s, she had been teaching for approximately 30 years in School 2. At the time of my study, she only taught one class, and spent 30 hours per week on teaching. She was also preparing for getting retired.

Teacher 11

Teacher 11 was on her late 20s. She joined School 2 straight after receiving her Bachelor’s degree in Beijing 6 years ago. Compared to other four participants in School 2, she had less teaching experience compared to the rest of teachers observed in School 2. She taught one class, and spent 35 hours teaching every week at the time of the study.

Teacher 12

Teacher 12 was also rewarded ‘teaching excellence’ during the year 2015-2016. At the time of my study, he taught two classes and spent over 40 hours teaching per week.

Teacher A

Teacher A was on her second year of teaching mathematics. Prior to joining mathematics in School 3, she used to be teaching assistant in Science. At the time of my study, she was also just starting her second year of Newly Qualified Teaching, after finished her PGCE course and postgraduate studies. She majored in Bio-medical science not mathematics. She spent 20 hours teaching per week. The students of Class A was the same group that with her from the year 2014, so she had been teaching this group of students for nearly one year and a half.

Teacher B

Teacher B had been teaching for almost 8 years. After obtained her Master degree, she then continued with teacher training. Right after that, she started teaching mathematics in School 3. At the time, she undertook 20 hours teaching per week as well. Besides, she was also the head of mathematics department.

Teacher C

Teacher C was in her late 20s. She jointed School 3 after she graduated with a Master degree. She taught five classes, and undertook 20 hours teaching per week as well.

Teacher D

Teacher D was on her fifth year of teaching. At the time, she also taught five classes and spent 20 hours per week on teaching. She was only teaching Class D for a month.

Teacher E

Teacher E was the most experienced teacher, with nearly 30 years of teaching experience in mathematics. He jointed School 3 only recently, about half a year ago. So he started teaching Class E half a year ago. He taught 6 classes, which worked out 24 hours per week spending on teaching.

Teacher F

Prior to joining School 3, Teacher F did her teacher training. After that, she started to teach mathematics to students of Year 7. And this was her second year of teaching. She also taught five classes and spent 20 hours teaching per week.

Teacher G

Teacher G had been teaching for approximately 15 years. After finished his teacher training course he taught science for a year and also worked in industry. Prior to joining School 3, he used to teach mathematics in another school for 3 years. He had been teaching mathematics in School 3 for 10 years. He taught six classes, which had a wide range of student abilities. He also spent nearly 24 hours teaching per week.

Teacher H

Teacher H had been teaching mathematics for 13 years. In School 3, he had been teaching for nearly 10 years. He taught five classes, and spent 20 hours teaching per week. This was Class H which was selected as the class to be observed by the researcher.

Teacher I

Teacher I had been teaching mathematics for 12 years. She had joined School 3 for almost 8 years. She taught five classes and spent 20 hours teaching per week.

Teacher J

Teacher J had been teaching for nearly 27 years. She jointed in School 4 since she graduated with a Bachelor degree. She taught seven classes from Year 7 to A level, and spent 28 hour teaching per week. This is Class K which was selected to be observed.

Teacher K

Teacher K joined School 4 about 3 years ago. She taught four classes and spent 20 hours teaching per week.

Appendix 6 Environment of School Sites in China and England

In this study, the data was collected from four schools; School 1 and School 2 in the mainland China, and School 3 and School 4 in England. Specifically, School 2 is located in Langfang city, Hebei Provence. The locations of School 3 and School 4 are in Coventry and Birmingham city respectively. School 1 is located in Hangzhou city, Zhejiang Provence, which is the most difficult school to be reached, but there is a direct training which takes about 5 hours. All schools are all academy schools. Precisely, School 2, School 3 and School 4 are all state, co-educational secondary schools, only School 1 is a private, co-educational secondary school, which followed the same national curriculum as school 2. The general information of schools can be seen in table below:

	School 1	**School 2**	**School 3**	**School 4**
Location	Hangzhou	Langfang	Birmingham	Coventry
Type	Upper and lower secondary school	Upper and lower secondary school	Upper and lower secondary school	Upper and lower secondary school
Authority	Private /Academy	National/Academy	National/Academy	National/Academy

Table Participant School Profiles

School 1

As mentioned earlier, School 1 is located in Hangzhou city, Zhejiang Province. Hangzhou is the capital and the largest city of Zhejiang Province in Eastern China. Because School 1 is a private boarding school, in order to compete with other state schools, the achievements of students are put as the priority.

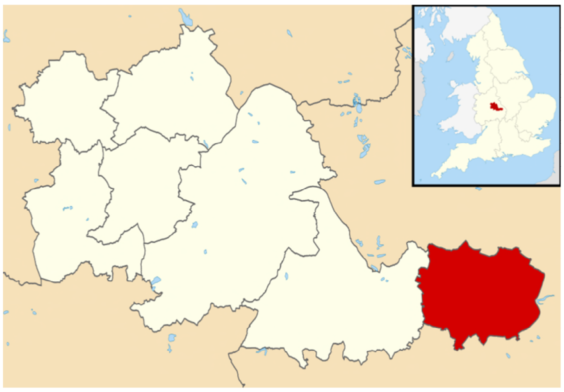
School 2

The location of School 2 is in Langfang city in Hebei province. Langfang is located approximately midway between Beijing and Tianjin. Different from School 1, it is a nation-run state school.

School 3

School 3 is in Birmingham city, located in the West Midlands of England. It is the largest and most populous city except London. As mentioned above, it is a state school, maintained directly by Birmingham City Council, and it is also a mixed secondary school including six forms.

School 4



As mentioned above, the location of School 4 is in Coventry. Coventry lies at the heart of England. It is the 2nd largest city of West Midlands region, the 10th largest city in England and the 13th largest city in the UK overall. School 4 is an all-inclusive academy in England.

Appendix 7 Chinese and English School Day Timetables

As there were four schools involved in this study and their school days were quite different, four school day timetables were presented below. School 1 and 2 are Chinese schools, whereas School 3 and 4 are English schools.

School 1 is a boarding school, this school therefore had a very restrictive timetable for students, especially the longest school hours among the four schools (see in table 1 below).

School Day	**Time-Table**
GET UP	6:20
BREAKFAST	6:20-6:50
Morning Reading Out Loud	6:50-7:00
Morning Self-study	7:00-7:40
Period One	7:50-8:30
Period Two	8:40-9:20
Period Three	9:30-10:10
Period Four	10:20-11:10
LUNCH	11:20-11:50
Self-study	11:50-12:40
Homeroom teacher’s speech	12:50-13:00
NAP (a short sleep)	12:30-13:00
Period Five	13:05-13:45
Eye protection exercise	13:45-13:50
Period Six	14:00-14:40
Period Seven	14:50-15:30
Period Eight	15:40-16:20
Outdoor excise	16:20-17:00
DINNER	17:00-17:30
Homework correction	17:30-18:00
Evening self-study 1	18:00-18:45
Evening self-study 2	18:55-19:40
Evening self-study 3	19:50-20:35
Students accompanied by teachers to accommodation	20:45
Light off warning	21:10
LIGHT OFF	21:20

Table 1 School Day Timetable in School 1

School 2 is a state school, it followed closely to the national school day timetable, which gave students some time and flexibility outside the school (see in table 2 below).

School Day	**Time-Table**
Morning Reading	7:30-8:30
Period One	8:40-9:40
Period Two	9:40-10:40
BREAK	11:00-11:20
Period Three	11:20-12:20
Period Four	12:20-13:20
LUNCH	13:20-14:15
Period Five	14:15-15:15
Afterschool	15:15-

Table 2 School Day Timetable in School 2

School 3 and School 4 followed almost the same school day timetable (as can be seen below in Table 3 and table 4).

School Day	**Time-Table**
Period One	8:40-9:40
Period Two	9:40-10:40
BREAK	11:00-11:20
Period Three	11:20-12:20
Period Four	12:20-13:20
LUNCH	13:20-14:15
Period Five	14:15-15:15
Afterschool	15:15-

Table 3 School Day Timetable in School 3

School Day	**Time-Table**
Period One	8:50-9:50
Period Two	9:50-10:50
BREAK	10:50-11:10
Period Three	11:10-12:10
LUNCH	12:10-13:10
Period Four	13:10-14:10
Period Five	14:10-15:10
Afterschool	15:10-

Table 4 School Day Timetable in School 4

Appendix 8 Data Collection Procedures in China and in England

The details of data collection procedures from both countries were presented separately in the following tables.

Data collection procedures in China

The procedures of data collection in China mostly were made through the researchers' personal negotiation with each of the participant teachers individually during the process of collecting data. In other words, the researcher first approached the teachers individually to arrange the time of observation and interviews on the basis of their convenience. Therefore, one individual interview after classroom observation was split into two interviews before and after classroom observation as shown in table 1.

School	**Procedure**	**Pre-observation Interview**	**Classroom observation**	**Post-observation interview**
School 1	Day 1 (4/5)	Teacher 1 Teacher 2		
	Day 2(5/5)	Teacher 3	Teacher 1	
	Day 3(6/5)		Teacher 2 Teacher 3	Teacher 3
	Day 4(7/5)		Teacher 4	Teacher 1 Teacher 2
	Day 5(11/5)	Teacher 5	Teacher 5	Teacher 4
	Day 6(13/5)	Teacher 6	Teacher 6	Teacher 5
	Day 7 (14/5)	Teacher 7	Teacher 7	Teacher 6
	Day 8(15/5)			Teacher 7
School 2	Day 1 (19/5)	Teacher 8	Teacher 8	
	Day 2(20/5)		Teacher 9	Teacher 8
	Day 3 (21/5)	Teacher 10	Teacher 10	Teacher 10 Teacher 9
	Day 4 (10/6)	Teacher 12	Teacher 11 Teacher 12	
	Day 5 (11/6)			Teacher 12 Teacher 11

Table 1 Data Collection Procedures in China

Data collection procedure in England

Unlike the two schools in China, the exact timetable of data collection for English schools was already made before conducting my study through negotiation with the head teachers of the department in both schools. The detailed information of data collection procedure can be seen below:

School	**Procedure**	**Classroom observation**	**Interview combining both pre-observation interview and post observation interview**
School 3	Day 1	Teacher A Teacher B Teacher C Teacher D	Teacher A Teacher B Teacher C Teacher D
	Day 2	Teacher E Teacher F Teacher G Teacher H	Teacher E Teacher F Teacher H
	Day 3	Teacher I	Teacher I Teacher G
School 4	Day 1	Teacher J Teacher K	Teacher J Teacher K

Table 2 Data Collection Procedures in England

School day	**Day 1**	**Day 2**	**Day 3**
Period one (8:40-9:40)	Teacher A observation	Teacher E observation	
Period two (9:40-10:40)	Teacher B observation	Teacher F observation	Teacher I observation
11:00-11:20	BREAK	BREAK	BREAK
Period three (11:20-12:20)	Teacher C observation	Teacher E interview Teacher F interview	Teacher I interview
Period four (12:20-13:20)	Teacher D observation	Teacher G observation	
13:20-2:15	LUNCH	LUNCH	LUNCH Teacher G interview
Period five (14:15-15:15)	Teacher A interview	Teacher H observation	
Afterschool	Teacher B interview	Teacher H interview	
	Teacher C interview		
	Teacher D interview		

Table 3 Data Collection Procedures in School 3

<table>
<tr><th>School Day</th><th>Observation/Interview time</th><th colspan="2">Classroom Observation</th><th colspan="2">Post observation interview</th></tr>
<tr><td rowspan="2">Period One
(8:50-9:50)</td><td>(8:50-9:20)</td><td>Teacher I (planned)</td><td rowspan="2">Teacher I</td><td rowspan="2" colspan="2"></td></tr>
<tr><td>(9:20-9:50)</td><td>Teacher L (planned)</td></tr>
<tr><td>Period Two
(9:50- 10: 50)</td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>BREAK
(10:50-11:20)</td><td>(11:10-11:20)</td><td colspan="2"></td><td colspan="2">Teacher I</td></tr>
<tr><td>Period Three
(11:20-12:20)</td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td rowspan="2">LUNCH
(12:20-13:10)</td><td>(12:10-12:25)</td><td rowspan="2" colspan="2"></td><td>Teacher I (planned)</td><td rowspan="2">Teacher I</td></tr>
<tr><td>(12:25-12:40)</td><td>Teacher L (planned)</td></tr>
<tr><td>Period Four
(13:10-14:10)</td><td></td><td colspan="2">Teacher K</td><td colspan="2"></td></tr>
<tr><td>Period Five
(14:10-15:10)</td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Afterschool
(15:10-)</td><td></td><td colspan="2"></td><td colspan="2">Teacher K</td></tr>
</table>

Table 4 Data Collection Procedures in School 4

Appendix 9 The Structures of Lessons In China and England

Structure of Lessons in China

The duration of a lesson lasted for 40 minutes. After each lesson, a ten-minute break was allowed. In school 1, Teacher 1, 2, 3, 4, 5 and 6 used the same textbook, ‘Mathematics’ (Year 7 Vol 2), which was published by Zhejiang Education Publication House. The textbook ‘Mathematics’ (Year 8 Vol 2) used by teacher 7 was also published by Zhejiang Education Publication House. In school 2, teacher 9, 10, 11 and 12 used the same textbook, ‘Mathematics’ (Year 8 Vol 1), which was published by People’s Education Press (PEP). The textbook ‘Mathematics’ (Year 9 Vol 2) used by Teacher 8 was also published by People’s Education Press (PEP). Although the textbook materials used in school 1 and school 2 were slightly different, all their textbooks were approved by the central authority –Ministry of Education of the People’s Republic of China.

The 12 classes were structured quite similarly, but the organisation of instructional activities varied depending on the teaching contexts and the teachers’ intention. At the beginning of every lesson, the students stood up and made a greeting to their teachers. Following this, the teachers often started to briefly review the previous knowledge such as previous day’s homework or previous lesson’s content. Then they came to introduce a new topic and gave some mathematical questions to the whole class. The questions seemed be in a hierarchy of difficulty, which were starting with a simple one, then building up to the difficult ones. After commenting and giving feedback to the students on their answers for questions, the teachers finally summarized the important knowledge or gave homework at the end. Teacher–fronted monologue occupied most of the classroom time in these lessons. Also, students usually stood up when being nominated by the teachers or when giving their answers. If they did not get the questions right, they would have to stand up there until their teachers allowed them to sit down.

There were some examples of the structure of lessons and instructional activities. Many teachers observed had asked students to present their answers or explain their answers to the entire class on the board or by speaking at different stages of their lessons. Teacher 2, teacher 3, teacher 5, teacher 7 asked their students to write down their answers of a quiz on the board at the end of his lesson. Whereas, teacher 9, 10, and 11, in their middle of the lessons, asked a couple of students to not only write down but also explain the problem solving and proving process on the board to the whole classes. The rest of the Chinese teachers all demonstrated to ask their students to give answers and explain their answers loudly to the entire class.

Structure of Lessons in England

In English secondary schools, the duration of lesson each lasted for 60 minutes. Different from a Chinese lesson which allowed a ten-minute break after each lesson, a 20-minute break was given before or after the second period of the school day, which was the only break during the school day. Besides, unlike Chinese teachers, English mathematics teachers did not usually bring a textbook with them in lessons, students did not use textbook but a homework book in class; however, they did follow the national curriculum, in this case, the revised KS3 programme of study to the students. As there were no textbooks in these lessons, the students were given their homework books at the start of the lesson. They wrote down things in their homework book, such as what they learnt and what they did not understand or were confused about by the end of the lesson.

The structure of English lessons was quite different from the Chinese lessons. Most of the time, the classroom was occupied by students' group work or discussion in these lessons. So compared to the Chinese classrooms, there was less teacher-fronted monologue in class.

Precisely, the 11 classes were structured similarly and the instructional activities were organized to include a wider range of group work, peer work, individual seat work, group discussion, and whole classroom discussion. Before the lesson, teachers wrote down 'the starter' on the board or PowerPoint. When the lesson started, the teachers went on reviewing the previous day's knowledge or homework. Following this, they began introducing a new topic of a discussion or a class activity to the whole class, which were in 'the starter' shown in PowerPoint. Then it was followed by student pair and group work. The students usually worked on a given task with a hand-out or on a given task on the board or PowerPoint. During this process, the teachers looked on the students' work and picked up some students to answer questions. Student presentation and whole class discussion often followed group or pair work. After students' presentations, the teachers gave comments and feedback and led the whole class for a discussion and reflection. In class, the teachers often circulated among the students to answer their questions and if the students were doing well, they would be given some colourful dots which indicated they were making how much progress and were seen as an encouragement by both of them. At the end of these classes, the teachers typically summarized the important knowledge, assigned homework or a puzzle game. In the PowerPoint and the hand-out, the teachers provided the students with different levels of questions. For example, in one school, students were often offered three options (Must, Should, Could). ‘Must, Should, Could’ was in an order from easy to difficult in the level of questions. ‘Must’ -the students must be able to do, ‘Should’- the students should be able to know how to do it, ‘Could’-the students could try those out if they can or have time to do so.

Appendix 10 Physical Settings of a Classroom in China and in England

In a Chinese classroom, the size of class tended to be large from 45-53 students. Students' seats were typically arranged based on their scores and test results from their examinations. In other words, they were sitting following an order that these students whoever got the highest scores would be put in the front row, and the lowest scores would be allocated to the back end of the classroom. Students' abilities varied across all classes and there was no setting by ability, they were all taught the same materials by the teachers (see below in Table 1).

Podium						
S1	S8	S15	S23	S30	S37	S44
S2	S9	S16	S24	S31	S38	S45
S3	S10	S17	S25	S32	S39	S46
S4	S11	S19	S26	S33	S40	S47
S5	S12	S20	S27	S34	S 41	S 48
S6	S13	S21	S28	S35	S42	S49
S7	S14	S22	S29	S36	S43	S50

Table 1 Physical Setting of a Chinese classroom

Whereas, in English classrooms, the size of class varied a lot according to their sets (setting by ability). The higher the set was, the more students it had in the classroom. For instance, a class is set 8; the class size is more likely to be under 10; a class is set 1, the class size can go up to 30. The size classes observed were arranged from 8 to 30. Regarding students' seat arrangement, unlike Chinese classrooms, it was quite flexible, they could seat anywhere they wanted since the fact that students were never allocated to one particular permanent desk and they ought to move around to different classrooms according to their subjects. This was quite different to the Chinese classroom where students often were allocated to one particular permanent desk no matter which lessons they were in, and the teachers ought to go around to different classrooms. Two types of physical layout observed in the English classrooms. The first one was students seating randomly wherever they wished to sit, without any requirements or rules as those of Chinese students. The students were seated as Table 2.

Teacher's table	Podium						
			S3	S4	S5		S1
	S14		S5	S6	S7		S2
	S15		S8	S9	S10		
			S11	S12	S13		

Table 2 Physical Setting of an English classroom

Alternatively, students were seating on round tables, as shown in Table 3.

Podium

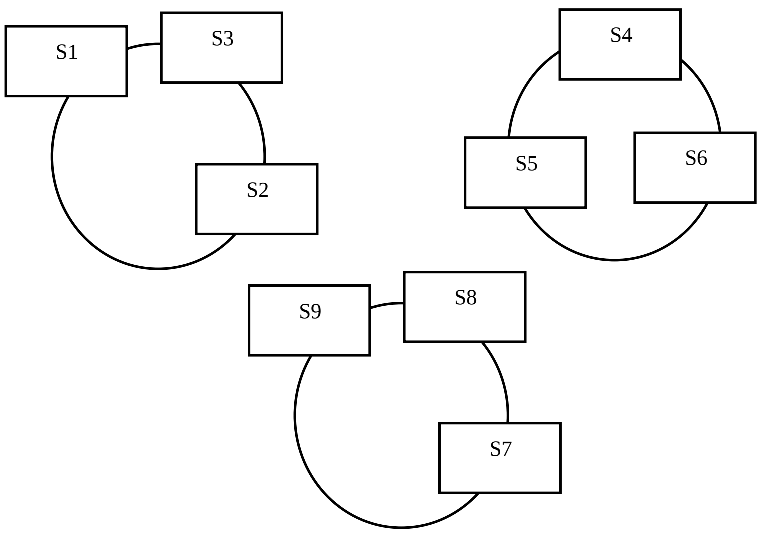


Table 3 Physical Setting of an English classroom

Appendix 11 English Version of Outline Sheet

My research topic is: A comparative study of beliefs and practices of teacher questioning in England and China. The research aims to explore teachers' beliefs in questioning and their questioning practices in teaching mathematics to Key Stage 3 in lower secondary school. The research therefore will be conducted through: Classroom observation and Follow-up one to one individual in-depth interview. I will firstly observe the lesson, then an individual interview will be carried out after the observation. Both lesson observations and interviews will be audio-recorded for further analysis.

Please note that the participation in this study is completely voluntary. You are free to withdraw from participation at any time. If you choose to participate, all information will be kept confidential. All data obtained from this study are for educational purposes only and only the researcher has the right to access to them, following the ethical guidelines of The University of Warwick.

If you have any questions about the information above or queries about the present study, you may discuss them with the researcher prior to the study or even after the study through the information below.

Besides, if you are interested in the results of this study, you are very welcome to contact the researcher and get the research findings.

Thank you very much for the support.

Wenping Zhang

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Appendix 12 Chinese Version of Outline Sheet

老师同意书

此研究的目的是在于探索老师课堂提问以及他们对课堂提问的看法的课题。因此，此课题主要通过听课和采访来实现。在研究中，老师课堂提问的情况会被录音，稍后的采访也会被录音。所有的录音只会用于日后研究分析。

你有权随时终止参与此研究，或者选择不回答某些问题。如果你同意参与，你的个人资料将会被保管严密，以匿名的方式在研究中出现。

如果你还有什么问题可以随时问我，也可以用下面的联系方式与我联系。

如若你对研究成果感兴趣，本人愿意提供此研究结果供你参考。

非常感谢你的参与与支持。

张文萍

英国华威大学教育学博士

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Appendix 13 Transcription Convention for Classroom Observation

This study was mainly focusing on teachers' questioning in class, the transcription conventions of observation were made to present the detailed information about who asked the question of whom, where, and when this question was asked should be included in the transcripts in order to understand the process of teacher questioning in real-time classroom. Additionally, how the question was asked, that is, the questioning behaviour should be also captured, the length of pause, the intonation and many other non-verbal behaviours. However, the teacher's natural classroom questioning turned out to be much messier than the written texts. For example, when the teachers spoke, they hesitated, they repeated the same words over times, and they sometimes asked questions in a high pitch or lower voice and so on. A transcription notation system was developed in order to capture all these accounts, as shown below (adopted from Chang 2009).

1. Identity of Speakers

T: Pseudonym of a teacher

S1:/S2: Students are generally numbered in the order they first answer teacher's questions. The student identity is given at the beginning of each turn.

TS: Utterance assigned to both teacher and students.

SS: Utterance assigned to a group of students

S: The identity of the speaking student cannot be identified

2. Inaudible speech

(Inaudible) Words that are unclear and cannot be noted down after being played repeated times

3. Pause or Wait Time

(SP) Every brief pause (less than 3 seconds) in the exchange between question and answers of students and the teacher is marked with 'SP'.

(LP) Longer pauses which are more than 3 seconds are marked with 'LP'

4. Intonation

? Words spoken with rising intonation are followed by ?

. Words spoken with falling intonation are followed by a full stop '.'

5. Emphasis

__ Words spoken with strong emphasis are used '__', for example, <u>what is 5+3?</u>

6. Lengthening

: Words spoken to lengthen sounds are followed by ‘:’. For example, you:

:: Words spoken with exceptionally long sounds are marked with ‘::’

7. Silence

(No response) …………..Stands for the silence of respondents

8. Non-verbal behaviour

(LF)..............Signals all laughter and laughter-like sounds

(ND)…..........Signals non-verbal feedback –nodding

(WT).............Signals physical activities--writing on the board

(PO) ....Signals pointing out to the next speaker

(SW) ....Signals the physical activities—showing out answers on the little mini-whiteboards

(HP) ....Signals students’ hands up

9. Activities beyond the whole classroom questioning

(Break out session) …………The omission of the off-task events such as group discussion, seats work and peer work activities

10. Particular questioning behaviours

[]? …………… Incomplete sentences that end with a rising intonation followed by a pause

Appendix 14 Types of Teacher Questioning

The research here aimed to explore the kinds of questions that teachers asked and why they asked these questions through an analysis of observed practice. Denton's (2013) classification was a combination of the Mathematical Assessment Task Hierarchy taxonomy framework (MATH taxonomy framework) (Smith et al. 1996) and Andrews et al.'s (2005) mathematical foci, supported by mathematical prompts proposed by Watson (2007) and Hodgen and Wiliam (2006).

Categories of questions *Adapted from Denton 2013a)*	***Prompts*** *adapted from Watson's analytical instrument (2007: 119)*	***Features***	***When used*** *Adapted from Andrews et al. (2005)'s mathematical foci*	***Formative question*** *stemmed from Hodgen and Wiliam (2006)*
Factual questioning	• Name • Recall facts • Give definitions • Define terms	Pose questions to introduce factual or descriptive information and to reinforce mathematical terms, definitions, and concepts	To emphasise or encourage the conceptual and factual development of their students	
Procedural questioning	• Imitate Method • Copy object • Follow (routine) procedures • Find answer using procedures • Give answers	Pose questions that require a level of problem solving, including imitate method, copy object, follow procedure, find answer using procedures	To emphasise or encourage the acquisition of skills, procedures, techniques or algorithms	
Structural questioning	• Show me… • Analyse • Compare • Classify • Conjecture • Generalise • Identify variables • Explore variation • Look for patterns • Identify relationships	Pose questions that direct students to identify characteristics and features of mathematical concepts, methods, properties and relationships, and also to make comparison and to identify variables and variations among these	To emphasise or encourage the links or connections between different mathematical entities, concepts and properties etc	Tell me about the problem. What do you know about the problem? Can you describe the problem to someone else? What is similar…? What is different …? Do you have a hunch? …a conjecture? What would happen if…? Is it always true that…? Have you found all the solutions?
Reasoning questioning	• Justify • Interpret • Visualise • Explain • Exemplify • Information induction • Information deduction	To ask students to provide their own explanations, justifications or interpretation of mathematical concepts, methods and properties	To emphasise or encourage learners' development and articulation of justification and argumentation.	Can you explain/improve/add to that explanation? How do you know that…? Can you justify…?
Reflective questioning	• Summarise • Express in own words • Evaluate • Consider advantages/disadvantages	To ask for students' personal thinking towards concepts, methods, and properties, including evaluation, expression in 'own words', and consideration of advantages and disadvantages	To emphasise or encourage learners' reflection of the learning	What was easy/difficult about this problem…this mathematics? What have you found out? What advice would you give to someone else about…?
Derivational questioning	• Prove • Create • Design • Associate Ideas • Apply prior knowledge (in new situations)	To ask students to prove, create and design their own mathematical problem-solving, based on their existing knowledge, and to apply their understanding into different mathematical situations.	To emphasises or encourages the process of development of new mathematical entities from existing knowledge	Have you seen a problem like this before? What mathematics do you think you will use? Can you find a different method? Can you prove that…?

Table Categories of teacher questioning in mathematics adapted from Denton (2013a)

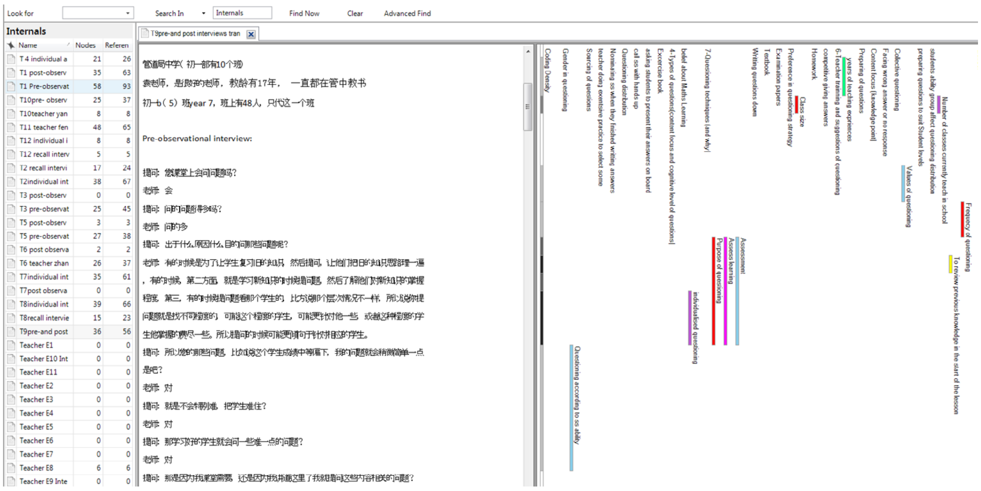
Appendix 15 Example of Coding Types of Questions

An example of the use of questions in teacher B's lesson in these categories in England

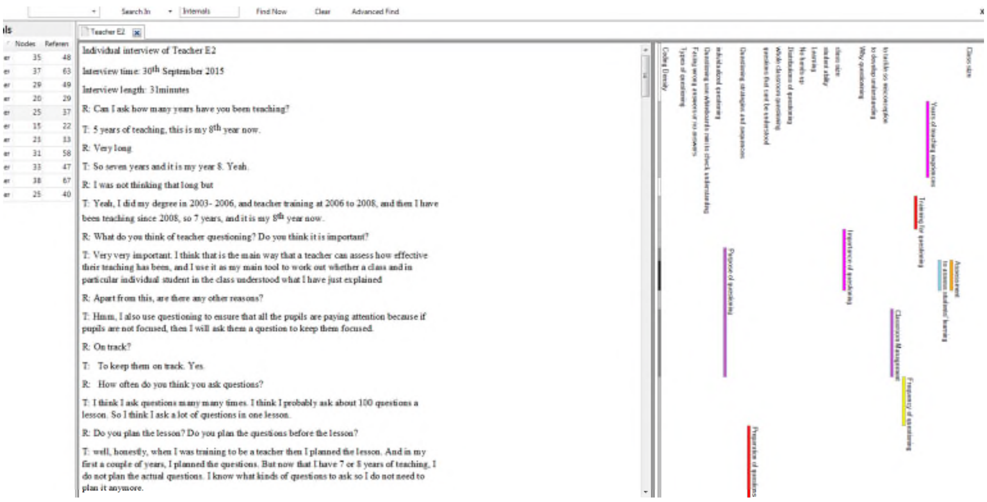
Classroom Dialogue	Coding	Sub-coding
T: Ok. Everyone should have the date and title copied and underlined. And we're going to move onto practising what we were doing yesterday, which is trigonometry, finding missing X. So, *has everyone got their scientific calculator out at the ready?*	Classroom management	Activity management
SS: Yeah.		
T: Fantastic. So, ok. Let's say we've got a right angled triangle then. Here it is. And this side is:: 12 cm, this is 72 degrees, and I want to find this side, X. *Now, who can remember what the first thing is, that we have to do when we're doing a trigonometry question? Who can remember what the first thing needs to do, when doing a trigonometry question?* Yes, S6. (Hand bidding)	Factual questioning	Recall facts
S6: You label it.	Classroom management	Redirect management
T: *Label what?*		
S6: The sides.	Factual questioning	Recall facts
T: Good. If you didn't copy this down yesterday, *<u>can you copy this down please</u>*, and first of all you have to <u>label</u> the sides. Brilliant. So S7*, can you do that for us?*		
S7: Erm, the left hand side is opposite.	Classroom management	Activity management
T: Fantastic.		
S7: And the bottom line's adjacent.	Procedural questioning	Copy object
T: Good.	Classroom Management	Activity management
S7: And the right side is a hypotenuse.		
T: Absolutely brilliant, that's fantastic. Well done, well remembered. Good. So firstly you have to label the sides. *What do we have to do second? Who can remember what we have to do second?* Now some people copied it down so they're going to know. Yes S8.	Factual questioning Classroom management	Recall facts Redirect management

Appendix 16 Example of Coding using Nvivo

The data analysis of this study was used computer-assisted analysis tool-Nvivo. The following four are examples of both interviews and classroom observations with the teachers in China and England coded under Nvivo.

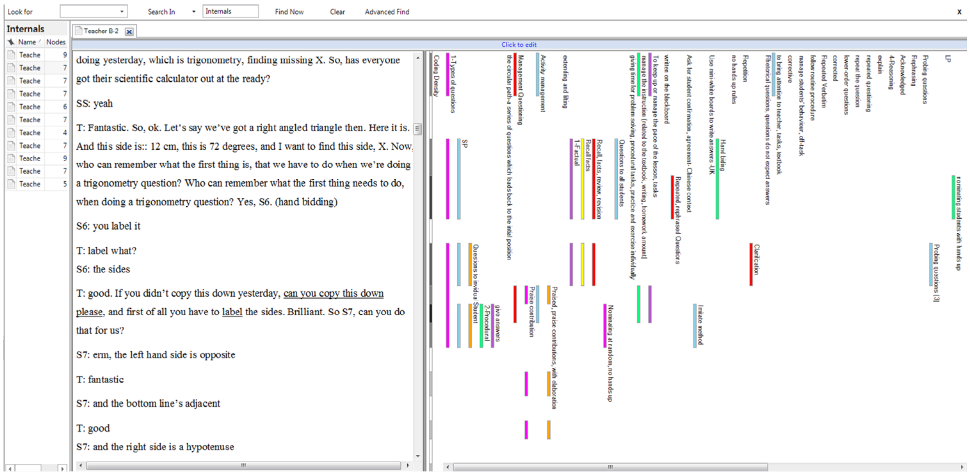


Example 1 Teacher interview coding using Nvivo in China



Example 2 Teacher interview coding using Nvivo in England

Example 3 Classroom observation coding using Nvivo in China



Example 4 Classroom observation coding using Nvivo in England

Appendix 17 Summary of Findings

Themes	Practices	Beliefs	Variations between Practice and Beliefs
Values and Frequency of Questioning	1. Both groups of teachers asked a lot of questions (2173 questions/4 question per min in China, 818 questions/ 1 question per min in England). 2. The Chinese teachers asked more questions compared to the teachers in England in terms of their frequency of questions.	1. Most of the Chinese teachers saw questioning slightly negative, whereas the teachers in England appeared to be very positive toward questioning. 2. Most of the Chinese teachers claimed asked very limited amount of questions (contradicted to their practices), whereas most teachers in England believed they asked a lot of questions.	There was an inconsistency in Chinese teachers' belief and practice in terms of teachers' questioning frequency. But the teachers in England indicated their beliefs were consistent with their practice regarding frequency of questioning.
Purposes and Types of Questioning	1. Most questions asked by the two groups fell into 3 categories: factual, procedural and classroom management questioning. 2. In these three categories, the proportion of classroom management questions in English and Chinese classrooms seemed to be more or less the same, as both accounted for nearly 70% of the overall teacher questioning. 3. Factual questioning in the Chinese classrooms seemed to be twice as prevalent as Factual questioning in English classrooms, whereas, Procedural questioning in the English classrooms appeared to be twice that in the Chinese classrooms.	1.Checking students' understanding, promote students' learning and managing classroom were among the most commonly mentioned questioning purposes by all the teachers interviewed. 2. Questioning was used to check students' current understanding and prior knowledge through reviewing the lesson. Questioning also helped to reveal misunderstanding of students. Questioning also was claimed to help in better knowing where students were and planning for what was the next to teach. 3. Questioning promote learning (get students to think). All the teachers in England pitched their questions to the level that students would be challenged, extended their thinking (scaffolded questioning). For some, questioning was also to be getting students to discover things (4 teachers in England). 4. Questioning was also claimed by most the teachers for the purpose of classroom management (many used questioning for punishment or embarrassment to keep students attention, while others suggested to bring questions out in a respectful way to make students to realise to focus on the lesson). 5. Additionally, the Chinese teachers also used questioning to maintain high level of interactivity in the whole-class setting, to keep students engaging by hearing from them. 6. Concerning the types of questions asked, the Chinese teachers claimed not paying attention to the types of questions, but preferred to ask questions with more than one solution. Whereas, the teachers in England claimed to be fully aware of different types of questions, with a preference on asking open questions (Bloom's taxonomy was also mentioned but was adapted into practice).	1. On a broad level, the purposes of questioning reported by the teachers in England and in China, seemed to be consistent with their questioning practice. 2. However, checking students' understanding claimed by the Chinese teachers seemed to be contradicted with their practice, in expecting all students to answer in unison, therefore, checking students' understanding in Chinese context should be redefined as checking understanding of the entire class. 3. Additionally, the teachers' report of their beliefs about asking open or opened questions did not seem to be consistent with their actual practice 4. Regarding the content focus, Chinese teachers' beliefs and practices seemed to be consistent.

		7. Chinese teachers' content focus of questions was on factual and procedural knowledge of mathematics (mathematical terminology and procedural fluency). 8. The teachers in England claimed to be asking open or opened questions (Bloom's taxonomy). 9. Many teachers from both groups reported that their kinds of questions were affected by the activities and topics of the lesson. 10. They saw students' abilities affecting their questioning. But the strategy they dealt with differently. The English mathematics teachers would adjust their questions to suit the level of ability in the class. Whereas, Chinese teachers were aware of students' different abilities, but they found it difficult to differentiate their difficulty level of questions as they had the same goals for all students across classes; they did claim to pose easy questions to lower level students, difficult questions to higher level ones), in order to engage students of bottom and top levels to have sense of belongs in class since the lesson was pitched at students of middle range level.	
Sourcing and preparation of Questions	1. Preparations of questioning in England and China were slightly different in that, all Chinese teachers planned their lesson on a daily basis, but most of the teachers in England planned for half of the term or a term based on the 'scheme of work' within the whole year. 2. Most teachers in England did not plan their questions and expected to come spontaneously depending on the situations and student understanding, (as one teacher said to feed students' responses) whereas the Chinese teachers planned some key mathematical questions relating to the content focus (curriculum which made it unlikely to suit individual students' needs since worked example and questions were already written in the textbook). But they said not to feed students' responses, as they had to plan the lesson pace following a teaching agenda. Many teachers from both groups believed teaching experience had a say on their questioning preparation. Precisely, they concluded the more experience they were, the more likely they knew where the questions should arise including where the students' misconceptions were. The teachers in England saw experience offering them opportunities for spontaneous questioning while experiencing the lesson, in other words, they developed confidence through years of teaching experience without preparation of questions. 3. Sourcing of questions differed a lot between the two nations. All the Chinese teachers explained their questions constraint by the textbook (closely), exercise books, curriculum, and examinations (papers), from which they selected some typical examples of questions to present at the class. In other words, the Chinese teachers did not usually create their own questions. But the teachers in England claimed a great deal of flexibility in creating their own questions, (based on students abilities accordingly), from internet, textbook (optional). 4. Another difference in sourcing and preparation of questions were 'who was the centre of the teaching' in that the teachers in England saw their students as the centre of preparation and sourcing of question, that they accommodated their levels of questions constantly to fit students' ability and levels in class, whereas on the opposite, the Chinese teachers saw lesson targets and lesson objectives as the centre of this, in which their questions and lesson were more structured compared to the English lessons. Class size was also claimed to one constraint for tailoring questions to suite students' ability.		
Wait Time	1. Most teachers' questions of wait time in both England and China were less than 3 seconds in length. 2. The teachers in England did seem to be offering rather more of an extended wait- time than their Chinese counterparts.	Most teachers in England and in China claimed they would wait for students to think before calling anyone to answer. But the length of wait time was vague; some teachers in England claimed to give a few seconds before, but many Chinese teachers said they did not know of the length, since most of their	It was hard to say if there was any consistency in their wait time reported and practiced in questioning in England and China. But the Chinese teachers' claim of posing

	3. Chinese students were allowed to self-select to compete to answer and contribute to their peer's answers at any point. Whereas, the teachers in England controlled tightly on who and when to speak. 4. Another finding that teachers employed other strategies for the benefit of providing students thinking time, such as deliberately giving a set of time to discuss possible answers in a group or work out answers individually.	questions were posed to the entire class whoever got the answer simply to shout out their answers.	questions to the entire class for students to decide the length of wait time was reflected in their actual practice. In addition, alternative strategy of extended wait time was observed in both Chinese and English mathematics lessons, but neither groups of teachers ever mentioned of that.
Questioning Distributions	1. The two groups of teachers demonstrated a very distinct difference in questioning distribution, the teachers in England used predominantly hand-bidding, whereas the Chinese teachers asked most questions to the entire class with no-hands rule. Students simply shouted out their answers to the teachers. 2. On an occasional basis, they both adopted nomination, nominating individual students by name without their hands up. 3. An interesting strategy was found that; the Chinese teachers asked students to put their hands up was to check their progression of work or check understanding of the entire class. Similarly, the teachers in England also used this hands-up for checking students' progression of work and checking understanding. But they also demonstrated of use of mini whiteboards to check understanding of the entire class.	1. All 12 Chinese teachers claimed to be using no-hands rules expecting all students answering without hands up. In contrast, the teachers in England were strongly in favour of their students to put their hands up whenever they wanted to say something or answer a question. 2. The teachers in England claimed that they did not like students shouting out answers (chaos; ill-mannered), with hand-bidding, the entire class can hear what people said and not putting anyone who did not know the answer on spot. 3. Another finding was that some teachers in both countries claimed to be using hand-bidding and nominating at individuals both strategies, to get all students prepared for answering questions to keep them on track, and to balance out the questions to those who did not put their hands up and the weak students (teachers in England), to those who were off-task and misbehaved. The teachers in England stressed the need to ask everyone a question at the lesson. 4. Many teachers in both countries believed the context of questioning such as the lesson topic, the questioning intention and how the students were doing affect their questioning distribution strategies. 5. Both the two groups of teachers mentioned of using hands-up to check progression of students' work, and for checking the understanding of the entire class to the Chinese teachers, but using mini whiteboards for the classrooms in England.	Data from the findings indicated a very high level of consistency in terms of beliefs and practices in teacher's questioning distributions in the two nations. However, the teachers in England claimed of asking every single student a question was inconsistent with their actual practice.
Funnelling and Focusing Questioning Patterns	Both groups indicated a questioning pattern that breaking one big broad mathematical questions into a sequence of focused questions that students eventually can answer without any effort. Some teachers in England also demonstrated to ask questions that focusing on students'	Most the teachers in two nations explained the need to restructure their questions of breaking down the broad mathematical questions into small questions, what they called it 'scaffolding' by the teachers in England. It was to bring the ladder down to the level of students' understanding, then build up back again to that level of question since some mathematical	Both groups of teachers justified the reasons for using this questioning pattern.

	responses and building up their thinking.	questions can be too difficult and broad, that students struggled to understand, not even to answer.	
Example-based Questioning vs. Inquiry-based Questioning	Another different questioning pattern lay on how their questioning was brought up, most the Chinese teachers demonstrated that they their questions were brought up through a series of worked examples most of the time. Students were required to be self-learning through the worked examples first, then the teachers started questioning them based on the worked examples. It is found that each Chinese teachers used at least 3 worked examples on average in their lessons. However, in most of the English classrooms, there were no worked examples. Teachers' questions arose through the process of problem-solving, which appeared to be explorative to find out what students know and do not know through problem-solving.	The teachers in England explained that they expected their students to discover themselves from problem-solving, then they adjusted their questions based on how well they solved problems. However, the Chinese teachers believed that a student cannot learn without the help of worked examples. Besides, those worked examples were already written in the textbook, which they had to teach them to those students. They also revealed their lack of confidence over students' self-study of worked examples, and claimed to repeatedly question them to reinforce some mathematical terms and key concepts to deep their memory of it.	Both groups of teachers justified the reasons for using this questioning pattern.
Questioning for Students' Explanations : through Presentation and Demonstrati ons on the board vs. Through Why Questioning	Most Chinese teachers observed demonstrated a tendency that they asked a question written on the board, then they picked up one student to write answers on the board and meanwhile explain to the entire class step by step. This questioning pattern gave the students the authority to lecture and explain to the entire class. The role of teacher questioning served as a monitor in monitoring the flow of the lesson and to make sure that all students were on the same page as their peers. In the classrooms in England, most teachers frequently asked students to explain how they got the answers through why questioning, whether students gave right or wrong answers, in providing neutral feedbacks.	The teachers claimed questioning students for why as their favourite questioning strategies, whereas most Chinese teachers stressed to question students to explain and write their answers on the board. They both expected to check that individual students' understanding. They then also claimed that students learn better than their own teaching. But the reasons were very different in that, the Chinese teachers believed this created a competition between those students, they paid attention to their peers because they wanted to find if what their peer said were wrong. But for the teachers in England, they believed their students would appreciate more about their peer's support. For Chinese teachers, It was learning opportunities for students who did not know how to solve the questions. It was also for classroom management that keeping students all on track and to avoid students copying answers from others in China. (Class size) More importantly, for the teachers in England, it was not only forcing students to be clear with their understanding, but also to prepare them for the world outside schools; to get them to take responsibility of their own study. Most Chinese teachers mentioned of deliberately setting a trap for students who were highly likely to get answers wrong to expose the misconceptions or mistakes in	The teachers in England and in China both seemed to demonstrated a consistency in the beliefs and practices in this questioning pattern. However, why questioning asked by the teachers in England in practice seemed to be merely asking for a few words of what the students did to get answers, indicating an inconsistency with their beliefs' of teaching students for reasoning skills.

		answering their questions. They saw them as student representatives to examine the understanding of the entire class, also to highlight the mistakes or misconceptions of one individual student could be shared by many others, the teachers hoped the entire class to learn from the incorrect answers.	
Differentiating Questioning or not	The teachers in England observed demonstrated they offered students of different abilities with different types of questions that suits their level of understanding. In most Chinese classrooms, the students were given the same question, there were no differentiations of types of questions at all.	All the teachers agreed that questioning were strongly associated with students' abilities. Thus, the teachers in England claimed they would give different level of questions with a working sheet of 'Must, Should, Could' or coloured questions into different levels to students to choose the level of questions they felt confident to answer (the reasons were: such design of question could cover students of all different ability, it also build students' confidence in accomplishing these questions, thirdly it also provided students the flexibility to move from one level to another). For some teachers in England, they thought it was hard to question students all at once because of different abilities. The Chinese teachers, differently, posed the same questions to all students, which they explained to have fixed goals and lesson objectives for all students.	The teachers in England demonstrated a consistency in their reported and practiced questioning pattern of differentiating questions accordingly based on students' different abilities.
Written vs. Verbal Questioning	All the 12 Chinese teachers demonstrated that they wrote their questions, their step by step problem solving process to make it visible for the rest of students, even in the case that students had presented their answers in speaking, but then the teachers would copy students' answers onto the board. On the contrary, the teachers in England mostly did not copy their students' answers or step by step problem solving process of their own to the board, they indicated more interested in getting students to listen actively to what they said.	Most of the Chinese teachers stressed the necessity of writing their questions and answers of theirs and students on the board so that their students could visually see the solving procedures and thinking process, also it helped to keep students to be focused, and also to help them to remember those deeply. It was also due to mathematics different from other subjects in that it involved many steps and procedures requiring a systematic and logical flow to process thinking. In order to process them, writing the step by step of questions and answer could help to do so. Most teachers in England expected their students to listen actively most of their questioning time, because they believed if students only got one chance to get it, then they had to listen carefully to what their teachers say.	The teachers' beliefs and practices in England and in China appeared to be consistent.
Teacher questioning Incorporating with Student's answers to the Entire Class vs. Teacher Questioning	All the Chinese teachers observed indicated a questioning pattern that, their questions appeared to be incorporating or building up their students' answers or explanations, either adopting evaluative questioning or responsive questioning. Students' answers or explanations here at the	In the Chinese teachers' interviews, they explained the reason why they did so was to reinforce some of key knowledge and some key steps of problem-solving to make sure that all students remembered these in their mind deeply. Whereas the teachers in England reported that they had finished questioning with that individual student, thus they wrapped up the conversation to	This questioning pattern seemed to be also one of the reflection of collective and individual questioning. Because the teachers' questioning in England tended to be individual focused, made it less likely to build into or incorporate with students' answers to

Ending in a Mini-lecture	Chinese classes seemed to be a tool to be able to let the teachers to build into or incorporate their questions to the entire class, either monitoring if the rest of class were following the progression of thoughts, or emphasizing on certain concepts or key knowledge. However, most teachers in England tended to conclude their questioning to a mini-summary with that individual students.	move on to the next question with different students.	question to the entire class. Whereas, the Chinese classrooms culture were more collective, which resulted in teachers keeping monitoring students' attention or thoughts at all time. This then was reflected in their questioning practice which tended to draw in or build upon students' answers.
Questioning for Peer-Assisted Learning	1. In the observations, when students gave wrong or inappropriate answers or I do not know or no responses, most of the teachers in the two groups indicated they tended to redirect the same question to their peers, who can answers. But the teachers in England also indicated in asking students to explain themselves first before turning to the next student. 2. Another questioning strategy that they both adopted was that when students gave answers they asked how many students agreed or disagreed with the answers. Then they asked students to explain their answers from both sides.	1. Most teachers in the two countries reported to direct their questions to their peers facing students' vague, wrong answers or 'I don't know'. 2. However, many teachers in England believed the first thing was to get students to explain to them, then they would pick up their peers to help. 3. Both groups agreed that students learnt better through their peers. 4. Another similarity that, they also mentioned of another strategy, when a student gave wrong or inappropriate answer, they would firstly ask the number of students who had the same or different answers, then asked each group to explain how they got their answers.	The beliefs and practice of this questioning pattern was consistent in England and China.
Teacher Training	1. Most Chinese teachers never had training for questioning. The training they had mainly was observing other teachers' teaching, experienced teachers in particular. Whereas in England, all teachers claimed they had training for questioning at university level, and CPD sessions and workshops related to teacher questioning. But one teacher demanded for no specific teacher training for questioning in the context of mathematics. 2. Both groups of teachers claimed that many of questioning came from their experiences.		

Appendix 18 Ethical Approval Form

Application for Ethical Approval for Research Decrees (MA by research. MPHIL/PhD. EdD)

Name of student : Wenping Zhang	MA	EdD	PhD

Project title: Dimensions of Teacher Questioning: A Comparative Study of Current Beliefs and Practices in England and China

Supervisor: Professor David Wray

Funding Body (if relevant)

Please ensure you have read the Guidance for the Ethical Conduct of Research available in the handbook.

Methodology

Please outline the methodology e.g. observation, individual interviews, focus groups, group testing etc.

This study will be conducted in Secondary schools in the UK and Junior high schools in China. So the data will be collected in two languages. The data collection process can be broken down into three stages: pre-observation individual interviews, classroom observations, and post-observation individual interviews. And it will be carried out from April to November 2015.

1. Interviews:

    The interviews will be conducted before and after classroom observation. Thus, the whole process will be described as below:

    1.1 Pre-observation individual interview:

Prior to classroom observation, this interview is to directly obtain teachers' personal beliefs about classroom questioning. Such beliefs will include teachers' perceptions of the values of questioning, their purposes for asking questions, their content focus related to their ways of sourcing questions, the cognitive level of the questions they ask, their language and manner in questioning, and their perceptions of student ability. Additionally, variables such as teachers' age, gender and years of teaching experience will also be taken into consideration. The duration of this individual interview will take approximately twenty minutes depending on teachers' interests and time allowance.

1.2 Post-observation individual interview:

These individual interviews will be conducted with the same groups of teachers that participated in my pre-observation interviews. This interview will be used as a supplement to classroom observation, and the purpose is to validate observed data from teachers' points of view, which allow them to explain what is observed in a particular lesson.

Both pre and post observation interviews will be semi-structured, which gives the researcher possibility to adjust and modify questions while the interview proceeds. This also suggests that all questions will be open-ended, with a pre-determined focus derived from my research purposes based on the review of relevant literature. Besides, both of the interviews will be audio-recorded. Recordings will be transcribed into text verbatim, using their original language, and this original language version used for analysis. Extracts of the Chinese language interviews will be translated into English to illustrate the analysis.

2. Classroom observation:

The classroom observation will be conducted after collecting teachers' perceptions about classroom questioning. Its aim is to explore how these teachers actually ask questions in real-time classroom settings. During observation, I will sit in the corner of classroom and take notes as many as possible. Meanwhile, I will be using an MP3 recorder to record question-answer exchanges between teachers and students. The whole observation will be non-participant observation, and I will not engage in any classroom activities and interactions. The classroom observations will allow further clarifications from the participants in post-observation interviews.

Participants

Please specify all participants in the research including ages of children and young people where appropriate. Also specify if any participants are vulnerable e.g. children; as a result of learning disability.

- Access and recruitment of my research participants will be done through convenience sampling/opportunity sampling.

- The participants of this research will be 10 teachers recruited from each of the UK and China.

- These teachers will be currently teaching year 8 and year 9 Key stage 3 classes in the UK and teaching year **1** and year 2 in Junior high school classes in China.

Respect for participants' rights and dignity

How will the fundamental rights and dignity of participants be respected, e.g. confidentiality, respect of cultural and religious values?

- Prior to data collection, voluntary informed consent will be gathered from all participants. The teachers will therefore be selected based on their willingness to take part in the research, in order to respect the participants' rights and dignity. In other words, the researcher will give a comprehensive briefing about the study and methods and answer any questions or concerns that the participants may have to ensure that they understand and agree to take part in all stages of data collection process including 2 interviews and one classroom observation.

- The purposes and the potential benefits of this study will be explained clearly to the participants before starting the data collection process between April 2015 and July 2015.

- The participants will be informed that the data collected from the interviews and observations will be used only for academic purposes and will be kept with strict confidentiality and anonymity.

- The researcher will inform the participants verbally on the first contact of their right to withdraw at any time, for whatever reason. The participants will also be reminded that they have the right to refuse to participate in any activities they are not comfortable with.

- The interview questions are designed primarily in English, but the Chinese participants will be asked in Mandarin to make sure they understand the questions clearly and they feel comfortable with them. Only appropriate language will be used in the communication during the interviews. The participants will be given transcribed summaries of their interviews and they will have the right to withdraw any parts they do not want to be included in the report of the research. During interviews, the researcher will avoid sensitive issues, and the participants will also not be forced to talk about issues which they are uncomfortable with.

<u>Privacy and confidentiality</u>

How will confidentiality be assured? Please address all aspects of research including protection of data records, thesis, reports/papers that might arise from the study.

- Details of the teachers involved in interviews (e.g. teachers' teaching experiences, educational backgrounds and age) and classroom observations will be made anonymous in this study and will be kept securely and strictly confidential.

- The data obtained will be used only for academic purposes, and will not be shared with anyone beyond the researcher and her research supervisor as necessary.

- The participants' personal information such as names, mobile numbers and email addresses will not be disclosed to anyone except the researcher in order to ensure their privacy and safety. Institutions and participants' names appearing in my interview coding and in the content of the observation transcriptions will be coded by the use of letters as Teacher A, student P and so on to keep the anonymity of the participants, and this coding system will be kept securely on my own computer.

- Permission to enter the institutions will be obtained. Permission to be interviewed and observed will be obtained from the participants. To ensure the privacy of the participants, they will be interviewed in a private and comfortable place. Prior permission to record the class using an MP3 recorder in observations will also be obtained beforehand.

- The data collected from the interview will be discussed with the participants for verification and trustworthiness purposes during and at the end of data collection process.

<u>Consent</u> **- will prior informed consent be obtained?** Yes

- From participants? Yes **from others? Yes**

Prior consent will be gathered from the participating institutions and teachers teaching mathematics in lower secondary schools in the UK and China

- Explain how this will be obtained. If prior informed consent is not to be obtained, give reason:

- Consent from the institutions will be obtained firstly by emailing or phoning the head of each institution, then the consent from teachers as participants will be collected verbally before the data collection takes place. Meanwhile, the purpose of this research together with the measures to be employed (e.g. research methods, instruments) will be explained explicitly regarding confidentiality and privacy.

- will participants be explicitly informed of the student's status?

- All participants will be informed explicitly of the researcher's status at any stage of the research, and they will be told that the research is a part of doctoral thesis.

Competence

How will you ensure that all methods used are undertaken with the necessary competence?

- A thorough review of literature pertaining to the data collection methods has been made. Only the appropriate methods will be applied in this study.

- The full data collection process will be piloted with a teacher who is currently teaching at a primary school in China to ensure smoothness during the actual procedure. Necessary measures will be taken to improve the methods based on the participant's responses and feedback from the pilot. For instance, during the interview, the researcher will gain feedback on the best way of phrasing questions, and which kind of questions are most appropriate for the participants, through which the researcher will be more fluent in running subsequent interview sessions and will hopefully gather more comprehensive responses from the participants.

- Discussion with the supervisor will also be maintained about my experiences and ability to conduct the methods competently from time to time.

- The researcher has successfully completed both the Foundation Research Methods course and the Advanced Research Methods course run by the Centre for Education Studies at the University of Warwick, and has developed thereby some competence in planning and executing a research project.

<u>Protection of participants</u>

How will participants' safety and well-being be safeguarded?

- The interview will be only conducted in a time and place where the participant feels secure and comfortable. Prior arrangements will be made with schools in order to get the most suitable place and time for the interviews. The researcher will also explain to participants that they will not be judged in order to maintain their responses' openness.

- The details of data will not be shared with others from or within the organization and will be discussed and shared only for academic purposes, and anonymously.

- Anonymity of the participants will be maintained throughout the research.

- Background information of the participants and their experiences will not be shared with anyone.

- Identity of the respondents will be under protection in all cases.

<u>Child protection</u>

Will a DBS (Disclosure and Barring Service formerly CRB) check be needed?

Yes/No (If yes, please attach a copy.)

Yes

<u>Addressing dilemmas</u>

Even well planned research can produce ethical dilemmas. How will you address any ethical dilemmas that may arise in your research?

- The nature and purposes of this study will be explained clearly to the participants both verbally and in writing.

- The collected data will be made anonymous to be shared with my supervisor only to maintain the reputations of the participants. They will be protected from harm as professionals and individuals.

- All the details and experiences will be conducted with confidentiality and anonymity.

- If ethical dilemmas happens, informed guidance will be consulted from my supervisor and the official BERA guidelines.

<u>Misuse of research</u>

How will you seek to ensure that the research and the evidence resulting from it are not misused?

- The data will be kept safe with password protection.

- The data will only be shared in reports and papers for research purposes, for which consent will be obtained from the participants.

- The data will also not be disclosed to any other parties apart from the researcher. It will be made anonymous before being presented even to my supervisor.

<u>Support for research participant</u>

That action is proposed if sensitive issues are raised or a participant becomes upset?

- **Only** prepared and willing participants will be involved for the purpose of data collection. The researcher will obtain their willingness in undertaking any actions of the research procedure.

- If sensitive issues occur during classroom observation, the researcher will apologize for that and leave the class.

- If the participant is upset or feel uncomfortable with the discussion during the interview, they will be made aware of their right to not to answer the questions, and the researcher will apologize for making them upset. Their willingness with the interview will be solicited. If they decline to continue, the interview session will be terminated immediately.

<u>Integrity</u>

How will you ensure that your research and its reporting are honest, fair and respectful to others?

- Data will be only reported through interviews and observations as listed above.

- Direct quotations will be used in the report to avoid misinterpretations of data.

- Data will be shared with the participants at all stages of the research so they can clarify and check with the researcher to ensure that interpretation of meaning is accurate.

- Interpretation of meaning will be done meticulously by justifying data from classroom observations and post-observation interviews to ensure reliability. By using interviews after observation in which seek for clarifications and verifications from the participants , the researcher will make sure that the data collected from classroom observations is translated transparently in a way that is close to the participants' intended meaning and words.

- Any sensitive issues that might arise from the interview sessions will be checked with the participants before being reported. The participants can choose to eliminate any information from the interview and classroom observation transcripts from the research.

- During or after the interview sessions, if the participants have a second thoughts, they can choose to change their responses.

- Data will be analysed and reported in a non-judgemental and transparent manner.

- Interpretation of the data will be obtained with the guidance of supervisor.

What agreement has been made for the attribution of authorship by yourself and your supervisor(s) of any reports or publications?

Any publications or reports arising from this research (apart from the thesis itself) will be coauthored with my supervisor, usually with my name first in order of authorship.

Other issues?

Please specify other issues not discussed above, if any, and how you will address them.

Signed