Newcastle University

An Exploration of Teachers' Understanding of their Questioning Practices in Science Lessons in Early Primary Teaching in Thailand

Chalita Cheewaviriyanon

A thesis submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy (Integrated) in Education and Communication

School of Education, Communication, and Language Sciences

June 2016

Abstract

Based on social constructivist perspectives (Rojas-Drummond and Mercer, 2003), teachers' questioning may have a direct impact on children's learning and the development of children's thinking. Most research into teachers' questioning has been conducted in Western countries. However, in-depth qualitative research on teachers' questioning practices in science classrooms in early primary education in Thailand is under-researched. Understanding teachers' questioning practices will contribute to the improvement of teaching practices and teacher training programmes.

This study aimed to explore Thai early primary teachers' understanding of their questioning practices in terms of questioning purposes, question types and strategies, and to explain the factors that influence those classroom practices, in the context of science teaching in Thailand. A qualitative case study approach within the interpretivist paradigm was employed. Data were mainly gathered in the form of video recordings of classroom interaction, through video-mediated interviews and relevant documents, such as lesson plans. This study is based on teacher reflections on questioning in which teachers identified some questions that they had asked.

Through an inductive analysis of the data using template analysis, the current study found that teachers reported asking questions for a range of purposes in science teaching. Eleven such purposes were identified: gaining attention, checking if pupils can recall information, checking prior knowledge, checking understanding, enhancing knowledge, integrating with other topic areas, encouraging observation, hypothesizing, experimenting, building understanding, and encouraging pupils' thinking. The finding shows that purposes relevant to hypothesizing, experimenting, and building understanding had a considerately higher proportion of open questions than closed ones. Another important finding was that eight categories of questioning strategies were employed by teachers in the classroom. The most commonly reported questioning strategy was repeating. It can be concluded that teachers' understanding of questioning was closely in line with the concept of scaffolding assistance. This is because teachers reported that some purposes in asking questions assisted learning and were linked to the questioning strategies used.

This research contributes to existing knowledge by providing a conceptual model of Thai teachers' questioning practice in the science classroom. The proposed model is based on social constructivist theory, which is comprised of the three major elements of questioning purposes,

question types, and strategies, and three layers of influencing factors: teacher cognition, cultural factors, and contextual factors.

Declaration

I declare that this thesis is my own work and that I have correctly acknowledged the work of others. I certify that no part of the material offered has been previously submitted by me for a degree or other qualification in this or any other University.

Name: Chalita Cheewaviriyanon

Signature: _____

Date: _____

Acknowledgements

Conducting this research has been a long and challenging journey. There are many persons that I feel indebted to during the period of this study. Without their help and support, it would not be possible to complete this research. Therefore, I would like to take this opportunity to present gratitude to those persons, even though just some of them are able to be mentioned here.

First of all, I would like to thank my supervision team. My first supervisor, Dr Hanneke Jones, stepped in as my principle supervisor during the time that I truly needed it. She has been very supportive and given me excellent guidance throughout the period of study. Her encouragement and kindness were important for me to overcome the questions I had during my PhD research. Above all, I would like to thank her for her patience in giving advice and constructive comments on my research.

I wish to express my sincere thanks to my second supervisor, Dr Carolyn Letts, for providing me with valuable feedback and suggestions on my thesis. Her incredible advice is evident, despite my issue with proficiency in English as a foreign language. Moreover, I am grateful for her regular meeting attendance and always advising me on the PhD process, particularly annual progression panels.

I would also like to express my special thanks to my former principal supervisor, Dr Elaine Hall, for her assistance at the early stage of this research as a supervisor. Although she moved to Northumbria University during my data collection period, her contribution has been clearly seen in this study.

I express my sincere thanks to Professor David Leat for providing a warm welcome to the Research Centre for Learning and Teaching. He has provided substantial guidance throughout my PhD experience. One aspect was the questions and suggestions he provided in terms of my mock viva which was ultimately worthwhile as part of the viva preparation.

I would also like to express appreciation and gratitude to Professor Lynn Newton and Ms Maria Mroz for being the examiners of this thesis. Our conversation and their suggestions guided me to have a greater understanding of constructivism, and of the role of questioning in the teaching of science in terms of pupil understanding.

I acknowledge the financial support from Suratthani Rajabhat University, and Newcastle University, for facilitating the necessary resources for conducting the research. The scholarship provided me with enormous support so I could fully focus on my study without financial concerns. Similarly important, doing research in the UK has enabled me to gain access to a

Table of contents

List of tables

List of figures

Chapter 1   Introduction

1.1   Introduction

Based on social constructivist perspectives, effective teachers' questioning is an important tool for teachers to help children's learning and the development of thinking skills (Mercer and Littleton, 2007). This research aims to explore teachers' questioning from the teachers' perspective in the context of early primary teaching in Thailand.

In this introduction chapter, the rationale for the study is provided in Section 1.2. Section 1.3 describes the context in which this research has been conducted, including Thailand's education system, the characteristics of early primary teaching, and the influence of Thai culture on the teachers and students. Thereafter, the research aim and questions are proposed in Sections 1.4 and 1.5, respectively. Finally, Section 1.6 provides an overview in terms of the organisation of the chapters. Appendix L provides a glossary of my specific use of key terms in this study.

1.2   Research rationale

Three main elements have been considered as the motivation to drive this research. Section 1.2.1 concerns the importance of questioning by teachers to assist the cognitive development of young learners. In Section 1.2.2, a key issue for raising the quality of early primary education in Thailand is considered. In Section 1.2.3, my own interest in classroom questioning is considered, as this played a part in the reason for conducting the research.

1.2.1   The impact of teachers' questions on children's learning

Teachers' questions are an essential part of talk between a teacher and his or her students, which can subsequently lead to the development of children's thinking. Rojas-Drummond and Mercer (2003) explained how teachers' questions can be used effectively when they are used creatively, such as if they are not only used to test knowledge. The researchers (Rojas-Drummond and Mercer, 2003, p. 101) found that teachers can use questions to encourage extended talk, guide children's learning, and model how to use language effectively for learning. In thinking about what makes for good questions, several researchers have suggested types of talk or interaction that benefit children's learning, including dialogic talk (Alexander, 2008) and exploratory talk (Mercer and Dawes, 2008). Classroom talk provides a good opportunity for children to articulate their thoughts, and share them with the class. Productive talk in the form of such interaction can help the development of their understanding of the topic under consideration (Mercer and Littleton, 2007).

The theoretical background to the importance of talk and teachers' questions is influenced by social constructivism, as will be discussed in Section 2.3. Learning is seen as a social activity and teachers' questions are one of the tools that teachers use as a form of mediation.

1.2.2 *The quality of early primary education in Thailand*

As part of a drive to raise education quality for all, Thai educationists have attempted since 1999 to transform the learning approach from a teacher-centred approach to a child-centred one. This is evident in the enactment of the National Education Act of B.E. 2542 (Office of the National Education Commission, 1999), which stipulates that education is at the heart of the national aim and a major factor in Thai economic development. Therefore, the policy of a learner-centred approach has been driven by the Ministry of Education. By law, the educational goals have three main areas of reform: teaching and learning approaches, the administrative systems of the teaching profession and the legal framework for Thai education. The most important of these reforms is the teaching and learning approaches, as stipulated in the National Education Act as follows.

> Education shall be based on the principle that all learners are capable of learning and self-development, and regarded as being most important. The teaching-learning process shall aim at enabling the learners to develop themselves at their own pace and to the best of their potentiality (Office of the National Education Commission, 1999, p. 12).

This statement clearly implies that teaching needs to be improved in order to benefit Thai learners. The reform emphasises the attributes of the learners, who should be competent, have virtuous minds, and be happy (Office of the National Education Commission, 1999).

However, evidence from research sources and the media shows that the quality of education and the critical thinking skills of Thai students is still a major issue in Thai education (Graham, 2010; PISA Thailand, 2014; Piumsomboon, 2015). There is a concern with regard to educational quality at all levels of education. According to International Student Assessment (PISA) in 2012, the exam results of 15 year-old students indicate that Thai student performance in mathematics, reading and science were below average in all three subjects, although the scores had increased slightly from the results in 2009 (PISA Thailand, 2014). Thailand ranked 50th amongst the 65 participating countries (PISA Thailand, 2014). Since 1999, Thai students have been promoting critical thinking skills, but Thai educators (Piumsomboon, 2015) reported in the news that the teaching approach used in rote learning, which aims for memorization of the content, was still prevalent. In recent news, the Dean of the Faculty of Science at

Chulalongkorn University, Prof. Pornpote Piumsombo, warned of the need for a change in the teaching approach.

> Nowadays, teachers usually teach using rote learning, rather than promoting critical thinking of children and learning by doing. There is a need to make a change in the teaching approach for children in terms of knowledge construction and self-discovery, through presentation and discussion in the classroom. For them to be involved in thinking and learning to find information and then share it with their classmates. (Piumsomboon, 2015).

Both the quality of education and the development of critical thinking skills have a direct link to the quality of teacher-child interaction, as mentioned above. Indeed, the more interactive the classroom, the better the promotion of the development of higher critical thinking skill on the part of the children (Baumfield and Mroz, 2002). Moreover, classroom interaction can be studied via a consideration of classroom questioning, as it plays a crucial role in classroom interaction. Therefore, classroom questioning studies can relate to the extent to which the critical thinking skills of children may advance.

1.2.3 *Classroom questioning and my experience*

Many researchers have stated that for decades talk in the classroom has been dominated by teachers, with teachers being responsible for around 70 percent of talk (Baumfield and Mroz, 2002). It is important to note that this figure varies according to certain aspects of the classroom setting, such as the teacher in question, the subject content, and the children's age. In the literature relating to primary teaching in the UK, 11 percent of classroom talk consists of teachers asking questions (Wragg et al.,1998 cited Baumfield and Mroz, 2002). Therefore, it is important to study the nature of teachers' questions.

According to my previous experience of being a kindergarten, school, and university student and a student teacher of computer programming for Year 5 students within a Thai educational setting, the situation of teachers' questions in Thailand is quite different from British classrooms. During that long period of study, my learning role was one of listening to the teacher and taking notes. I do not remember being asked questions or asking questions in the classroom. In others words, the teacher tended to dominate the talk in the classroom and children had little chance to express their thoughts, feelings and ideas. After I started doing my Integrated PhD programme in Education and Communication in 2010, I took a module about developing thinking skills, in which the lecturers asked questions and inspired me to think about questioning, question taxonomies, and relevant teaching approaches. These tools help develop the cognitive, affective, and metacognitive areas of the child's developments (Robson and

Moseley, 2005). This led me to be curious about the understanding which Thai teachers have of questioning in their classroom practice.

Therefore, I was keen to undertake research by exploring the understanding of Thai teachers' questioning in early primary science in Thailand. Having conducted an extensive literature review in relation to learning theories and questioning, I think that if Thai teachers had a clearer understanding of questioning skills, it could help improve the quality of classroom talk and children's learning. Opportunities for talk between a teacher and children through questioning should exist, and teachers should learn to use such an approach as effectively as possible.

1.3   Context of the study

Having clarified the rationale driving this study in the previous section, this section presents the context within which this research was conducted. There are three essential perspectives which are considered helpful for the further stages of this research: the current education system in Thailand, Thai early primary education, and the social and cultural factors which relate to the Thai education system.

1.3.1   The Thai education system

The current education system in Thailand was influenced by the Constitution of the Kingdom of Thailand, which was promulgated in October 1997. Two years later, the National Education Act of B.E. 2542 (Office of the National Education Commission, 1999; Office of the National Education Commission, 2004) was promulgated in order to reform the education system.

The current Thai education system has two levels of basic and higher education, as shown in Figure 1.1. As of 2002, for the first time, 12 years of basic education were free for all Thai children of six to eighteen years (Office of the Education Council, 2008). The first three years of early primary education for children aged three to five years is included, to allow 15 years of free education. This was announced in 2009 by the government due to the importance of this level of education (UNESCO, 2011). The basic education system provides three years of pre-primary education (Anuban 1-3: Foundation Stage) and six years of primary education (Pratomsuksa 1-6: Grades 1-6), three years of lower secondary education (Matayomsuksa 1-3: Grades 7-9), and three years of upper secondary education (Matayomsuksa 4-6: Grades 10-12). Although compulsory education consists of nine years of schooling from the primary school to the lower secondary school, the provision of free education includes upper secondary education. Based on the national curriculum, the students learn in eight core subject areas. These areas are Thai language, mathematics, sciences, social studies, religion and culture,

health and physical education, arts, careers and technology, and foreign languages (Bureau of International Cooperation, 2008).
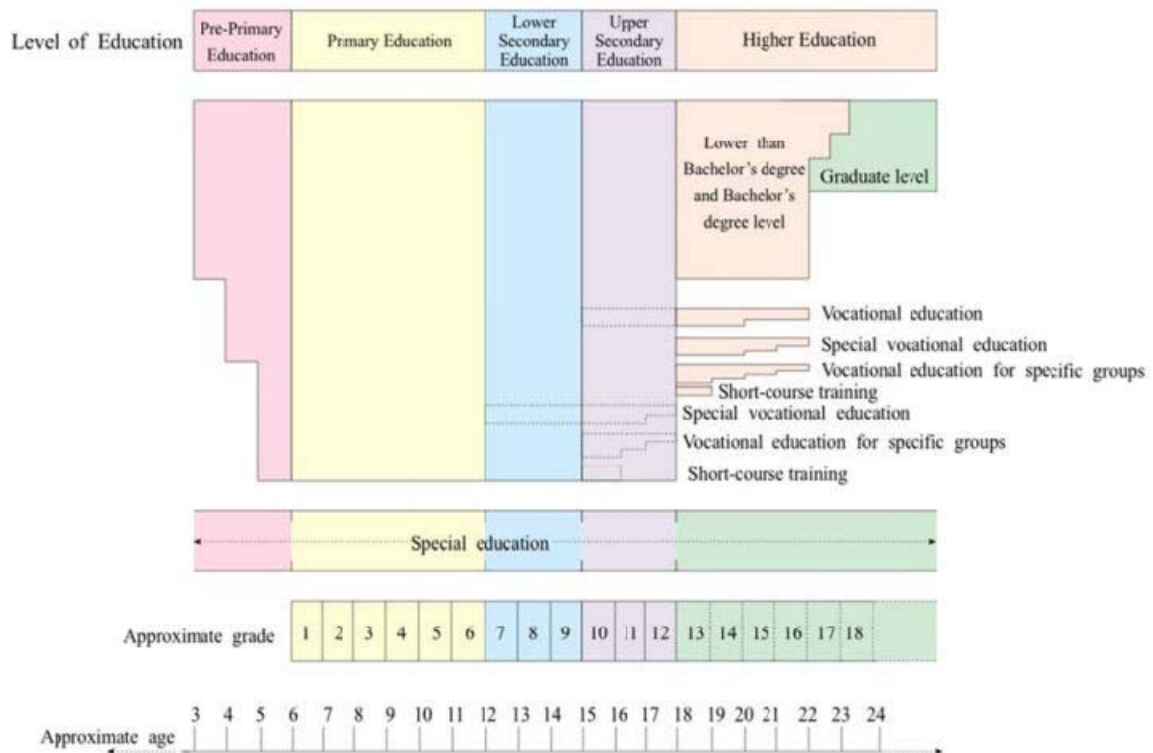
Figure 1.1: Structure of the Thai education system (Office of the Education Council, 2008, p. 25)

At the higher education level, universities normally provide four to six year programmes for undergraduate degrees, depending on the field of study, two year programmes for masters degrees, and three year programmes for doctoral degrees.

1.3.2 *Early primary education in Thailand*

The context of this research was that of early primary education. Seven state schools were selected as the location for the research with regard to teachers' questioning.

This study focuses on early primary education. It may be important to note that, in Thailand, this level of education is not compulsory. However, both public and private institutions commonly provide education at this level. The National Education Act B.E. 2542 states in section 18 paragraph (1) that:

> Early childhood and basic education shall be provided in the following institutions:
> (1) Early childhood development institutions.

(2) Schools, namely: state schools, private schools, and those under the jurisdiction of Buddhist or other religious institutions.

(3) Learning centres (Office of the National Education Commission, 1999).

The state has established public institutions that provide early primary education. These see a high number of attendees. The length of courses in early primary education may vary in terms of the types of institutions in state government or public schools. A two-year course is typically provided for children aged four to five years. According to Office of the Education Council (2008, p. 110) 88 percent of children (2,497,928 children) aged three to five received early primary education in 2006. In 2015, almost all three to five year old children received an early primary education.

One important national plan in 2002 involved the expansion of early primary education, the two years of education for children aged three to five years prior to primary education. In public schools at the present time, early primary teaching is provided under the auspices of the Office of the Basic Education Commission (OBEC), the Ministry of Education (MOE). Due to the Act (Office of the National Education Commission, 1999) related to decentralization, 175 Educational Service Areas (ESAs) were established to administer education to institutions in local areas. This number was increased to 185 in 2008 (Office of the Education Council, 2008, p. 32). Each ESA is responsible for about 200 educational intuitions with 300,000 to 500,000 students (Office of the Education Council, 2008, p. 32). Educational policies, plans and standards are initiated from the central offices to be implemented in the relevant institutions. The responsibility of the ESA is to provide support and promotion in relation to government policies, plans, and standards. Even though the educational reforms fostered unity in education under the MOE, a number of ministries, such as the Ministry of Science and Technology, are involved in the management of education (Office of the Education Council, 2008).

Early primary education in Thailand is underpinned by the educational philosophy of whole child development (Angeles-Bantista, 2004). The education for three to five year old children aims to encourage harmonious social, physical, emotional and cognitive development, and prepare children of this age for their formal schooling. As stated in the guidelines developed by the Ministry of Education , the curriculum must "…provide basic learning experiences for individual and social development, emphasise the importance of Thai language, and enhance thinking, understanding, creativity and analytical skills of learners" (Angeles-Bantista, 2004, p. 24). In the Thai early childhood curriculum, there is an emphasis on active learning by learning through play, as will be further discussed in this section. Therefore, as part of

experience enhancement activity, which normally involves conversation with peers and teachers, guidance on the teachers' role in questioning is briefly mentioned:

> Teachers should use open-ended questions that encourage children to think. In other words, they should not ask questions with "Yes-No" answers or forced alternative questions. Enough time should be given for children to think of answers (Department of Local Administration of Thailand, 2004, p. 63).

In the present early primary education in Thailand, less attention is given to the important role of teachers' questioning. Social constructivism is a focus of this study on teachers' questioning, as it may be an important tool to promote understanding and the thinking skills of young children.

Time	Daily activities
7: 30 - 8: 00	Greetings parents and children
8: 00 - 8: 30	Pledge to the flag and prayer
8: 30 - 8: 50	Greetings, attendance and health check
8: 50 - 9: 10	Movement and rhythm activities
9: 10 - 10: 00	Creative and free-choice activities
10: 00 - 10: 10	Snack
10: 10 - 10: 30	Experience enhancing activities
10: 30 – 11: 00	Outdoor activities
11: 00 - 12: 00	Lunch
12: 00 - 14: 00	Nap time
14: 00 -14: 20	Transition time
14: 20 - 14: 40	Snack
14: 40 - 15: 00	Educational games

Table 1.1: Typical daily activities in early primary education, adapted from the Department of Local Administration of Thailand (2004, p. 56)

Each school develops its own early primary curriculum to be matched with their local context, according to Thai government guidelines (Angeles-Bantista, 2004). Two main documents: "Thai National Early Childhood Curriculum" (The Ministry of Education of Thailand, 2003) and "The Learning Experience Plan in Early Childhood Education" (Department of Local Administration of Thailand, 2004), and support provided by ESAs, enable teachers to create their own school curriculum. The first document states goals, contents, and child development and assessment methods, and the latter document aims to give rough guidelines for the design of a school curriculum. The school curriculum aims to promote learning experiences for the development of Thai children. Therefore, weekly teaching plans are designed to identify teaching topics, such as resources, coconuts, rice, and animals, covered in six activities per day. This content changes every week, as outlined in the weekly experience enhancement plans.

According to the guidance provided, a typical daily activity and timetable is as shown in Table 1.1 above.

There are some key issues for future development in early primary teaching in Thailand. The lack of consistency when it comes to designing the school curriculum sometimes leads to low quality of teaching. Angeles-Bantista (2004, p. 23) stated that the educational quality of schooling in urban areas is better than that found in rural areas.

> Implementation of the curriculum varies widely between urban and rural centres, largely as the former tend to have more highly-educated and better-trained staff, greater financial and material resources, and a higher level of active parental involvement and support, as they are often in a better position to contribute time and material resources.

The Thai Early Childhood Curriculum emphasises child-centredness (Angeles-Bantista, 2004; Pinyoanuntapong, 2013) and this emphasis may influence teachers' views on the purpose of their questioning. The curriculum privileges learners and learning, rather than teachers and teaching. In both "Thai National Early Childhood Curriculum" (The Ministry of Education of Thailand, 2003) and "The Learning Experience Plan in Early Childhood Education" (Department of Local Administration of Thailand, 2004), teachers are conceptualised as planners and facilitators in a child's educational journey of learning through play:

> When providing experiences for children aged three to five years, integrated activities are organised through play in order for children to learn from hands-on experience. Such experiences promote knowledge, skills, attitudes and dispositions, as well as the development of physical, affective, social, and cognitive domains (The Ministry of Education of Thailand, 2003, p. 34).

This emphasis on "hands-on experience" could be explained by the Piagetian perspective on teaching, whereby teachers are facilitators. However, this approach seems to underestimate teachers' role as *teachers*, in terms of scaffolding and constructions of learning (Jordan, 2009). Based on Vygotsky's social constructivism, the vital role of teachers is to fostering children's learnings. Vygotsky proposed that the "…mediation of human action by cultural artefacts played a central role in human development" (Cole and Wertsch, 1996, p. 250). Teaching strategies—especially questioning—are not explicitly mentioned in the guidance documents, which provides guidance for how teachers can successfully promote children's learning. It is therefore suggested that there is a need to pay attention to the vital role of teachers and teaching.

Understanding the current practices of teachers in terms of questioning in early primary teaching in Thailand would lead to an identification of teacher training needs as a means of increasing the quality of teacher-child interaction.

1.3.3 *The importance of Thai culture to the teachers and students*

The collectivist nature of Thai culture has an impact on teachers and students, and will be explained. This may create a difficulty when developing the thinking skills of Thai children because the individualistic and teaching approaches of critical thinking skills are embedded in Western culture.

In the Thai social system, seniority and status is embedded in school organisations (Mulder, 1996) in terms of the fact that people in positions of superiority, such as school principals over teachers and teachers over students, will ensure that those with less status do as they are told (Hallinger *et al.*, 2000). If school principals ask teachers to make a change in their teaching practice the teachers will say "Yes" and then do as they are told, due to the Thai culture of *greng jai.* This aspect of Thai culture means showing consideration for older people, and is a central norm of Thai culture (Holmes *et al.*, 1995; Mulder, 1996). However, the drawbacks of *greng jai* outweigh the benefits. Although social cohesion may be created (Hampden-Turner & Trompenaars, 1997), this could be considered to have serious drawbacks in the development of creativity and criticality.

As part of the Thai culture, teachers are perceived to be knowledgeable and respectful to learners (Hallinger *et al.*, 2000). Their role as a teacher is not only to provide knowledge and advice, but also makes them responsible for instructing children in moral aspects and the values associated with being Thai. It is clearly seen that one aspect of child development is Thai identity or *Thainess* (Chanbanchong, 2014)*,* in terms of which children are taught discipline, having beautiful smiles, and respect for elders. Due to their roles, teachers are highly respected, and are considered to be authoritative and knowledgeable. This is related to the concept of *bunkhun*, in which the receiver feels a moral debt to the teacher. Therefore, in turn, they pay respect and consideration to the teacher (Mulder, 2000). In terms of learners, Thai children are often passive and feel shy, an aspect which is influenced by our Thai culture.

1.4 Aims of the study

Due to the fact that research into teachers' questioning in the context of Thai early primary scientific education is under-researched, this study aims to explore the questioning practices of Thai teachers based on the teachers' perspectives, and to explain what may influence such practices in the teaching context of early primary science lessons in Thailand. Understanding the current practice of Thai teachers' use of questions may enable me to provide suitable ways to improve the practice of questioning. The findings from this study may also contribute to the

development of education in a wider international context, especially in countries with a cultural context which is similar to that of Thailand.

1.5   Research questions

The research questions of this study on the questioning practices of Thai teachers have been developed. The main research question is:

How do Thai teachers perceive their questioning practice in science lessons?

The three sub-research questions are as follows:

1. What purpose do Thai teachers report to have in asking questions?
2. How do these understandings relate to open and closed questions?
3. What strategies do Thai teachers identify for structuring questions?

1.6   Overview of the thesis

The remainder of this thesis is divided into five chapters: literature review, methodology, findings, discussion and, finally, conclusions of this research. The details of the individual chapters are as follows:

Chapter Two provides a review of the literature relating to learning theories, pedagogical concepts related to social constructivist theory, questioning as a form of pedagogical practice, early primary pedagogy, science teaching, and teachers' beliefs and reflections. I will compare three learning theories in this chapter, and show why this study of Thai teachers' questioning strategies is situated in the social constructivist approach. Additionally, research on teachers' questioning in school contexts in Western countries and in Thailand is reviewed, and the research gap is identified in this chapter.

Chapter Three is devoted to the research paradigm, the research methodology and methods, and the justification for their adoption. This includes ethical considerations, measures of trustworthiness and the limitations of this research.

Chapter Four contains the main findings with regard to teachers' questioning practices.

Chapter Five provides a discussion of the main findings with regard to the questioning practised by early primary teachers in the science classroom. A model for understanding early primary teacher's questioning practices is proposed by building in the integrations of this study's theoretical framework.

Chapter Six covers the research conclusions. A summary of the study illustrates how this research was conducted. Then, the main findings with regard to the research questions addressed will be clarified. The pedagogical implications are then disclosed, as relevant to early childhood teachers, academics and policy makers. This chapter also contains the contribution of this research, both to knowledge and methodology. Finally, recommendations for further research are included in this chapter.

Chapter 2   Literature review

2.1   Introduction

The main purpose of this study is to explore Thai teachers' understandings of their questioning practice in the context of early primary science teaching, and factors that may influence their questioning practice. This chapter aims to position this study in terms of learning theories, classroom questioning, early primary teaching, science teaching, education in Thailand, and teachers' beliefs and reflection. The theoretical framework for this study includes social constructivism, socio-cultural theory, and teacher cognition because the studies that will be discussed in this chapter highlight the importance of 'open' questions for fostering learning and as part of the scaffolding process. Even though most of these studies were conducted in Western countries such as the United Kingdom, the United States, and New Zealand, such research would appear to be applicable to the context in Thailand. I will make it clear if the research was conducted in Thailand or in other places.

For investigating the questioning practices used by early primary teachers in Thailand, social constructivist learning theories was selected to underpin this study. Within social constructivism, it is argued that a teacher's role is important to promote children's learning through interaction (Vygotsky, 1978; Tharp and Gallimore, 1988; Wells, 1999; Burns and Myhill, 2004; Smith and Higgins, 2006; Mercer and Littleton, 2007; Alexander, 2008). Some authors (Fisher, 1999; Higgins *et al.*, 2001; Venville *et al.*, 2003) have suggested that teachers' questioning is relating to teaching thinking skills.

This literature review will provide a brief overview of learning theories, and offers a comparison of three contemporary learning theories in Section 2.2. Concepts of learning, based on three different perspectives of behaviourism, cognitive constructivism, and social constructivist theory will be examined. Furthermore, the reason why this study of teacher questioning adopts the social constructivist perspective of learning will be discussed. The review will then discuss the pedagogical concept of scaffolding, before moving on to consider prior knowledge and formative assessment relevant to social constructivist theory, and an approach to teaching science in Section 2.3. Section 2.4 of the review deals specifically with teacher questioning and in particular whether or not it is an important tool for teachers. In Section 2.5, pedagogy in the early years will be discussed, including the impact of contextual factors on young children's learning. As my study is contextualised within science lessons, I will review the teaching of science. A historical overview, and writing in terms of curriculum and pedagogy, of the United Kingdom and Thailand will be included in Section 2.6. It is

necessary to review the concept of teacher reflection and teachers' beliefs on classroom practice, as presented in Section 2.7. This concept is also necessary for this study, to separate what actually happens in the classroom, and what teachers understand in relation to the use of questioning. At the end of this chapter, in Section 2.8 a theoretical framework for this study will be integrated from these areas, and Section 2.9 shows how this research adds new knowledge to the field.

2.2 Learning theories

With the purpose of investigating teachers' views on teaching and learning, this review will focus on different perspectives of teaching and learning. Comparisons are drawn between the principle concepts of three contemporary learning theories – behaviourism, cognitive constructivism, and social constructivism – and their implications for pedagogy, especially the roles of teachers' questioning as a scaffolding strategy. Based on social constructivism, the definition of learning that is relevant to this study is "the way people learn to make sense of the world, become able to solve problems and … take on new perspectives" (Mercer and Littleton, 2007, p. 3). An understanding of the world results from the construction of mental models in which the teacher's role is important in terms of promoting children's learning through interaction.

2.2.1 Behaviourism

Arthur and Cremin (2010) explained that behaviourists think that because the working of the mind is unobservable, all we can do is observe behaviour as a result of thinking processes. Regarding learning, the learner is a passive recipient of a predefined body of knowledge (Davis, 1991; Cohen *et al.*, 2004; Arthur and Cremin, 2010). Human learning is seen as an extension of the learning of animals (Collier *et al.*, 2011), and several psychologists such as Ivan Pavlov, John Watson, Edward Thorndike, and B. F. Skinner demonstrated in their experiments using animals that a particular stimulus caused an expected behaviour as follows.

According to an account by Collier et al. (2011) of their experiments to test conditions of stimulus and response, Ivan Pavlov (1849-1946) trained dogs' behaviour to be triggered by a bell. John Watson's ideas of "frequency" and "recency" led to learning (Collier *et al.*, 2011). Some studies (Collier *et al.*, 2011; Gonzalez-DeHass and Willems, 2012) found that the more frequently and recently that an event happened, the greater the relationship between the stimulus and response. Gonzalez-DeHass and Willems (2012, p. 180) commented that the factor of frequency refers to the importance of repetition, while recency focuses on the timing. Thorndike had ideas about the concepts of satisfiers and annoyers as having the function of

reinforcing appropriate behaviour. As Jordan et al. (2008) state, in the 1930s Skinner introduced the concept of operant conditioning, in which "the behaviour of the subject determines the response to the subject's own actions" (Skinner 1938 cited in Jordan *et al.*, 2008, p. 25). Skinner trained a rat to press a lever to obtain food pellets. In the condition of positive reinforcement, if the rat pressed the lever and received food pellets, this caused the behaviour to recur. In the opposite condition, if, after pressing the lever food pellets were not given, the behaviour was eliminated.

In the classroom, the main method of teaching involves "skill and drill" exercises (Arthur and Cremin, 2010). This aims for a recitation of information and an emphasis on correct answers (Cohen *et al.*, 2004). Generally, in classrooms, positive feedback ("Well done!") would encourage answering questions, whilst no praise ("No") would deter giving a wrong answer. The sequence of questions and answers function as a stimulus-response in terms of "increasing difficulty, guided practice and regular reviews of material" (Arthur and Cremin, 2010, p. 44).

This learning theory of behaviourism is not useful for my current study on teachers' questioning, because questioning is seen as a stimulus for children to reply to correct answers, which requires factual information. In other words, this questioning is not a tool that can be used by teachers to help children's learning. What follows is an account of two learning theories based on constructivist approaches. In contrast to the behaviourism associated with teaching as knowledge transmutation, according to constructivism, learners learn by the formation of knowledge and understanding.

2.2.2 *Cognitive constructivism*

The literature on the nature of children's learning and development and the role of teachers in supporting learning from the cognitive constructivist view will be discussed in this section.

In terms of branches of constructivism, cognitive constructivism assumes that "the acquisition of knowledge is an individual process with individual outcomes, which depends on personal mental frameworks and processes" (Jordan *et al.*, 2008, p. 59). Constructivists view "learning as the result of mental construction" (Pritchard, 2009, p. 17). Learning is an active process and happens by adding and mapping new information to a child's current knowledge, understandings and skills (Whitebread, 2000; Pritchard, 2009). Johnson-Laird suggests that mental models act as the foundation structure of human cognition:

> It is now plausible to suppose that mental models play a central and unifying role in representing objects, states of affairs, sequences of events, the way the world is, and the social and psychological actions of daily life (Johnson-Laird, 1983, p. 397).

The mental models are representations of the real world in various situations. The construction of the mental models refers to understanding: "To understand and to remember discourse is to build a representation of its meaning in memory" (Taylor and Taylor, 1990, p. 75).

The construction of a mental model that connects information (knowledge, concepts, ideas, etc.) together can be explained by the inferencing process. Generally there are two types of inferencing: backward and forward inferencing (Johnson-Laird, 1983; Fincher-Kiefer, 1992; Newton, 1996).

> Backward inferencing … gives the discourse coherence by relating terms to their referents (Newton, 1996, p. 216).

For instance,

> The bird stands on the tree.

> It has a long yellow beak.

"It" refers to the bird by backward inferencing. In forward inferencing, prior knowledge about the bird may provide us with other information; for instance, what food that bird eats such as worms, fish and flies. The hypothesis is formed based on prior knowledge. If that hypothesis is false due to misunderstandings, this may lead to a new one which matches the situation (Fincher-Kiefer, 1992).

> Forward inferencing … integrates prior knowledge with present experience to generate expectations with facilitate the processing of the discourse. Hence, it anticipates the future direction of the discourse (Newton, 1996, p. 216).

The capacity of a mental model relies on the ability of the working memory to articulate and to integrate relevant knowledge which we refer to as understanding (Newton, 1996). In order to develop understanding, teachers can encourage pupils to reveal existing mental models and then present them with simplified models of scientific concepts (Mayer, 1989).

Piaget's theory of children's learning and development had a very significant influence on education during the twentieth century. According to Piagetian theory, children actively develop their understanding of the world through interaction with their environments (Davis, 1991; Wood, 1997): "children's active construction of their own understanding is fundamental to their cognitive growth" (Mercer and Littleton, 2007, p. 9). Moreover, the child's existing knowledge can be influenced by external experiences (Jordan *et al.*, 2008, p. 20). In the opposite of behaviourism this conception of development is acknowledged to be "*stage-like*" (Davis, 1991, p. 19, original emphasis). Wood (1997, p. 52) explains that Piaget's concept of

developmental stages does not consider development to be an accumulation of knowledge and understanding; instead, it is considered a progressive development of thinking, which becomes logical thinking, according to age.

Pre-operational stage relates to the pupils in my study aged between four and five years old; for this reason, the main features of the relevant Piagetian development stages will be discussed below. In terms of the implication of Piaget's theory, effective teaching is constrained by children's levels of development (Wood, 1997). Young children aged from two to six years are called pre-operational learners and they generally move to the next stage of concrete operations at age seven. Key features of the two groups of children, according to Piaget's pre-operational and concrete operational stages, can be seen in Table 2.1. Piaget provides a significant understanding of children's development. One difference between children aged two to six years and those aged seven to 11 years was that they differ in their operational thinking. In light of the evidence collected from the 'concrete-operational' test questions, "they could not conserve, categorize and put things in order" (Athey, 2007, p. 33). However, Piaget's pre-operational stage has been criticized by Donaldson (1987) because it underestimates young children's ability in logical reasoning, which will be discussed in Section 2.5.

Table 2.1: Piaget's stages of cognitive development based on Wood et al. (2002), cited in Halpenny and Pettersen, 2013, p. 119)

Stages	Characteristics of children:
Pre-operational (2-7 years)	• build a mental model of the world • are still egocentric, only seeing world from their own point of view • can perform mental operations such as addition only when objects are present
Concrete operational (7-11 years)	• generate rules and principles based on their actions on the world • are able to understand only rules of which they have had direct experience • cannot yet use rules to generalize to situations not yet experienced • develop an ability to see other points of view

A key concept in cognitive constructivism theory is that of cognitive dissonance or cognitive conflict. The learning process happens when a learner encounters a new experience, which can add to, reinforce, or contradict his/her existing knowledge (Jordan *et al.*, 2008). This means

that the child learns and modifies his/her understanding according to the new experience he/she encounters. Piaget viewed the growth of cognition as a process of adaptation to one's environments, which happens through assimilation and accumulation (Wood, 1997; Pritchard, 2009; Halpenny and Pettersen, 2013).

> Assimilation – the process through which children incorporate new information into an existing schema.
> Accommodation – the process through which children change or adjust their schemas in order to accommodate new information. (Halpenny and Pettersen, 2013, p. 28)

Pritchard (2009) describes a case of cognitive conflict, in which a young child may know that a dog is small, and has four legs and fur. He notes that cognitive conflict in this learning process would mean that new information – about a cat, for example – contradicts the child's existing knowledge, and may cause it to create a new concept concerning animals with four legs and fur. It can therefore clearly be seen that such conflicts can help learning to take place and aid the child's cognitive growth.

In this view of learning, the role of teacher has an indirect role by providing "an appropriate experience and environment in which to foster the child's natural capacity to develop and learn (Davis, 1991, p. 19). Mercer and Littleton (2007, p. 9) drew an analogy between a child's development and a gardener growing plants: "direct or intrusive adult intervention could be harmful to the natural trajectory of the child's intellectual development." Therefore, giving support could be seen to be an obstacle to the learning process.

In terms of teaching approaches, "discovery learning" is influenced by Piaget's theory. "This kind of discovery learning is based on the idea that children learn effectively when guided to discover principles or causes through their own investigations" (Pritchard, 2009, p. 57). The cognitive constructivist theory is less relevant to this study because the teachers' role is to create a situation in which learning will take place, but some concepts in Piaget's stages of cognitive development and cognitive conflicts were found to be very useful to this study on teaches' questioning. Learners are responsible for their own learning by interacting with the environment, so giving guidance by asking questions may be interrupting their learning.

2.2.3 Social constructivism

In contrast to the cognitive constructivist view of learning, which emphasises interaction with environments, according to social constructivism, social interaction between people is very significant to children's learning and development, particularly in terms of interaction between

teachers and children. In this section, I will outline how learning takes place and how teachers' questions are one example of teacher-child interaction.

Although Piaget and Vygotsky shared similar beliefs regarding the concept of learning as knowledge construction, the social constructivist theory of learning focuses on social interactions between a teacher and children or among the children themselves, as will be discussed below. As social constructivism and socio-cultural theory are closely related and linked to learning theories, it is necessary to define the terms. New and Cochran (2007) note that a distinction can be made in "how each theory views the contextual nature of learning and the construction of knowledge" (p. 745). According to social constructivism, social interaction influences learning and development. However, in additional to social interaction, the socio-cultural perspective of learning also perceives cultural tools and artefacts as having an impact (Cole and Wertsch, 1996; Wood, 1997; Daniels, 2001). Cole and Wertsch (1996) note that "artefacts clearly do not serve simply to facilitate mental processes that would otherwise exist. Instead, they fundamentally shape and transform them" (p. 252). Vygotsky was highly influential in the development of social constructivist theory, and this is the learning theory that informs this study, as will be explained.

Social constructivist theorists perceive learning as being situated in social interactions, which leads to the development of understanding and thinking skills. The development of thinking happens in two stages, from the social to the individual through the use of language.

> Vygotsky suggested that using language to communicate helps in the development of new ways of thinking: what children learn from their 'inter-mental' experience (communication between minds through social interaction) shapes their 'intra-mental' activity (the way they think as individuals) (Hardman, 2008, p. 134).

From this perspective, children learn to think and talk as a result of interacting with other people. It emphasises the need for social interaction between the child and more capable peers as part of the learning process. In this process of learning, teachers' questioning supports the learning and is undoubtedly important due to the interactions involved. Key concepts for explaining how interaction helps children's learning in social constructivist theory are the "Zone of Proximal Development" and "Mediation", which will be discussed in the following sections.

Another influential developmental psychologist was Bruner, who continued Vygotsky's work, although part of his concept of children's development is congruent with Piaget. Wood (1997) performed a brief comparison of the three, arguing that the distinction between Bruner and Piaget and Vygotsky's theory of child development involves information theory, which

originates in ideas about adult thinking and problem-solving. For Bruner, "learning involves the search for pattern, regularity and predictability" (Wood, 1997, p. 38). In a similar way to Vygotsky, Bruner stressed the importance of social interaction regarding language and interaction in the formation of minds, whilst, like Piaget, he mentions "the importance of biological and evolutionary constraints on human intelligence" (Wood, 1997, p. 39). Whitebread (2008) noted two major contributions by Bruner to education for young children: the important role of language in learning, and his concept of a "spiral curriculum", stating that "anything can be taught to children of any age" (Whitebread, 2008, p. 5).

The Zone of Proximal Development

The key concept of Vygotsky's theory, the Zone of Proximal Development (ZPD), is defined as:

> the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers (Vygotsky, 1978, p. 86).

The ZPD represents a learning zone in terms of what a child can do with assistance. What the child is not able to do on his/her own can be achieved with support from a more able person, such as a parent, a teacher or a more knowledgeable peer. Well (1999 cited in Daniels, 2001) noted that the ZPD is related to assessment and instruction. Firstly, Wood (1997, p. 27) explained in assessment practices that two children have the same level of attainment when they have an ability to complete the task on their own. Due to the fact that the ZPD of some children is wider than others, they have an ability to learn better than another child when being helped. Secondly, in schools, instruction should be such as to advance the actual level of a child's development if it is to be useful, so that the use of questioning has to relate to the ZPD. In Vygotsky's words, "Instruction is only useful when it moves ahead of development" (Vygotsky, 1987 cited in Daniels, 2001, p. 54).

Mediation

Daniels (2001) explained that, according to Vygotsky, human beings use psychological tools for developing mental processes, and he lists examples of these tools: language, counting systems, maps and pictures. Among these tools for learning, language is considered the most important cultural tool (Mercer and Littleton, 2007) for the development of knowledge and understanding. In the current study, teachers' questioning is seen as one such tool that teachers use to educate young children. As Wells (1999) pointed out, Vygotsky and Holliday consider

language to be a man-made tool, constituting a medium of social communication with a particular goal in mind. Since talking makes learning a social activity, ideas can be considered, shared and developed between a child and its equally skilled or more capable peers (Pritchard, 2009). As a result of talking, a child is able to see a range of ideas and, in turn, develops his/her own.

Based on both cognitive constructivist and social constructivist perspectives "individuals actively construct their own knowledge and understanding" (Pritchard, 2009, p. 115). Learning is the construction of mental models of the world through interaction. For Piaget, a child learns by an interaction with environments, and learning is a process of the accommodation of new information to existing knowledge and understanding (Pritchard, 2009; Halpenny and Pettersen, 2013). Piaget is of the opinion that the role of more able people such as teachers or peers to be an obstacle to a child's learning because relationships between adults and children are a constraint due to the authority and asymmetry of social power (Kutnick and Manson, 2000, p. 83). In contrast, Vygotsky believes that social interaction with more able peers is a significant influence on learning (Light and Littleton, 1999; Mercer and Littleton, 2007; Pritchard, 2009).

> But whereas Piaget's emphasis was on the status-symmetry of such interactions, Vygotsky's emphasis is more on the competence-asymmetry that will often be a feature of peer relations (Light and Littleton, 1999, p. 9).

How can social interactions be a part of a scaffolding process for learning? Vygotsky contributes to education in terms of how learning happens within social interaction, and points to the important role of culturally-mediated tools (Light and Littleton, 1999). The development of higher mental functions such as thinking, reasoning and understanding happens through social interaction rather than through individual interaction, as that interaction mediates the child to learn about the world (Light and Littleton, 1999). In science, constructing an understanding of science investigation practical work provides students with experience and, importantly, leads to "asking questions to help the learner make links and make their understanding open to reflection" (Newton, 2012, p. 47). Teachers' questioning or peer-to-peer questioning are beneficial for promoting understanding as "discussions can check on understanding, bring it all together and extend it" (Newton, 2012, p. 47). This is supported by Tharp and Gallimore (1988) who suggest that learning is a process of "re-intervention", as social interaction leads the learner to construct understanding.

2.2.4 *Different views of learning*

Three different views of learning are discussed and the main concepts related to the three learning theories were explored in the previous sections. According to Pritchard (2009), behaviourists have defined learning as "the acquisition of new behaviour" (p. 6) which is observable and ignores mental activities (Jordan *et al.*, 2008; Pritchard, 2009; Arthur and Cremin, 2010). Arthur and Cremin (2010) explained that knowledge is viewed as a set of behaviours which is acquired passively and influenced by a mechanism of responses to a stimulus. The behavioural psychologist, Skinner (1976, cited in Arthur and Cremin, 2010), presumed that "knowledge is action, or at least rules for action" (p. 43). Constructivism on the other hand can be divided into two schools of thought: cognitive and social. They both focus on "what people do with information to develop knowledge" (Jordan *et al.*, 2008, p. 55). There are shared beliefs that:

> people actively build knowledge and understanding by synthesizing the knowledge they already possess with new information. For constructivists, learning is an active process through which learners 'construct' new meaning (Jordan *et al.*, 2008, p. 55).

The main difference between the two views of learning is that cognitive constructivists perceive learning as individually constructed by discovery, whilst according to the social constructivist view of learning, social interaction with someone with a more advanced level of knowledge has a significant impact on children's learning.

This section has reviewed three key perspectives of how children learn, the cognitive constructivist view of learning enables understanding of individual learning through interactions with environments, and we also have a greater understanding that social interaction between a teacher and children fosters children's learning through questioning. There is a strong relationship between the ZPD and mediation, as teachers' questioning helps or supports children's learning through interaction. This is why I chose social constructivist theory as the most relevant theory of this study. The following section will now explain current concepts relating to the social constructivist theory of learning, which could be applied in teaching.

2.3 Pedagogical concepts related to social constructivist theory

This section includes the pedagogical concepts of scaffolding, prior knowledge, and formative assessment, which are all relevant to social constructivist theory. I will also discuss how social constructivist theory is related to science teaching.

Scaffolding

Scaffolding is a persuasive metaphor for the process in which a person provides support for a less able person to achieve a task. "Scaffolding" was introduced by Wood, Bruner and Ross (1976) in the context of the tutoring process in an interaction between an adult and a learner. The definition of scaffolding is described below as the process of providing support or help to a child in solving a task that the child cannot do without such help.

> [Scaffolding] refers to the steps taken *to reduce the degrees of freedom* in carrying out some task so that the child can concentrate on the difficult skills she is in the process of acquiring (Bruner, 1978 cited in Mercer, 1995, p. 73, original emphasis).

In order for a child to solve a 3D puzzle built from a set of wood blocks and pegs, the crucial role of the adult is in controlling the whole task: "the adult 'controlling' those elements of the task that are initially beyond the learner's capacity" (Wood, 1976, p. 90). A successful model of instructive scaffolding is thus demonstrated by the example of the 3D puzzle. In the context of mother and child interaction, Wood and colleagues found that the child who could do it alone after instruction was the child that the mother supported most closely in line with the child's needs (Wood, 1991). This way of support can be described as "contingent control of learning" (Wood, 1991). Mercer (1995, p. 73) states that: "Successful 'scaffolding' requires the adult to be sensitive to the child's competence in the task – responsibility is handed over to the extent that the child shows they are able to cope with it."

Many studies have investigated scaffolding features in adult-child interactions in the last few decades (van de Pol *et al.*, 2010). In solving the 3D task mentioned above, six scaffolding functions were provided in tutor-tutee interactions, including reciting interests, minimising the task, controlling the direction, the progress and frustration, and modelling (Wood *et al.*, 1976). Tharp and Gallimore (1988) explicitly noted that questioning is one means of instructional scaffolding. They (1988) also refer to questioning as a fundamental tool in education since questions foster the type of thinking from which linguistic and cognitive responses are required. In relation to this study, questioning was found to be the most interesting scaffolding strategy to study.

Mercer (2000) further proposed five guidance techniques that are normally employed by teachers to link prior and new knowledge.

> 1) recaps: a teacher summarises what has been taught
> 2) elicitations: a teacher obtains information from students about what they know
> 3) repetitions: a teacher paraphrases information given by students back to the class

4) reformulation: after a teacher receives a student's response, a paraphrasing response with a little change in the form acts as feedback to the class

5) exhortations: a teacher emphasises important information to be remembered.

Such techniques can be used as part of effective pedagogy "for generating a common frame of reference" (Mercer, 2000, p. 138) but only elicitations would involve teachers' questions. Likewise, the 'Using Talk to Activate Learners Knowledge' project (Myhill *et al.*, 2006) shows that participant teachers employed all such techniques in teaching literacy. Wertsch (1985 cited in Mercer, 2000) also found two similar guidance techniques: "establishing a referential perspective" and "abbreviation" that parents of young children use.

Prior knowledge and formative assessment

Formative assessment plays an important role in supporting learning. According to Black and Wiliam (1998b), formative assessment can be defined as follows:

> We use the general term assessment to refer to all those activities undertaken by teachers—and by their students in assessing themselves—that provide information to be used as feedback to modify teaching and learning activities. Such assessment becomes formative assessment when the evidence is actually used to adapt the teaching to meet student needs (p. 140).

As Shepard (2005) points out, like scaffolding, formative assessment is a dynamic process where support from teachers, adults and peers help children to move on the next level of their ZPD (Shepard, 2005). In connection to the formative assessment concept, a very useful strategy of formative assessment is "eliciting prior knowledge" (Shepard, 2005), as a child constructs their understanding and makes sense of new experiences based on what they already know. The metaphor of weaving as "comprehension" (Tharp and Gallimore, 1988) refers to us understanding new information because "it has become woven into our *system* of meanings and understandings" (p. 109, original emphasis).

Social constructivism and the teaching of science

The teacher plays an active and sensitive role in supporting children's learning of science. The Nuffield Primary Science scheme (Nuffield-Chelsea Curriculum Trust, 1993) is based on both cognitive constructivist and social constructivist theories, in that teachers can give support to children's science learning as follows:

1. finding out what children's ideas are
2. reflecting on how children may have arrived at their existing ideas and on where they are in a progression towards developing more scientific ideas

3. helping children to develop process skills so that they test out and apply their ideas scientifically
4. providing opportunities which test or challenge ideas, leading to possible changes
5. assessing the extent of any change in ideas and in process skills which may have resulted.

(Nuffield-Chelsea Curriculum Trust, 1993, p. 35)

In connection to Nuffield's guidelines (including the first, the third and the fifth), teachers' questions provide opportunities for children to talk about and exchange ideas in class. In order to enhance the learning experience, the teacher can encourage children to design and test their ideas by experimenting, as "they are not solving a problem set by someone else" (Nuffield-Chelsea Curriculum Trust, 1993, p. 3). It is important for the teacher to know the level of children's existing understanding, and what should be the next stage of learning.

Undoubtedly, questioning is a vital means of scaffolding and formative assessment; teachers access the current level of children's understanding and move forward to the next level of understanding in their ZPD. It is therefore interesting to investigate teachers' intentions when asking questions during the scaffolding process.

2.4 Questioning as a form of pedagogical practice

According to Harrop and Swinson (2003), the appropriate use of questioning is an important skill for every teacher, and teachers' questioning remains "the most common strategy for eliciting responses" (Myhill *et al.*, 2006, p. 17). This literature review in Section 2.4.1 includes a consideration of teachers' practices on the use of questioning based on social constructivist theory, in which interaction is a key to learning. We then refine this to an examination of the appropriate practices of questioning in classrooms, as discussed in Section 2.4.2.

2.4.1 Questioning within social constructivist theory

In this section, due to the importance of "talk for learning" (Mercer, 2000), I will discuss social constructivist perspectives in terms of how teachers' questions could be used effectively to create extended interaction, as well as to scaffold children's learning. Based on social constructivist perspectives with regard to teaching and learning and the literature on the importance of talk for learning, it is suggested that more interactive teaching approaches such as interactive teaching (Burns and Myhill, 2004), interactive pedagogy (Smith and Higgins, 2006), and dialogic teaching (Alexander, 2008) may improve children's learning. These teaching approaches share an emphasis on asking 'open' questions on the part of the teacher, as a way for teachers to help children to learn. I will examine and define open and closed

questions in the next section on types of questions. According to Smith and Higgins (2006), open questions refer to teachers' questions with the intention of encouraging children's talk in order to create interaction, e.g. to predict the result of an experiment. Such questions help the construction and reconstruction of knowledge and understanding. Open questions are referred to as good or effective. As Wells (1999) noted, they do this "by contributing to the joint meaning making with and for others", and by doing so "one also makes meaning for oneself and, in the process, extends one's own understanding" (p. 108). In contrast, closed questions require short responses, acting in such a way as to prevent the pupil's responses (Edwards and Westgate, 1994); they therefore tend to be used as a "control mechanism" (Myhill *et al.*, 2006).

It is also known that, in traditional classrooms, classroom talk between a teacher and pupils tends to be of low quality; most teachers are unaware of using closed types of questions only to elicit short responses (Mercer and Dawes, 2008). From a social constructivist perspective with regard to teaching and learning, current researchers (Mercer and Littleton, 2007; Alexander, 2008) offer a new way of talk (dialogic talk) where teachers' questions may be used to guide children's learning. The term, dialogic talk, is used to explain a particular type of classroom interaction in which "both teachers and pupils make substantial and significant contributions and through pupils' thinking on a given idea and the theme is helped to move forward" (Mercer, 2003, p. 74). Robin Alexander has conducted an international study in five countries and found that:

> In most of the classrooms he observed, teachers talked more than pupils; but the balance and nature of contributions varies considerably, both between countries and between classrooms. One of the reasons for this variation was that in some classrooms a teacher's questions (or other prompts) would elicit only brief responses from pupils, while in others they often generated much more extended and reflective talk. (Mercer, 2003, p. 74)

These statements show the nature of talk between teachers and children, and that what causes the variations in teaching is the teachers' questions.

In terms of the pattern of teacher-student interaction, as first identified by Sinclair and Coulthard (1975), IRE or IRF (Initial, Response, Evaluation or Feedback), exchanges are common in the classroom. The interaction is described as "recitation script" (Tharp and Gallimore, 1988), which relates to the interaction initiated by the teacher's questions which require correct and factual responses. After the pupil responds, the teacher tends to evaluate whether the answer is right or wrong. Previous studies in developing (Abd-Kadir and Hardman,

2007; Hardman, 2008) and developed countries (Smith *et al.*, 2004) have shown that the most prominent kind of talk is called "recitation script":

> …closed teacher questions, brief student answers and minimal feedback which requires students to report someone else's thinking rather than think for themselves, and to be evaluated on their compliance in doing so (Hardman, 2008, p. 133).

In the classroom, teachers have more power than learners, and try to control lessons as they have planned them. Mercer and Dawes (2008, p. 57) noted that the pattern of IRF exchanges occurs all around the world because of "the participants following a set of conversational rules". There are some "ground rules" in classrooms for controlling learning. One rule is "Only a teacher can nominate who should speak" (Mercer and Dawes, 2008, p. 58) so no child can speak unless the teacher asks.

However, other authors (Mercer, 1995; Nassaji and Wells, 2000; Smith and Higgins, 2006) have suggested that this pattern of IRE or IRF interaction could be used more effectively by using move types in a follow-up move. Nassaji and Wells (2000) stated that teachers' questions usually initiate a sequence of interactions because they raise an issue for discussion and an invitation to pupils to give responses. For example, Wells (1999) and Nassaji and Wells (2000) demonstrated that if, in the follow-up move, teachers choose a variety of options rather than evaluation this may lead to an extended interaction by creating a co-construction of knowledge of the topic. The option that one teacher used in their study required a justification from the class: "OK, why do you agree with Michael, Nir?" (Nassaji and Wells, 2000, p. 9).

The power of teachers' feedback can be attributed to greater opportunity for children's participation. For increasing children's participation, Smith and Higgins (2006) suggested that

> it is the feedback given in reaction to pupil responses and the historical precedence of the perception of teacher intent this engenders, which either opens or restricts classroom interaction (Smith and Higgins, 2006, p. 500).

Those feedback moves which allow peer comments and welcome pupils' ideas, and building on their ideas, will create open classroom interaction. From this perspective, the feedback and the teacher's intent when it comes to asking a question, rather than the question itself in terms of act and type of question, are pre-conditions for opening or restricting classroom interaction. Moreover, they concluded that teachers' behaviour to children's responses supports alternative techniques to questioning, as proposed by Wood (1992) and Dillon (1988) (as will be discussed in Section 2.4.2).

According to the research results mentioned above, one importance of the use of questions is to create interaction between teachers and students. Based on the implications of social constructivist theory and recent studies on classroom talk, we now know that questions can be used in both effective and less effective ways for educational purposes.

2.4.2 *Pedagogical practice and questioning*

The literature review is related to five selected features (i.e. the reasons for asking questions, the types of question, questioning strategies, wait time, and the selection of respondents) associated with questioning as part of pedagogical practice. This brief review will cover previous studies on teacher questioning, and how they influence children's learning.

Type of questions

To begin with, I will discuss the fact that question types are usually grouped into open and closed questions. The literature (Galton *et al.*, 1999b; Siraj-Blatchford and Manni, 2008; Lee and Kinzie, 2012) has emphasized the importance of 'open' questions for developing children's understanding and high-levels of thinking skills. Some researchers (Galton, 1999a, Siraj-Blatchford and Manni, 2008) have categorised questions based on feedback. For the purpose of this study and data gathering, I will follow the definitions of open and closed questions provided by Edwards and Westgate (1994) and Myhill and Dunkin (2005), which are based on the apparent intention of questions asked by teachers.

> Closed questions elicit factual information which have pre-determined answers. In contrast, open questions are used to stimulate children's thinking and have more than one possible answer.

The definition of these can depend on teachers' intentions when asking a question, and can be mentioned explicitly or implicitly (Galton *et al.*, 1999b; Smith and Higgins, 2006), as will be discussed.

In reviewing books about questioning skills, Kerry said that "An open question permits a range of responses, but a closed question implies that the teacher has a predetermined 'correct' response in mind" (Kerry, 2002, p. 70). This is supported by MacNaughton and Williams (2009), who pointed out that open and closed questions differ in terms of a teacher's expectations:

> Open questions are often used to find out how others are thinking about and making sense of the social and natural world about them (p. 154).

Often, a closed question is a request for factual information and the answer to it is clear and known to the questioner (p. 153).

In an early work on question classifications, Edwards and Westgate's (1994) definition of a closed question was that: "they are asked from a position of knowledge and are intended to find out whether the pupil questioned knows what the questioner clearly knows already" (p. 126).

In 1999, Galton *et al.* (1999b) argued that open question classifications by teacher's apparent intention of questions do not guarantee varied pupil's responses, so that he defined a teacher's question as either open or closed based on "the teacher's reaction to the pupils' answers" (p. 63). For example, after observing a chemical reaction experiment, a teacher may ask: "What do you think is happening when the solution turns blue?" This encourages the pupils to speculate as to what might be the cause of the experiment. In this case, the teacher might accept more than one answer. In the event that a pupil knows and provides the correct answer ("because it's got copper in it"), the question can be judged as closed; however, if the teacher then probes: "What do others think? What else could it be?" to the whole class in order to obtain varied responses, then this would be classified as an open question.

In their detailed analysis of open and closed questions, Smith and Higgins (2006) questioned Galton's definitions of open and closed questions, as I will mention below, arguing that teachers' intent when it comes to asking questions tends to determine the type of feedback. If teachers ask genuine questions, their feedback will maximize pupil participation. They (2006, pp. 490-491) demonstrated that a factual question: "Something plus 27 plus 78 makes 168", would lead to classroom interaction if the teacher probes: "Do you agree, Ray?" or "Can you tell us how you worked it out?". This argument is in line with that of Edwards and Westgate (1994) and of Burn and Myhill (2004). Similar open questioning which has the intention to lead to speculation could lead to fragmented responses.

Galton *et al.* (1999b) reported that, in 1996, only 5.5 percent of Stage 2 primary teachers' questions were open questions. In 2008, in a robust quantitative study, the Researching Effective Pedagogy in the Early Years (REPEY) study, the researchers showed that adults teaching early primary pupils asked even fewer open questions (5.1%) (Siraj-Blatchford and Manni, 2008). In addition, questions demanding factual information were the most commonly-asked in classrooms. Brown and Edmondson (1984) notes that more than 60% of questions involve recall of facts. The reason why factual questions are so common and used the most in the classroom is that:

Information has to be known before it can be applied; curricular objectives and examinations often stress factual content; to ask higher level questions require[s] preparation, thought and perhaps training (Brown and Edmondson, 1984, p. 104).

It is also concluded that approximately 50 percent of questions asked by infant, primary and secondary school teachers in the study was closed questions which led to factual responses (Harrop and Swinson, 2003). For instance, the study (Harrop and Swinson, 2003, p. 54) found that infant teachers used 47 percent of closed questions, 7.1 percent of open questions, 27.7 percent of task supervision and 18 percent of routine questions.

Together, these studies indicate that the concepts of open and closed questions is problematic. Regarding types of questions, open questions may not encourage wider and accumulative pupil responses as a result of this type of questions being posted. Therefore, it is important for this study to indicate the purpose in asking questions, and the relationship between the purpose and the open and closed questions. The purpose in asking questions, the types of question, questioning strategies, wait time, and the selection of respondents will now be explored and examined in the forthcoming sections in order to justify a suitable approach to question classification in this study.

Purposes of questions

It has been noted that the same questions can be used for many purposes, and so it is important to consider the purpose of asking questions in teaching. Newton (2013) emphasized that "All [types of questions] are useful productive questions but are stronger in their use if focused on particular stages in a lesson. (p. 11)". Her view on productive questions is called "focused questions" which means "It is not a matter of one kind of question being better than another but of recognizing which kind is needed and knowing how to use it to a good effect" (Newton, 2013, p. 11). Reviewing the definitions of open and closed questions leads to the view that what constitutes a closed or open question should be seen in terms of the purpose behind the question. Some studies (Wragg and Brown, 2001; Kawalkar and Vijapurkar, 2011) have shown that teachers ask questions for varied purposes but most of them require facts, not developing understanding or thinking skills.

Importantly, given the nature of language (Walsh, 2006), the same form of question could have more than one function. In order to understand why teachers use questions, it is necessary that teacher questions have to be investigated in the context of teacher-child interaction. Despite the fact that teachers ask a number of questions, a question may have the same form but different functions.

> [We] need to distinguish between *form* and *function* when analysing and evaluating questions in teacher-pupil dialogue: and we can only judge the function of questions, and any other forms of language, in dialogic context (Mercer and Littleton, 2007, p. 36, original emphasis).

Burns and Myhill (2004, p. 45) found in their analysis of the different forms and functions of questions and statements that "the same utterance could function in a different way in different contexts". According to Using Talk to Activate Learners' Knowledge (TALK Project) (Myhill and Dunkin, 2005), the findings show that the most and least common functions of the questions considered were to obtain factual information (26%) and develop vocabulary (2%), respectively.

Questioning strategies

In order to encourage children's talk, the effective use of particular strategies may lead to a continuing exchange between a teacher and a group of children (Wood, 1992). Traditionally, it has been argued that using "move types" rather than direct questions would develop the talk (e.g. Dillon, 1988; Wood, 1992). Move types refers to a repository of strategies that can be used by teachers in the feedback move of IRF or IRE exchange (Sinclair and Coulthard, 1975). Dillon (1988) argued that asking many questions leads to recitation. Therefore, his suggestion is to use alternative move types, for example, making a statement relating to a pupil's response, which encourages higher thoughts and longer responses. These suggested strategies are similar to Wood's (1992) five types of conversational "move types."

1. Enforced repetition   "Say, 'I have one at home' ".
2. Two-choice question   "Did you have a good time?"
3. Wh-type question   "Where did you go yesterday?"
4. Personal contribution "I think sugar is bad for you."
5. Phatic   "Oh lovely."
                          (Wood, 1992, p. 207)

In researching classroom talk, teachers' questions usually require recall, rather than exploration of possible answers. The functions of feedback seem to decide the level of co-construction of knowledge (Nassaji and Wells, 2000; Smith and Higgins, 2006). Nassaji and Wells (2000, p. 400) argued that if, "in the follow-up move [of the factual, known answer questions], the teacher avoids evaluation and instead requests justifications, connections or counter-arguments", this would therefore promote participation and engagement. Smith and Higgins (2006) found that the teachers who intended to open an interactive learning environment were sensitive in using four types of feedback moves: encouraging peer participations, using cues to help responding, providing genuine feedback, and following pupils' ideas to lead the lesson.

Wait time

Wait time is an important part of the interaction pattern (Ingram and Elliott, 2015) which may create an extended interaction and consequently lead to learning. The reason why teachers should wait after posing questions is that children need some time to formulate responses. Extending wait time from three to five seconds after a question has been posed and asking for a student's response allows children to think (Cazden, 2001 cited Mauigoa-tekene, 2006). Wait time is particularly beneficial when teachers ask higher-order questions; for example, Tobin and Capie (1982) found that asking higher-order questions and providing increased wait time significantly influenced an increase in student engagement. The effect of using wait time is positive for both teachers and students. According to Rowe (1986) and Tobin (1987), for students, the benefits of increasing wait time include:

- increases in the length of the pupils' answers
- increases in the quality of the pupils' answers by more inferences and superior thinking
- increases in pupil-teacher exchange
- developments in confidence
- improved marks.

Walsh and Sattes (2005, p. 78) explain that answering questions is a process which has five steps: 1. Listen to the question; 2. Understand what is being asked for; 3. Answer to self; 4. Answer out loud, and 5. Rethink and revise the answer.

Selection of respondents

An aspect of good questioning in a classroom is the wide distribution of students responding to questions (Groisser, 1964 cited in Good and Brophy, 1973). The effective selection of respondents depends on to what extent the method of selecting respondents involves class participation. According to Good and Brophy (1973), the three approaches adopted by teachers are:

1. Calling the student's name directly before asking a question
2. Calling the student's name directly after asking a question
3. Calling for student volunteers when asking a question.

An action research study aimed at enhancing the quality of 20 Pacific Island early childhood teachers' questioning skills found that teachers asked for a volunteer to answer questions after the training, whilst before, most of the time, it was generally children in the line of sight who were selected (Mauigoa-tekene, 2006). Wragg and Brown (2001, p. 31) reminds us that direct

questions invite chorus answers and that causes children's loss of interest in the teacher's questioning.

As mentioned above, the evidence presented in Section 2.4.2 suggests that question classifications based on the question type is not useful for teachers. It may be important to investigate the purposes of questions as related to question types. Together these studies provide important insights into teachers' use of questions in terms of leading to classroom interaction. Based on social constructivist perspectives, the appropriate use of questions should maximize pupil participation and engagement; therefore, there may be a need to identify questioning strategies in this study. What follows is an account of what may control or limit teachers' use of questions, especially with young children.

2.5   Early years pedagogy

This study of teachers' questions has to consider the contextual factors that may influence the outcomes of learning by young learners. I will explore empirical studies based on educational psychology to identify the factors influencing success in learning, i.e. how designed tasks and language can influence success at solving a task.

In connection with the features of the pre-operational stage explained in Section 2.2.2, Piaget viewed that a young child was "egocentric" and that this limits their ability to reason and understand. Egocentric simply refers to an undeveloped ability to understand from other perspectives (Donaldson, 1987). However, other researchers (Isaacs, 1936; Donaldson, 1987) have shown that young children's ability to think and reason is considerable. Wood (1997) and Athey (2007) wrote that in the early nineteenth century, through observing young children in her nursery, Susan Isaacs (1936) noticed they had logical reasoning. Donaldson (1987) criticized Piaget's concept of "egocentric". She demonstrated that context is bounded in their ability to view another's point of view of a designed task. In the "mountain task" experiment, which is a model of three different sizes of mountains with snow, a hut and a red cross on top, a child is asked to select the picture of the correct scene from a set of mountain scenes where a doll is viewed. The "mountain task" was too hard for young children because the task was "artificial and unfamiliar" (Wood, 1997, p. 65), which is the reason they were unable to achieve the task. Convincingly, one finding of the "hiding game task" found that 27 out of 30 children were able to complete the task (Donaldson, 1987, p. 200). Hughes (1975, cited in Donaldson, 1987) designed the task, which is considered from one point of view and is more understandable for young children. In the task, a child is asked to hide a boy from a policeman using two intersecting walls. Wood (1997) used Donaldson's research to support his criticisms of Piaget's

stages of learning and gives three explanations of an inability to perform a task: the language of the question asked, the context, and the task. These factors would make it difficult for the four and five year old children in my study to respond to teachers' questions.

As Donaldson (1987) pointed out, young children and adults are egocentric to some extent but the young may have less ability to decentre, which means the ability to take account of the multiple aspects of an event (Halpenny and Pettersen, 2013, p. 88). Therefore, it is important for teachers to understand and help them overcome this. Based on social constructivist theory as discussed previously, effective teaching depends on closing the gap in knowledge between teacher and learners, and having a good understanding about young children. In Donaldson's account of Laurie Lee's first day at school (1965, p. 50), his expectation that he would receive a present was caused by misunderstanding the meaning of the word "present" when the teacher meant that he was in the classroom. She concludes that "we [both children and adults] are all egocentric through the whole of our lives in some situations and very well able to decentre in others" (Donaldson, 1987, p. 25). In order to reduce the gap in knowledge, teachers not only carefully organise tasks for students but also know how to close the gap in knowledge. In the *Let's Think!* programme about sciences, teachers' actions on "encouraging children to explain and talk about their ideas" were attributed to improving year one students' "good thinking" (Venville *et al.*, 2003, p. 1313). In this teaching programme, teachers' questioning about simple scientific experiments may help young pupils to overcome egocentrism.

In this section, I have presented a review of the factors that may obstruct early primary pupils from performing well at learning. Regarding teachers' questioning within science, these factors may be attributed to children's inability to respond to teachers' questions and to what extent their questions are appropriate to the needs of pupils, as well as helping them to decentre by seeing various points of view. In the next section, I will specifically discuss teaching in the context of science.

2.6   Teaching science and the importance of teachers' questioning

I will provide an overview of science teaching in England as the literature is available and highly relevant to my study, and that literature seems to apply to the Thai context. Since the Plowden Report (1967), science teaching approaches have changed for teachers to be able to teach science effectively in fostering children's scientific development. This section is a discussion of the most important models designed from psychological behaviourist, cognitive constructivist, and social constructivist learning theories. Additionally, the impact of the role

of teachers' questioning is discussed in terms of the development of science classroom teaching and children's learning.

2.6.1 Historical context of teaching science

A number of teaching models have been proposed to teach science more effectively. Currently, the model that allows children to engage in active enquiry and classroom talk seems to be the most useful. Collier *et al.* (2011) state that not until the United Kingdom (UK) government centralised the education system in the early 1980s did individual schools and teachers have their own ways of organising science learning. Collier *et al.* (2011) writes that before the mid-1960s, teaching science in the UK for young pupils was related to activities such as nature walks and the use of a nature table in the classroom. Students may have been encouraged to bring nature artefacts to allow students to observe the pattern of change in the classroom; for instance, after collecting seeds in the autumn, they grew them in the soil (Collier *et al.*, 2011).

According to behaviourism, children's minds were perceived as empty vessels to be filled with the right scientific ideas (Dunne and Peacock, 2012). In cognitive constructivist science teaching models, "discovery learning" was popular in primary teaching in the 1970s and 1980s, and was influenced by the Plowden Report (1967).

> The assumption underlying learning was that children would spontaneously 'discover' the laws of science by being presented with the right materials in the right environment by the teacher, acting in the role of 'facilitator' (Collier *et al.*, 2011, p. 78).

The widely accepted concept of the process of learning science based on constructivism is related to "concepts and conceptual change" (Wilson, 2000, p. 38). Evidence suggests that pupils have their own ideas before they are taught (Driver, 1983; Harlen, 2007). Regarding teaching approaches, the Children's Learning in Science Project (CLISP) (Driver and Oldham, 1986), and Science Process and Concept Exportation (SPACE) were influenced by both cognitive and social constructivism (Driver and Oldham, 1986; Bell, 2008; Collier *et al.*, 2011). The CLISP teaching approach is composed of five phases: orientation, elicitation, restructuring, application, and review. Elicitation involves probing prior knowledge to identify their 'alternative framework' about topic areas (Driver, 1983). Likewise, the teaching method of the SPACE project emphasises starting from children' ideas, providing learning experience based on their ideas, and assessing their progress in learning (Harlen, 2007; Bell, 2008).

A move has been seen towards Vygotsky's social constructivism because of "increasing dissatisfaction with this 'laissez-faire' approach" (Collier et al., 2011, p. 78). Recently, science teaching based on social constructivist theory has emphasized the importance of talk, and the

development of children's knowledge and understanding of scientific concepts. Science learning is seen as a "discursive process", due to the fact that learners come to understand a phenomenon through talk and the use of language (Mercer *et al.*, 2004). In the same vein, talking about science influences learning about science (Lemke, 1990). Collier *et al.* (2011) write that teaching science causes a tension between a child's learning themselves and learning the scientific idea, but the dialogic talk seems to cope with this problem. Due to such tension and teacher's talk domination, Alexander (2008) and Mortimer and Scott (2003) drew our attention to dialogic talk in education, as explained in Section 2.4.1. Mortimer and Scott (2003) characterise talk between a teacher and students into two dimensions of interactive/non-interactive and dialogic/authoritative. They propose four different classes of communicative approach in science teaching as:

- Interactive/dialogic: teacher and pupils consider a range of ideas
- Non-interactive/dialogic: teacher reviews different points of view
- Interactive/authoritative: teacher focuses on one specific point of view and leads pupils through a question-and-answer routine, with the aim of establishing and consolidating that point of view
- Non-interactive/authoritative: teacher presents a specific point of view (Scott and Asoko cited in Scott and Ametller, 2007, p. 78).

They think that teaching as an interactive/dialogic process is justified when the presentation of pupils' and teachers' ideas is included in the discussion on scientific ideas. The reason why the interactive/dialogic approach is important for children in terms of moving towards an understanding of daily concepts and subsequently scientific concepts is because "*meaningful* learning involves making *connections* between ways of thinking and talking so that the learners sees how any new ideas fit with existing understanding" (Scott and Ametller, 2007, p. 82, original emphasis). Scott and Ametller (2007) suggested that talk in science lessons should involve a cycle of cumulative approaches which creates a balance between children's ideas and school science. Therefore, teachers' questions that lead to dialogic approaches within teacher-child interaction may improve children's learning.

In conclusion, the role of teachers' questioning becomes increasingly important for today's science teaching, as from a social constructivist theory the development of children's ideas from everyday science to school science is effective through interactions, often involving question initiation.

2.6.2 *Early primary curriculum and pedagogy in relation to science in England and Thailand*

Regarding this study of teachers' questions in science lessons, I will explore and compare science teaching in the UK and Thailand in terms of: areas of learning and development, scientific contents, and teaching approaches. The review provides an understanding of how science could be taught more effectively in early primary classrooms in Thailand. In both Thailand and England, the curriculum for science for early primary pupils is for whole child development, rather than focusing on knowledge of science as a subject. Before proceeding to discuss the curriculum, it will be necessary to state when pupils first start primary education. Children in Thailand enter primary education at the age of about six, as discussed in Section 1.3.1, whilst in England young children transfer from the foundation stage to year one at the age of five. In Thailand, state government schools in particular organise early primary classes for two years. It has been suggested that English Early Years Foundation Stage (EYFS), which has four main principles, should be extended to the age of six or year one to make it more useful (Alexander, 2010; Pugh, 2010; Roberts-Holmes, 2012). In terms of early years learning and development, the Framework (Department for Education, 2014) in England has seven sections: communication and language, physical development, personal, social and emotional development, literacy, mathematics, understanding the world, and expressive arts and design. However, it is explicitly indicated that the first three sections are the most important, and aspects of science are placed into the learning area of understanding the world. Teachers are recommended to organise learning experiences to meet these learning goals:

> The world: children know about similarities and differences in relation to places, objects, materials, and living things. They talk about the features of their own immediate environment and how environments might vary from one another. They make observations of animals and plants and explain why some things occur, and talk about changes (Department for Education, 2014, p. 12).

In fact, learning science not only develops learning goals but also inseparably contributes to other areas and lays the foundation for the primary science curriculum (Coltman, 2000).

In contrast, in Thailand's early childhood curriculum (The Ministry of Education of Thailand, 2003), first implemented in 2003, the four areas of whole child development: physical, emotional, social and cognitive. From twelve learning goals, four are related to cognitive development, which science learning is closest to. Types of learning experience are identified separately by individual age groups, and the four main components are the child, people and environments, nature, and things around us. Learning science may be most suitably taught

when the weekly teaching topics are about nature, and the teacher organises the learning experience in relation to science. The relevant learning goals are identified in terms of developing skills and positive attitudes, as it is clearly stated in the curriculum that the "contents are used as a medium in teaching with children … do not focus on contents and memorising" (The Ministry of Education of Thailand, 2003, p. 35).

The goal of teaching science in primary schools in England is to foster scientific development in three domains: concepts, process (or enquiry) skills, and attitudes. In primary school teaching, these domains are identified explicitly in the curriculum, whilst teaching preschool children in relation to this is enhancing the experience on a particular aspect of those domains. Harlen and Quarter (2004) raise awareness of teaching science by stating that the general aim is "to develop an overall understanding that helps them to make sense of new phenomena and events" (p. 61). Gaining experiencing with domains of knowledge helps children to develop skills in a context which will foster the acquisition of knowledge (Coltman, 2008, p. 314). More specifically, in early years teaching, process skills are mostly developed separately before children investigate with these skills in the primary learning context (Coltman, 2008, p. 314).

The appropriateness of learning activities and experiences suggested by educators for early primary pupils has been debated (English, 2001; Roberts-Holmes, 2012). As English pointed out, teaching in the early years should be suitable for a child's development in terms of psychological perspectives. Teaching in early years clearly differs from teaching in primary education in terms of teaching for understanding (English, 2001), and offers an opportunity for play. "Teaching for understanding" is central to their learning, rather than teaching for memorisation, which is merely a small part of learning (English, 2001). Many educators (David, 1999; Whitebread, 2000; Siraj-Blatchford, 2009) have emphasised that the most suitable and dominant teaching approaches for young children are play-based learning, in which a teacher supports learning with children. Bruner also noted that "Play… is all about developing flexibility of thought." (Whitebread, 2000, p. 152). Regarding social constructivist perspectives rather than cognitive constructivist view of teaching, during various learning activities and experiences, teachers are encouraged to have a more active pedagogic role (English, 2001; Roberts-Holmes, 2012). In 'Researching Effective Pedagogy in the Early Years (REPEY)' Siraj-Blatchford and Sylva (2004) analysed the data from 14 effective early primary settings in England. They found that excellent teachers intervened (i.e. discussing) to make it suitable with regard to the topic being discussed and the child's ZPD. On the other hand, if we agree with Piaget's concept of 'readiness', the teacher's role is to be a facilitator or supporter (English, 2001). Roberts-Holmes (2012) mentioned that the research outcomes of the REPEY

study, which were concurrent with socio-cultural theory, dramatically influenced the pedagogic guidance in the EYFS in 2007. It can be clearly seen that the EYFS publication recommends that teachers deliver "…the development of sustained shared thinking by offering encouragement, clarifying ideas and asking open questions which support and extend children's thinking and help them make connections in learning" (p. 8).

Overall, there seems to be some evidence to indicate that for young children to able to learn individual aspects of the domain of science learning well, at their ages in the Thai classrooms, teachers need to offer support (i.e. discussion) whilst they involve the pupils in play-based activities with the aim of developing understanding. By asking questions linked to the teaching topic and to the child's current understanding, they will develop relevant basic scientific concepts. In the section that follows, it will be argued that a study of teachers' beliefs is important to reveal their understanding of pedagogical practices.

2.7   Teachers' beliefs and reflection

So far this chapter has focused on learning theories and teachers' questions, early primary teaching and the teaching of science. The following section will discuss the theoretical aspects of teacher reflection and teacher beliefs and their influence on classroom practices, particularly research studies on teachers of young children.

2.7.1   Teacher reflection

Teachers become reflective practitioners by reflecting on their practices. Several theorists have been influential in developing a conceptual understanding of reflective practices in education: John Dewey, Jürgen Habermas, Donald Schön, and David Kolb (Calderhead, 1989; Moon, 1999). The pioneering theorist was proposed by Dewey, who perceived the concept of reflection broadly (Calderhead, 1989) as an "active, persistent and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and further conclusions to which it leads" (Dewey, 1933, p. 9). Dewey's purpose was "the elucidation of educational processes and the more general understanding of human function" (Moon, 1999, p. 11). Expanding Dewey's ideas of reflection, Schön (1983; 1987) introduced two concepts of reflection-in-action and reflection-on-action, as will be discussed in the next section.

Schön's (1983; 1987) work has great importance in teacher education and his work provides the research design of this study, as will be described in the methodology chapter. The two main processes of Schön's reflection in professional development are "reflection-in-action" and "reflection-on-action". Schön explained that "knowledge in-action" is important because

in a successful active teaching situation a teacher's knowledge about "strategies, understanding of phenomena, and ways of framing a task" (Schön, 1987, p. 28) are used effectively. However, that knowledge is tacit and unconscious in the mind (Schön, 1987). Therefore, the process of reflection in action is required to improve our teaching. The process helps us understand what condition drives our decision making on an action of teaching at the moment:

> We may reflect in the midst of action without interrupting it. In an *action-present*–a period of time, variable with the context, during which we can still make a difference to the situation at hand–our thinking serves to reshape what we are doing while we are doing it (Schön, 1987, p. 26, original empasis).

The immediacy of this process is different from "reflection-on-action":

> In reflection-in-action, the rethinking of some part of our knowledge-in-action leads to on-the-spot experiment and further thinking that affects what we do (Schön, 1987, p. 29).

As I will explain in the methodology chapter, this study gathered data from reflection-in-action and reflection-on-action.

2.7.2 *Importance and definitions of teachers' beliefs*

The importance of teachers' beliefs in terms of understanding teaching has been recognised and discussed in the literature. Firstly, a teacher's beliefs strongly influence his/her practices (Pajares, 1992; Fang, 1996), as was originally noted by Clark and Peterson (1986), who states: "Teacher behaviour is substantially influenced and even determined by teachers' thought processes" (p. 225). Secondly, their preparation and selection of teaching tasks and strategies depends on their beliefs. Anning (1988) pointed out that the way in which teachers structure tasks and perceive how pupils learn is governed by common sense theories relating to pupils' learning (Anning, 1988). Thirdly, although beliefs are difficult to change, if teachers have an awareness of their own beliefs this could lead to the development of their classroom practices.

In my review of the literature, teachers' beliefs have been defined differently. Pajares (1992) mentions the inconsistency of the definitions of the term "beliefs" used by researchers, because the diverse studies about beliefs in many educational areas do not use the same specific definition. He argued that "beliefs cannot be directly observed or measured but must be inferred from what people say, intend, and do" (Pajares, 1992, p. 314). Brown and Cooney (cited in Pajares, 1992, p. 313), think that "beliefs are dispositions to action and major determinants of behaviour, although the dispositions are time and context specific". Recently, Borg used the term "teacher cognition", specifically in the context of English language teachers, meaning "the

unobservable cognitive dimension of teaching – what teachers know, believe, and think."
(Borg, 2003, p. 81). There is the relationships between teacher cognition, teacher learning from
personal experiences in schools and professional education courses, and classroom practice.
The cognition of teachers is about teaching and learning, and this strongly influences their
classroom practice.

In order to study teachers' beliefs, some concerns or assumptions have to be considered. Firstly,
the terms used in the study of beliefs are varied. Secondly, the two notions of belief and
knowledge are sometimes inseparable (Pajares, 1992; Calderhead, 1996) or distinct
(Fenstermacher, 1994) due to the distinct classification of these terms (Borg, 2006). The terms
"beliefs" and "knowledge" have been used to refer to the same concept of teachers' thinking
and there is no absolute distinction. Pajares (1992, cited in Meijer *et al.*, 2001, p. 172)
acknowledged that "knowledge and beliefs are seen as inseparable, although beliefs are seen
roughly as referring to personal values, attitudes, and ideologies, and knowledge to a teacher's
more factual propositions". Thirdly, beliefs are difficult to reveal.

Borg's definition on teacher cognition is "the unobservable cognitive dimension of teaching –
what teachers know, believe, and think." (Borg, 2003, p. 81)". Thereafter I will use this term
of teacher cognition in the remainder of my thesis. As the section has provided the importance
of teachers' cognitions as linked to their tendency to influence behaviour, this study reviews
Thai teachers' understanding in relation to questioning practices.

2.7.3 *Teacher cognition and classroom practices*

Compared with a number of studies conducted on primary teaching, only a small number of
studies on teachers' cognitions and/or practices relating to teaching and learning have been
conducted in early primary education. Teachers hold cognitions about how children learn or
should be taught, which drives what they do in their classrooms. In Anning's (1988) study, six
primary teachers who taught children aged three to 11 years revealed that they were
constructivist teachers, as they organised activities for independent learning. McLachlan-Smith
and St. George (2000) conducted a small case study of twelve New Zealand early years teachers
in 2000, which indicated that teachers saw themselves as constructivist teachers because they
employed a variety of play-based activities in teaching literacy. Moreover, different groups of
teachers may hold a variety of cognitions. Moss and Penn (1996) asked teachers about
underpinning philosophies and the perceived roles and values; these teachers worked at two
different early primary education services as day nursery staffs and nursery school teachers.
They (1996) concluded that the day nursery staffs aimed to cater children's feeling safe, warm,

and healthy, whilst the nursery school teachers perceived their role in teaching three to four year old children as being to help them learn and master linguistic and numerical skills.

Some studies (Anning, 1988; Ekasingh, 1992) have concluded that teachers' cognitions and the teaching strategies used by teachers are associated. Preferred teaching strategies are employed by teachers if they think these are appropriate for teaching young children. Anning (1988) analysed data from six teachers (teaching three to 11 year old children) who were involved in English Local Education Agency (LEA) in-service courses. They found that there was a link between the individual teachers' cognitions relating to the principles of children's learning and the teaching strategies they employed. Her account of one teacher's interview showed that as "children learn through an accumulation of experience" (p. 139), "her role as a teacher was to provide an underlying structure for children's learning" (p. 139). Another study by Bernstone (1992) concluded that fifteen teachers in New Zealand working at two early childhood centres perceived themselves in accordance with the socio-cultural theory of learning. However, for developing children's thinking and problem-solving abilities, the only type of scaffolding strategy they actually employed as a mediation was direct instruction. This strategy means "transference of power through an instruction from the more expert teacher or child to the less expert child" (Ekasingh, 1992, p. 162). The literature reviewed indicates that teachers' cognitions about children's learning are connected to the particular use of teaching strategies, and so it is interesting to investigate this link as part of the current study.

Some research (Vartuli, 1999; Sahin *et al.*, 2002) has shown that, although teachers usually have a common understanding, their behaviours may differ. The consistency of teachers' cognitions and practices has an impact on effective teaching practices (Charlesworth *et al.*, 1993; Marcon, 1999). The findings of Vartuli's study (1999) indicated that early years teachers had a higher consistency between cognitions and practices than primary teachers. It appears to be difficult to draw conclusions regarding the consistency or inconsistency of their cognitions and practices. Sahin *et al.* (2002) suggested that the primary teachers in their research employed a variety of skills and did more than they said, because of the complexities of classroom life that are shaped by contextual factors (Fang, 1996).

Teachers' personal backgrounds could account for the discrepancy between cognitions and classroom practices, since teaching certificates, teaching experience, and educational background have all been identified as influencing teachers' classroom practices (Vartuli, 1999). Vartuli (1999) compared four groups of teachers in terms of self-reported cognitions, and self-reported and observed practices based on "development appropriate practices". She concluded that "Teachers with fewer years of teaching experience and those with certification

in early childhood education were more likely to believe in and use more developmentally appropriate practices" (p. 489).

From this view of teachers' cognitions and classroom practices, it is clear that teachers' understanding about teaching and learning greatly influences what teachers do in the classroom. It also shows that there appears to be a relationship between their cognitions about teaching and learning and the teaching strategies used in the classroom.

2.8 Theoretical framework of this study

The following section provides an overview of the research's theoretical framework, derived from a combination of social constructivism, socio-cultural theory, and teacher cognition, as shown in Figure 2.1. I will briefly discuss why these are viewed as useful in my study of Thai teachers' questioning practice, and how they are inter-related.
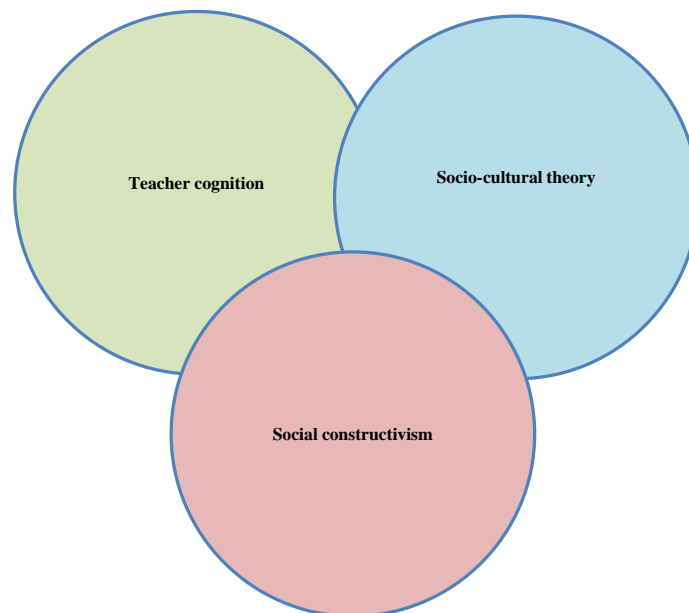
Figure 2.1: Theoretical framework of the research

Social constructivism

Unlike Piaget's cognitive constructivism, social constructivism, developed by Vygotsky, emphasises learning as being situated in social interactions, leading to the development of thinking. Vygotsky (1978) argued that the development of thinking happens in two stages from the social to the individual through the use of language. The key concept of Vygotsky's theory is the ZPD, representing a level of potential development on the part of a learner with support given by the more able. In this sense the role of the teacher and that of their peers in providing support is vital in a child's learning. Instruction should be such as to advance the actual level of a child's development if it is to be useful, so that the use of questioning by the teacher could

create such social interactions and has to relate to the ZPD. As already noted, in Vygotsky's words, "Instruction is only useful when it moves ahead of development" (Vygotsky, 1987, cited in Daniels, 2001, p.54).

Socio-cultural theory

Socio-cultural theory, which is a development theory influenced by the work of Vygotsky, has an important element relating to context that is relevant to the Thai context of this study. Unlike learning as an individual action within an environment, Vygotsky proposed that the "…mediation of human action by cultural artefacts played a central role in human development" (Cole and Wertsch, 1996, p. 250). Human social processes are mediated by tools and signs, and examples of such tools are language which is referred to as "the tool of tools" (Cole and Wertsch, 1996; Wells, 1999), together with counting systems, maps and pictures (Daniels, 2001). When a learner internalises psychological tools, these tools help promote higher mental functions such as perception, memory, and attention (Kozulin, 2003). Importantly, psychological tools are specific in each culture in terms of being useful in a particular society (Kozulin, 2003). In my study, the learner and what is being learned are mediated by a teacher, and such mediation happens through questioning by the teacher, which is both a specific type of interaction and a form of mediation. The pedagogical tools used in specific cultural contexts can therefore be seen as socio-cultural tools, and in this thesis activities which are specific to Thai culture will be identified as such and discussed accordingly.

Teacher cognition

The view of teachers and teaching in terms of teacher cognition differs from the behaviourist view in terms of which forms of effective teaching can be identified from sequences of observable behaviour (Calderhead, 1996). According to Borg (2003, p. 82), "teachers are active, thinking and decision-makers who make instructional choices" and teaching is viewed as a complex activity. Borg (2003, p. 81) defines teacher cognition as "the unobservable cognitive dimension of teaching – what teachers know, believe, and think." Teacher cognition is about teaching and learning, and this strongly influences their classroom practice. This is why teacher cognition is an important element of my study.

According to the three theories mentioned above, a combination of social constructivism and socio-cultural theory facilitates this study's investigation of questioning practice in the context of Thai culture, because teachers' questioning is viewed as a socio-cultural tool used by teachers to help children's learning. The framework of teacher cognition indicates that their

cognition about teaching and learning greatly influences the classroom practice of questioning. Therefore, it is important for this study to investigate cognition.

2.9 Identified gap in knowledge

Most of the research on teachers' questioning practice in early primary education took place in Western countries. Little is known about the situation in countries in South-East Asia, especially Thailand, where most of the research has been quantitative. Moreover, few studies have investigated question forms, functions and the strategies of teachers in Thai classrooms. These include the work of Ekasingh (1992), Dumteeb (2009) and Meng *et al.* (2012). However, the research approaches used by Ekasingh (1992) and Dumteeb (2009) were quantitative empirical studies involving the frequencies and percentages of categories of questions. It is contended that their studies would have been more useful if the authors had considered teachers' views about their intentions when asking questions. Additionally, although Meng *et al.* (2012) employed a qualitative study in their research, it involved an interview of only one participant. As a result, there is a need for research that draws conclusions from a larger number of research participants to enhance the quality of the research.

Based on the literature review, this study of Thai teachers' questioning strategies is situated in the social constructivist approach to learning. Many researchers have explored this important area and have suggested that:

1) A small proportion of 'open' questions as per my definition is asked by teachers for encouraging ideas and developing meanings and understandings (Edwards and Westgate, 1994; Galton *et al.*, 1999b; Myhill, 2006; Siraj-Blatchford and Manni, 2008)

2) Researchers (Rojas-Drummond and Mercer, 2003) have found that questions could be used creatively by asking 'why?' and 'how?', and thus extending the responses of pupils and modelling answers

3) Scaffolding strategies promote learning if they are used as "contingent control of learning" (Tharp and Gallimore, 1988; Wood, 1991)

4) Teacher cognition about teaching and learning may influence their particular use of teaching strategies (Anning, 1988; Calderhead, 1996)

5) Contextual factors such as the task have a great impact on young children's learning in terms of completing problem solving tasks (Donaldson, 1987).

These studies have focused on particular features of questioning strategies and therefore have influenced the constructs of teachers' questioning practices to be investigated in this study set in early primary education.

In addition, the theoretical framework for this study includes teacher reflections, which potentially uncover their understanding of their use of questioning in practice and the factors that influence it. Teacher reflection is an important concept and may enable improvements in teachers' practice of asking and answering questions. Although this research specifically explores Thai teachers' reflections on questioning in science in the early years, it will make a specific contribution to the knowledge of questioning in the wider world.

Furthermore, some studies (as summarized in statements 4 and 5) have shown that teachers' cognitions and social and cultural factors determine the use of particular teaching strategies. There appears to be a lack of research that includes a consideration of the contextual factors that influence questioning practice in the South-East Asia teaching context, especially Thailand.

It may be that, in relation to classroom questioning, science is the most appropriate subject from which to start, since science stimulates students' curiosity. As a result, teachers tend to use questioning to drive their science classrooms. Therefore, it is an authentic setting in which to study teachers' use of questions, as it is likely to produce rich data naturally.

In summary, it is important to address the main gap in knowledge, which is the lack of research on teachers' understanding of their classroom questioning practice, particularly in the science classroom in early years study in South-East Asia countries. For the research to be useful for teacher practitioners, researching teachers' questions should consider the question asked in the context. Based on the extensive review on the topics of teachers' questioning and teacher reflection, it appears that the situation of teachers' questioning in early primary education is still unclear, and therefore this research will add new knowledge to the field.

Chapter 3   Methodology

3.1   Introduction

This chapter outlines the research issues raised and the relevant methodologies employed in the study. The rationale behind the particular selected methods is also justified. Firstly, Section 3.2 discusses the interpretivist paradigm, which was adopted as a guideline in conducting this study. This is followed by a qualitative strategy and a case study approach in Section 3.3. Section 3.4 shows the school settings and research participants in detail. The ethical issues around gaining access, informed consent, and confidentiality will then be discussed in Section 3.5. The chapter goes on to address data collection and data analysis methods, which were chosen for gathering data and used in the analysis stage in Sections 3.6 and 3.7, respectively. Section 3.8 discusses the validity and reliability of the research. Finally, no research is without limitations, and therefore such limitations are revealed in Section 3.9.

3.2   Research paradigm

A paradigm is "a way of looking at the world. It is composed of certain philosophical assumptions that guide and direct thinking and action" (Mertens, 2010, p. 7). Following Guba and Lincoln (2005 cited in Mertens, 2010, p. 10), there is a set of beliefs that underpin the way people conduct research, which is composed of three questions:

1. Ontology refers to "What is the nature of reality?"
2. Epistemology refers to "What is the nature of knowledge and the relationship between the knower and the would-be known?"
3. Methodology refers to "How can the knower go about obtaining the desired knowledge and understanding?"

Out of all the paradigms, two opposite paradigms frequently described in social research are positivism and interpretivism (Creswell, 2009; Gray, 2009). The ontological assumption of positivism has an objective view of social reality, which is external to social actors and quite tangible on its own (Bryman, 2008). In an opposite view, social reality based on interpretivism is constructed by social actors who play an active role. Unlike the objects of positivism, which are external to the world and independent from social actors (Cohen *et al.*, 2011), interpretivism takes the standpoint of the construction of knowledge. Individuals develop subjective meanings on their own, which are varied and multiple (Creswell, 2009, p. 8).

Epistemology comprises an assumption of the nature of knowledge and how we can collect it. It is influenced by the researcher's view of reality and leads to the strategy and methods used to collect and analyse data. Therefore, knowledge from a positivist view is based on "careful

observation of a measurement of the objective reality that exists 'out there' " (Creswell, 2009, p. 7). Interpretivist researchers claim that "meanings are constructed by human beings as they engage with the world they are interpreting" (Crotty, 1998, p. 43). The meaning is constructed, not created (Crotty, 1998). Researchers who adopt an interpretivist view not only interpret meaning from human beings but also try to put them into a social scientific framework, with their own interpretations, and the relevant concepts, theories and literature of a discipline (Bryman, 2008).

According to this study's aim of exploring teachers' understanding of their questioning practices, the interpretivist paradigm was adopted to guide the thinking and action of conducting the research. My goal for the study is "to understand the multiple social construction of meaning and knowledge" (Mertens, 2010, p. 18). This is consistent with the intent of this research to understand teachers' questioning practices from the teachers' perspective, where knowledge comes from collaborative work between teachers and the researcher.

The use of questioning in the science classroom has a complex position as part of the teaching and learning process. Individual teachers may use questioning in similar or different ways in teaching science, as they judge appropriate at the time and within the context of the lesson. A question can be used for differing purposes in classrooms (Burns and Myhill, 2004; Mercer and Littleton, 2007), where a teacher teaches a group of children from different backgrounds. In this way, it is clear that an interpretivist paradigm is best suited for this research.

> The constructivist [or interpretivist] paradigm assumes a relativist ontology (there are multiple realities), a subjectivist epistemology (the knower and respondent co-create understanding), and a naturalistic (in the natural world) set of methodological procedures (Denzin and Lincoln, 2008, p. 32).

Some authors use different terms to represent this paradigm, such as an interpretative paradigm and a qualitative paradigm (Robson, 2011). Teachers' questioning practices in classrooms are considered to be complex phenomena to understand. They cannot be measured and modelled simply using a quantitative method, because there are many factors that cannot be measured quantitatively that affect teachers' decisions when asking a question (the child's current knowledge, for example). In order to achieve a level of comprehension, different teachers' own perspectives and understanding of questioning in the classroom must be investigated. Thus, this research is based on relativist ontology, where teachers participating in this research view their world of teaching from their own perspectives. The understanding of teachers' questioning practices resulting from this research will have emerged from their perspectives.

Regarding the subjectivist epistemology, the teachers' understanding of their own questioning practices is subjective. Knowledge is a co-constructed process between the teacher and researcher. Therefore, interviews using videos were employed to stimulate teachers' understanding of their own questioning practices. Moreover, data such as teachers' accounts, video recordings, and documents were used to record individual teachers' professional background and identify contextual factors in relation to questioning practices.

The methodological framework of this study is presented in Figure 3.1.
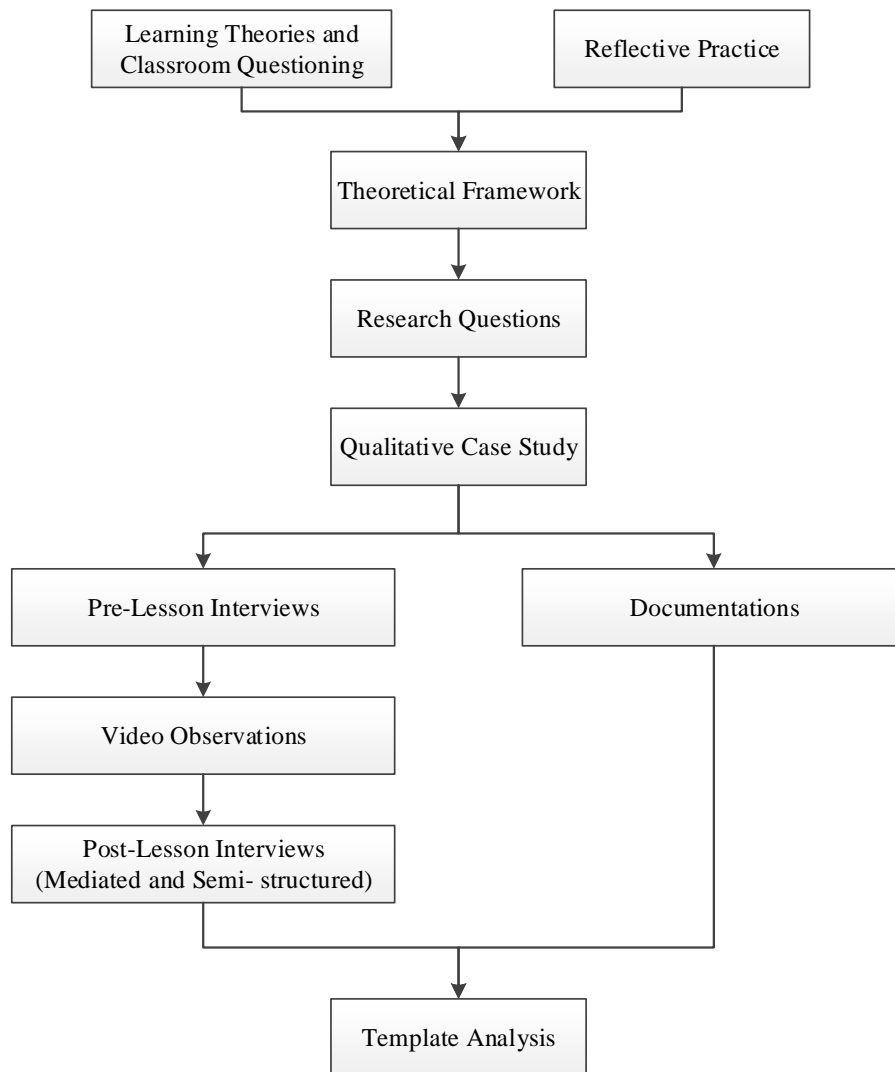
Figure 3.1: Methodological framework

3.3   Research strategy and research design

This section will discuss the rationale of using qualitative case study research in an investigation of teachers' questioning practices.

3.3.1 Qualitative research

The central purpose of this study is to understand teachers' questioning practices, which are considered to be a complex and dynamic situation. Therefore, the qualitative approach is an appropriate tool for investigating this situation. In order to study teachers' questioning practices, it is necessary to explore, investigate and examine teachers' questioning practices from the teachers' own perspectives.

> Qualitative researchers study things in their natural settings, attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them (Denzin and Lincoln, 2005 cited in Creswell, 2007, p. 36).

In addition, qualitative research has characteristics (Creswell, 2007; Denzin and Lincoln, 2008) on which the rationale of this research strategy is based. In terms of research inquiry, qualitative research is an inductive process employed to "discover and develop the new and to develop empirically grounded theories" (Flick, 2009, p. 15) rather than testing theories. Understanding teachers' questioning is about teachers' thoughts on their own questioning practices, and other contextual factors related to these. In terms of data, multiple data sources are gathered for review, by "organising them into categories or themes that cut across all the data sources" (Creswell, 2007, p. 38). The collection of data for this study was achieved using pre- and post-lesson interviews, video observations, and documents. I collected detailed information in school, which is a real life context. Finally, detailed information derived from data such as interview accounts will help give the whole picture of teachers' questioning practices. I believe that a "rich description of the social world [is] valuable" (Denzin and Lincoln, 2008, p. 16) and will enable a clearer understanding of teachers' questioning practices in science teaching.

3.3.2 Case study

A case study, as one form of qualitative approach, was utilised and chosen for this research since the purpose of the study is "to develop an understanding of a complex phenomenon [teachers' questioning practice] as experienced by participants" (Gall *et al.*, 2003, p. 438). The research interest is the phenomenon of Thai teachers' questioning practices in science teaching in state government schools.

The case study was undertaken through an investigation in natural settings, where the phenomenon of the study is complex and the context and phenomenon cannot be completely separated. Regarding the definition of case study, Gall *et al.* (2003, p. 436) explained that a case study is "the in-depth study of instances of a phenomenon in its natural context and from

the perspective of the participants involved in the phenomenon." Similarly, according to Yin (2009, p. 18), in his prominent case study book, in a section on the definition of case study:

> A case study is an empirical inquiry that
> - investigates a contemporary phenomenon in depth and within its real-life context, especially when
> - the boundaries between phenomenon and context are not clearly evident (Yin, 2009, p. 18).

Furthermore, in order to understand the phenomenon in depth, case study researchers are likely to use multi-methods of data collection (Creswell, 2007, p. 73). This research uses an embedded, single-case design (Yin, 2009) where the case is a set of seven state government schools at kindergarten level, and the individual teacher is the unit of analysis. This allowed for an analysis in the context of common state schools and of individuals as a bounded system (Merriam, 1998) to investigate teachers' questioning. They are all located in Surat Thani province, in the south of Thailand.

In relation to the characteristics of the case study, the phenomenon of interest, as mentioned above, is teachers' questioning practices in science teaching. The focus of the study is to explore teachers' questioning practices and thence to describe this phenomenon using thick descriptions. This study was conducted at schools in Thailand, by visiting teachers at schools in their workplace. Experience in being at schools is important to draw a rich picture of teachers, teaching, and especially questioning practices: an observation of school and classroom settings, an observation of teachers' questioning practices, and a conversation on these practices with teachers. It enabled me to see what was really happening in relation to their questioning practices. Furthermore, in this research, three data collection methods – video-mediated interviews, video observations, and documents – were employed to explore these questioning practices.

Regarding the research design, three types of case study were considered to identify the study outcomes. Yin (2009) explained that there are three different types of case study: explanatory, descriptive, and exploratory. The focus of this study is to explore the use of teachers' questions and describe teachers' understanding of their own questioning practices. It was justified as being a descriptive case study. Indeed, a major focus of this investigation is to draw a vivid picture of Thai teachers' understanding in relation to questioning practices. Therefore, the type of case study employed is a descriptive one.

The steps of this research procedures can be seen in Figure 3.2.

Year 1: Research design	Year 2: Data collection	Year 3 and Year 4: Data analysis and writing-up thesis
• Do a literature review - focus on teacher questioning and learning theories • Writing-up my research proposal • Nov-Jan 2012: observe early year teaching at a school in UK • Apply an ethical approval	• Mar-May 2013 in Newcastle • recruit teacher participants via phones or email • May-Sep 2013 in Thailand • Introduce myself and my research with school principals and participants • Visit each teacher 3 days: pre-lesson interview, video observation and post-lesson interview using videos	• Do an analysis of interview data using Template Analysis • June 2014 • Present an initial finding at the ECLS conference, Newcastle University • Do an analysis of video data • Writing-up thesis chapters

Figure 3.2: Steps in research procedures

3.4   State government schools and research participants

It was decided to conduct the study in Surat Thani, which is an area of my hometown. This city is the biggest city in the north of southern Thailand, with a population of 1,031,812 (National Statistical Office, 2014). State government schools provide free basic education for all Thais. In Surat Thani province, there are more than a hundred schools, all authorised under the Office of the Basic Education Commission (OBEC), Ministry of Education, Thailand. Therefore, the state government schools became the focus of this study. Following the need to gather rich data for this study, seven state government schools in Surat Thani were selected, based on early childhood centres or co-centres, the co-operation of school principals, and the researcher's safety in accessing the school. The information on these schools, and teachers' contact numbers, were provided and advised by the educational supervisor working at OBEC in Surat Thani.

From the centre-based management of the OBEC, the seven schools within sector one of Surat Thani province were located around three districts (Amphurs): five schools located in Mueang Surat Thani district, one school in Kanchanadit district, and one school in Don Sak district, as shown in Table 3.1. School 1 was in the city centre and the other six schools were in semi-urban areas. Four of the schools (Schools 3, 5, 6 and 7) are medium-sized, catering for fewer than 600 students, while the others are classified as large-size schools. In terms of levels of education, Schools 1, 3 and 4 provide an education from early years to primary education (Prathomsukka 6: Year 6), and the others operate up to lower secondary education

(Matayomsukka 3: Year 9), which is the end of compulsory education in Thailand. It should be noted that early childhood education is not compulsory, but at present most children enter school at this level (as described Thai early primary education in Section 1.3.2).

Table 3.1: Schools settings in the study

Name	Location	Age range of students	Education level	Number of students on roll	Number of teachers	Number of classes
School 1	Meang	4 - 12	Anuban – Primary education (P. 6)	1,315	56	38
School 2	Meang	4 - 15	Anuban – Lower secondary education (M. 3)	621	31	21
School 3	Kanchanadit	4 - 12	Anuban – Primary education (P. 6)	528	26	22
School 4	Meang	4 - 15	Anuban – Lower secondary education (M. 3)	642	36	22
School 5	Meang	4 - 15	Anuban – Lower secondary education (M. 3)	285	22	12
School 6	Meang	4 - 15	Anuban – Lower secondary education (M. 3)	522	36	19
School 7	Don Sak	4 - 12	Anuban – Primary education (P. 6)	590	24	19

The schools have their own school directors and are authorised as part of the OBEC. They are called public servants (Karatchakarn). These schools have centre-based management, which means that most of them know each other and have been involved in training during the year. The schools provide five days' teaching from Monday to Friday, from 8:30 am to 3:00 pm, but at 8 am every morning children sing a national anthem to show respect to our nation and king. The kindergarten level offers education and care for children aged four to five years old on two levels: kindergarten one (4-5 years) and two (5-6 years). Early years teaching, including both kindergarten levels, has six learning activities according to the content guidelines in the curriculum, operating throughout the day as suitable: free activities, creative activities, movement and rhythm activities, experience enhancing activities, outdoor activities, and educational games. Science is taught in the experience enhancing activities. A variety of topics may be taught during the yearly teaching calendar, such as myself, eating habits, eggs, and

animals. More information about the teachers, the children and the activities will be presented in Section 4.2.

Table 3.2: Participants in the study

Teacher	Age (years)	Gender	School	Type of school	Education background	Teaching experience (years)	Teaching experience at kindergarten level (years)
1	28	Female	School 1	State	Master's degree (ECE)	4	4
2	29	Female	School 1	State	Bachelor's degree (ECE)	7	7
3	54	Female	School 2	State	Bachelor's degree (Home Economics)	33	20
4	32	Female	School 3	State	Bachelor's degree (ECE)	6	6
5	40	Female	School 3	State	Bachelor's degree (ECE)	15	15
6	40	Female	School 3	State	Bachelor's degree (ECE)	18	16
7	36	Female	School 3	State	Bachelor's degree (ECE)	13	10
8	53	Female	School 4	State	Bachelor's degree (Library)	29	3
9	52	Female	School 4	State	Bachelor's degree (Psychology of Guidance)	25	2
10	54	Female	School 5	State	Bachelor's degree (Primary Education)	30	20
11	45	Female	School 6	State	Bachelor's degree (ECE)	25	13
12	28	Female	School 6	State	Bachelor's degree (ECE)	3	3
13	55	Female	School 6	State	Bachelor's degree (Agriculture)	33	8
14	53	Female	School 7	State	Master's degree (Primary Education)	30	25
15	30	Female	School 7	State	Bachelor's degree (ECE)	6	6

The research participants in this study were fifteen teachers, as shown in Table 3.2. The rationale for selecting the participants was the use of purposive sampling to "sample cases/participants in a strategic way" (Bryman, 2008, p. 415). I stopped recruiting participants once fifteen teachers were achieved. They were chosen based on four criteria:

1) Willingness to participate in this study
2) Full-time teachers
3) Teachers of children aged about 4-5 years
4) Permission from the school principal for me to conduct this study.

In addition, teachers' ages ranged from 28 to 55 years. Their teaching experience at kindergarten level varied from the least experienced (two years) to the most experienced (twenty-five years). In terms of their educational background, two teachers had graduated with masters degrees, one in Early Childhood Education and another in Primary Teaching, whilst the other teachers had typically gained bachelor degrees in Early Childhood Education. The teachers need to have a qualification that is at least at bachelor level and relevant to education.

The children and their families were mostly from low-socio economic backgrounds. The parents' jobs involve labouring to earn money. The occupations in each local area are different because of the geographical backgrounds. For example, School 3 is located near the sea and nipa palms grow in the surrounding area. Therefore, most of the children's parents are fishermen, and some of their houses are built near the beach. In contrast, School 1 is located in the city and rubber trees grow in the surrounding area. The parents' occupations here involve working on hide. These families are low-income, based on the documents collected. In terms of the parents' education, they usually have a study level of around primary education (Pratomsuksa 6). About half of the families are single-parent families.

3.5 Ethical issues

This research was conducted in Thailand, which is outside the UK. The ethical approval for conducting research and studying outside the UK was given by Newcastle University, UK. There are some issues relating to research ethics in conducting the research. All research participants gave informed consent and school principals gave permission for gathering data in schools.

3.5.1 Gaining access

Access to schools and teachers was gained through school principals, at the beginning of the data collection phase. Meetings with school principals were held to give an introduction to the

research project and my position as a PhD student. The details of the research project, which aimed to explore Thai teachers' understanding of questioning as a pedagogical tool in teaching early years science, were discussed. The official letter (see Appendix A) requesting permission for conducting research was signed by the research supervisors and myself, and was sent to the school directors by hand. With the permission of the school principals, a short meeting with school teachers followed to arrange the time schedule. It should be noted that recruitment of research participants had already been performed beforehand. The relationship with teachers had been established since the first contact was made with teachers by phone and/or email whilst planning the research project in the UK.

3.5.2 *Informed consent*

Informed consent can be defined as "the procedures in which individuals choose whether to participate in an investigation after being informed of facts that would be likely to influence their decisions" (Diener and Crandall, 1978 cited in Cohen *et al.*, 2011, p. 78). To guarantee the participants' rights in participating in this research, some procedures had to be operated as follows. Firstly, information about the research project was clearly given in detail. It was emphasised that the research purpose was to understand and not evaluate their questioning practices. Some time was afforded for asking questions and then further time was provided for them to make the decision whether to participate. Secondly, to obtain informed consent, confirmed participants were given additional information about participants' involvement and their rights, such as the right to withdraw from the project at any time. After that, a consent form written in Thai was read, agreed, and signed by both research participants and researchers. Copies of the documents – the Participant Information Sheet (see Appendix B) and consent form (see Appendix C) – were given to teachers. The written documents were given to the teachers to assure both confidentiality and that ethical practices were followed in the implementation of the project.

In addition, parents or carers were given information about my visit at the schools and about the video recording of their children. While children are involved in this research as participants in the questioning and in the lessons, they are not the direct focus of the research. Nevertheless, the Parent and Carer Information Sheet (see Appendix D) was sent to parents and carers. It was noted on the form that children would have the right to withdraw from the research and be placed in another classroom whilst the video recording was taking place.

3.5.3 Anonymity and confidentiality

Video data and interview data and were recorded in the form of electronic files, so that they had to be organised cautiously to ensure privacy. The video and audio files were stored in my personal computer, protected with password login, and on the H drive of the university. Regarding these files, only the teacher and I had permission to access them. After the completion of this research, all data will be permanently deleted.

All data and information collected were managed confidentially, and used exclusively for educational purposes in this research, and only with the permission of the participant. The name of the school was not disclosed and each participant remained anonymous. Serial numbers, abbreviations and pseudonyms was used for data analysis and for publications such as conference presentations and other papers, as well as for this thesis.

3.6 Data collection

To collect evidence of Thai teachers' understanding of their questioning practices, three main instruments were employed: namely, visually-mediated interviews, non-participant observations, and documents (more details shown in Table 3.3). Their rationales are discussed in Sections 3.6.1, 3.6.2, and 3.6.3, respectively, and the procedure of data collection is explained in Section 3.6.4.

3.6.1 Visually mediated interviews

Visually mediated interviews are a creative way to enhance a traditional interview. The focus of this is to aid participation, resulting in rich and in-depth information based on discussion. Using visual items in the interview is associated with visual methods, which were originally developed in disciplines associated with the social sciences (Prosser, 1998; Banks, 2001). In the twenties, a large number of research studies in education were conducted using a variety of visual items or activities to mediate interviews. This research employed the visual method to enhance traditional interviews.

Visual items are very powerful in inclusive participations and in empowering participants in research. This is because, during the interviews, both participants and researchers look at the same visual items being discussed; in this project, the items were videos of the questioning practices. Woolner *et al.* (2009) reviewed the methodological assumptions and implications of visually-mediated methods of interviewing and how these can enhance the traditional interview. Two distinct advantages of visually mediated interviews are: 1) visual items "have the potential to empower participants and allow them to drive the encounter, but also facilitate

understanding between researcher and participant" (p. 3); 2) in some situations, "information produced by such methods is different" (p. 3).

Visual items play a role in 'the immediacy' (Woolner *et al.*, 2009) between participants and researchers. In education settings, based on the Research Centre for Learning and Teaching at Newcastle University, a variety of visual-mediated activities including diamond ranking, photo elicitation, and the 'toolbox' approach are developed creatively (Clark *et al.*, 2013). The researchers (Woolner *et al.*, 2009, p. 5) stated that using these activities "the visual provided an immediate way into discussions about their experiences". In the case of photo elicitation activity, Harper (2002, p. 20) notes that the photos could help in "bridging the gap between the worlds of the researcher and the researched" because the photos help both the participant and the researcher understand, at least in part. In this research, videos of the teachers' questioning practices were used to mediate an interview in a similar way to other visual items, which had the purpose of 'participative modalities' (Hadfield and Haw, 2012). At the end, information collected may contain different information from a traditional interview. Thereafter I will use this term of video-mediated interviews in the remainder of my thesis.

Interviews with pre-school teachers provided an opportunity for them to give an account of their purposes in asking a question, questioning strategies, and two others features of wait time and selection of respondents. Interviews are a very useful tool for research because of the "rich, and detailed answers" (Bryman, 2008, p. 437) which are given as a result. The interview process is flexible. Although an interview guide, in the form of a set of questions, can be prepared, to some extent the interviewee is encouraged to talk and lead the interview. For example, the sequence of questions can be adapted to suit each interviewee. Following the issues that are important to the interviewee leads to the interviewee's view of their questioning practice. In contrast, there are some disadvantages of interviews. "The transcription of interviews, and the analysis of transcripts are all very time-consuming" (Bryman, 2008, p. 436). The success of doing interviews mostly depends on the interviewer's skills and their experience in interviewing.

Themes for the interview guide (see Appendix E) were designed to scope this research based on the research questions and the literature review. In order to ascertain the context of their lesson, the pre-lesson interview theme was the teaching of science in early primary education, particularly in the lesson. In order to ascertain teachers' understanding of their questioning practice, the interview guide for post-lesson interview covered the following themes:

1)   Purposes in asking questions

2) Questioning strategies

3) Additional features related to questioning: wait time, and selection of respondents.

3.6.2 *Non-participant observations*

Non-participant observation was employed in this study to explore how teachers use different types of questions over time in a science classroom. I was in the natural setting – the school – from which a direct experience could be gained. In observation, "the research can look directly at what is taking place *in situ* rather than relying on second-hand accounts" (Cohen *et al.*, 2011, p. 456). Observation data is objective. Although the presence of the researcher may be intrusive (Cohen *et al.*, 2011, p. 456), establishing relationships with teachers may overcome this problem.

In this research, non-participant observation was adopted in this research with the intent to was to collect video recordings which were used as part of video-mediated interviews and as data for this study. Participant observation means being embraced by a situation, "to gain access to insiders' behaviours and activities" (Cohen *et al.*, 2011, p. 465). In contrast, the distinct feature of non-participant observation is not getting involved in activities which may impact upon the behaviour of the research subjects. Accordingly, sitting at the back of the room (and video recording) would avoid interruptions as much as possible.

3.6.3 *Documentary data*

Document versions of lesson plans were collected, alongside assessments (if available), teachers' handbooks, Thai early childhood curriculum, early childhood school curriculums relevant to science teaching, and an observed lesson. Documentary data better enabled me to understand the context of the observed lesson, such as the lesson objectives and the preparation of any questions.

3.6.4 *Data collection procedures*

The main stages of data collection for this study are illustrated in Figure 3.3 and the data collected are detailed in Table 3.3. The main research activities in a rough chronological order will be described as follows.
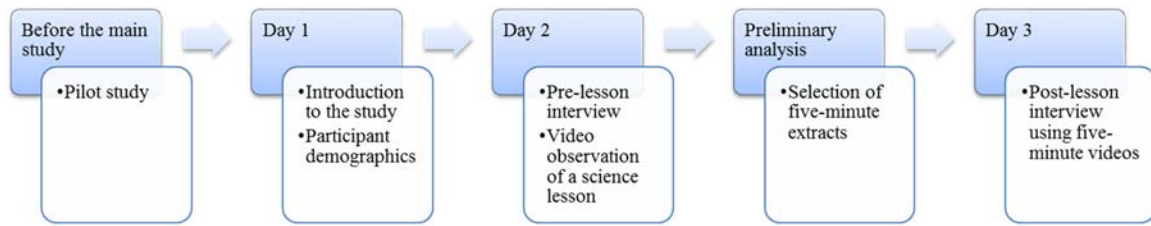
Figure 3.3: Data collection procedures

Table 3.3: Overview of data collected

Data collection methods	Data collected	Description
Pre-lesson interviews	-About 3 hours of audio recordings - Participant demographics	15 interviews
Video observations	- About 7 hours of video-recorded lessons	15 science lessons observed
Post-lesson interviews	- About 34 hours of audio recording	15 interviews using videos
Documents	- School profiles - Early childhood school curriculums - Teachers' handbooks - Lesson plans - Lesson assessment (if available)	

The data collection in Thailand took place between May and September 2013. During the process of data collection, I visited each teacher for three days, building the relationship in order to make the research more natural. Creswell (2009) suggested that "The more experience that a researcher has with participants in their actual setting, the more accurate or valid will be the findings" (p. 192).

A pilot study

A pilot study with one Thai teacher was conducted to test the research instruments and reorganise the data collection schedule. This happened before the main data collections of this study. The permission from the school principle and informed consent was obtained before the pilot study. After piloting, the three-day plan for data collection as designed seemed to be suitable to obtain data relating to teachers' questioning. Some interview questions were modified to make them more easily understood.

Introduction to the study

I visited each teacher for about half a day to introduce the study to them, observe their daily activities, and take notes. This helped me to become familiar with the teacher and children and how teaching and learning took place within experience enhancing activities. During the day when a teacher had time, we started talking about my study. The research project was explained to the teacher in detail. The aim of the study was emphasised, specifically that the research intended to explore the teacher's questioning practices rather than evaluate them. Topics such as the aim and the benefit of the research, as well as participants' involvement and their rights, were discussed. Any questions needed to clarify the research were taken. This was to help avoid stress and to make the next video observation as natural as possible.

Two documents were provided to the teacher to give them information about the study. These were the Participant Information Sheet (see Appendix B), and informed consent (see Appendix C) as explained previously in Section 3.5.2. Informed consent forms were given to teachers during the day. Information about my visit was passed to parents. In terms of teachers' professional background such as their educational backgrounds and teaching experience, each teacher was given and completed the form, Demographic Information of the Participants (see Appendix F).

Pre-lesson interview

Interviews were structured in two stages: a pre-lesson interview and a post-lesson interview. In this research, the purpose of the pre-lesson interview was to collect information about the upcoming lesson. The lesson plan was discussed in terms of topics and objectives, approaches, and teaching materials. This information enabled me to understand the context of the lesson. In the post-lesson interviews, the vast majority of my data were gathered. The post-lesson interviews were thus much more important for my study than the pre-lesson ones.

Video observations

The main purpose for observing these lessons was to collect video recordings as data for this study. Video data were used as part of video-mediated interviews and as data in the additional analysis by me of Research Question 2. Before I started to observe the lesson, a pre-lesson interview was conducted for the purpose of lesson context.

I observed a science lesson, with a focus on their use of questioning in teaching and learning situations. One observed lesson lasted about 30 minutes on average. This classroom

observation employed the principles of non-participant observation mentioned in Section 3.6.2. During observation, I was then not involved in teaching. I sat at the back of the room, filmed the lesson and took field notes. The observed lesson was recorded, with the camera panned in the direction of the teacher. The field notes about teaching lessons covered: the date and time, the topic and material used, the classroom organization, and the five features of the questioning practices.

Selection of five-minute extracts

I carried out a preliminary analysis of the video data and selected a five-minute extract from each lesson to be used in the post-lesson interview. These extracts were used in video-mediated interviews to gather information with regard to the teachers' questioning practices. The video extract was selected by myself, and I combined two short extracts from each lesson so that the video extract lasted approximately five minutes. The two extracts were from either the beginning, the middle, or the end of the lesson. The criteria for selecting the two video extracts were based on the appearance of rich data in the questioning in which there were signs of interaction between the teacher and the children. At this stage, the videos were watched several times to make sure they were a good selection.

Post-lesson interview

After observing teaching, the post-lesson interview was aimed at giving the teacher an opportunity for a detailed description of teachers' questioning in teaching and learning science. The focus of the interview was centred on the purposes in asking questions, the questioning strategies and two additional features of wait time and respondent selection. The teachers' questions were found to vary according to the context of the learning of the child and the teachers' pedagogical goals. Additional information on their thoughts and feelings about the interview were collected during the post-lesson interview.

In order to gather in-depth data relevant to classroom practices, the visually mediated-interview method was used. Teachers were invited to identify specific questions they had asked and then explain why they had used these questions. During this interview, a five-minute extract of the observed lesson was used to mediate the interview between the teacher and myself. By watching the video extracts, the teachers' questioning practices were made explicit to them. Teachers selected a number of questions to focus on. As a result, the number of questions identified by teachers varied, with a mode of three questions. In fact, a higher number of questions were discussed with Teachers 10 to 15 (see Table 4.2) because I maximized the

effectiveness of the interview process as an interviewer. Probes and prompts were used to elaborate on an initial response and clarify information relating to the interview question asked (King and Horrocks, 2010). An example of probes was "Why did you ask that question?", and prompts included: "Can you tell me more about other questions you asked?" More detailed of this study's interview guide is shown in Appendix E.

3.7   Data analysis

After all data gathered this section will present an analysis of the approaches employed. Template Analysis is a method of analysis of post-lesson interview data. Video analysis was employed with video recordings. Before discussing the methods in Sections 3.7.2 and 3.7.3, the relevant data sources to research questions will first be explained in Section 3.7.1.

3.7.1   *Answering research questions*

In order to answer the three sub-research questions asked in this study, the two main sources of data were post-lesson interviews and video recordings. The other data such as pre-lesson interviews, field notes, and documents were not included because these data were collected for the contextual information. The aim of this study is to explore early primary teachers' questions and understand their questioning practices in the context of science teaching in Thailand. This study attempts to answer one main research question:

How do Thai teachers perceive their questioning practice in science lessons?

The three sub-research questions (RQ) are as follows:

1. What purpose do Thai teachers report to have in asking questions?
2. How do these understandings relate to open and closed questions?
3. What strategies do Thai teachers identify for structuring questions?

According to Research Questions 1 and 3, the post-lesson interview data were analysed using Template Analysis to identify major themes and/or recurring patterns of questioning practices. The first research question looked at purposes in asking questions and then the questioning strategies were investigated in the latter. Other factors may also influence this, such as teaching experiences. An additional analysis of video recordings happened after Thematic Analysis of the post-lesson interview data with teachers about their questioning practice. This analysis using descriptive statistics of video data was related to Research Question 2. This analysis is related to Research Question 1 because I further examined the question types and the nature of children's responses.

This process of data analysis started at the beginning of the data collection stage. This was partly because this research used video-mediated interviews involving a procedure of identifying five-minute extracts of video recordings that were later used to mediate interviews with teachers.

Further systematic data analysis happened after the completion of data collection. Data derived from different methods were used to clarify different research issues. In connection to Research Question 1, the purposes of asking questions were analysed inductively from post-lesson interviews in conjunction with video recordings. The dataset of teachers' questions which were identified by the teacher during the post-lesson interviews was recorded in full sentences. Moreover, this research was exploratory in nature and so the 74 questions selected by teachers for discussion led to the focus of the data analysis and research findings, since I was searching for information that was relevant to the research topic. One example of the 74 specific questions was "What is a tree's colour?" (T4, E1), in a lesson dealing with a tree's components. Then, these questions were categorised based on the data and on the existing literature.

In order to answer Research Question 3, which involved understanding the questioning strategies of the teachers and the teachers' reasons, the data derived from post-lesson interviews were mainly used. The video recordings gave detailed information of the context of the questioning strategy. This illustrated the teacher's questioning strategy, showed details of the children, and attempted to analyse what had happened in the lesson.

Data from post-lesson interviews were analysed to identify cognitive and cultural factors which may influence their questioning practice. In the pre-lesson interviews, contextual factors such as types of activities, and teaching topics were explained.

The three research questions were addressed with data collected from multiple methods, as shown in Table 3.4.

Table 3.4: Data collection methods

Data collection methods	Research Questions			
	Main Research Question	RQ1	RQ2	RQ3
Pre-lesson interviews	√			
Video observations	√	√	√	√
Post-lesson interviews	√	√		√
Documentary data	√			

Transcribing and translating the data

Transcription is defined as "the process of converting recorded material into text" (King and Horrocks, 2010, p. 142); accordingly, the interview data from both pre- and post-lesson interviews, in the form of audio-recordings, were transcribed into the Thai language. As the participants' first-language was Thai, the transcription was transcribed "word for word (verbatim)" (King and Horrocks, 2010, p. 143). This meant that the whole segment of transcription was typed as they spoke in Microsoft Word. Although this process is a very time and effort consuming one (King and Horrocks, 2010), it helped me to become familiar with the data. Transcribing sounds into words allowed me to focus on the meaning of the respondents' experience in relation to the research questions. During transcription, I also took notes and highlighted interesting keywords, which helped the formation of ideas for data interpretation. To ensure the validity of my transcriptions, they were double-checked by the participants.

Translating the data from Thai to English was very complex. Esposito (2001, p. 570) notes that translation is "the transfer of meaning from a source language… to a target language" (such as English). I tried to keep the meaning of the quotations as close as possible to the Thai original. Data translation was only done when quotations were needed for purposes of illustration within the thesis. The quotations of the two languages were given and were discussed with a native English speaker for feedback and revision purposes.

3.7.2 *Template analysis*

Interview transcripts contained rich data associated with the respondent teachers' understanding of purposes in asking questions (Research Question 1), of the use of questioning strategies (Research Question 3) in teaching science and of the use of wait time and selection of respondents. Template Analysis was adopted in this study to draw this picture. The rationale for template analysis and its process will be described in this section.

Template analysis was thought to be suitable for this research based on the epistemology used and its flexibility in terms of thematic analysis, as explained in the next paragraph. Template analysis is an analytical technique of textual data which mainly involves transcribed interview data. Template analysis is a technique for producing an understanding of the teachers' accounts which contain "extensive and complex textual data" (King, 2012, p. 426). In this research, this consisted of template analysis of textual data involving mainly interview transcripts derived from video-mediated interviews. Each interview transcript contained more than 10,000 words of rich and detailed information about teachers' understanding of their questioning practice.

The central aspect of template analysis is to produce a template that is "a great help in producing a clear, organized, final account of a study [teachers' understanding in questioning practice]" (King, 2004, p. 268). Template analysis is "a style of thematic analysis that balances a relatively high degree of structure in the process of analysing textual data with the flexibility to adapt to the needs of a particular study" (King, 2012, p. 426). Therefore, it was decided to use template analysis in this research to analyse data from this primary fieldwork, which is considered rich and in-depth as mentioned above. This, in turn, led to the gaining of insight into classroom questioning practice, based on teachers' understanding.

A distinct feature of the template approach compared with other thematic approaches such as generic thematic analysis and grounded theory is "the development of a coding template" (King, 2012). There are three main stages of template analysis: initial template creation, template development, and final template, as illustrated in Figure 3.4.

Firstly, an initial template is normally developed from a subset of the data, and then the template is applied to the rest of the transcripts (King, 2012). There are three ways to develop the initial template:

- Have pre-defined codes/a priori codes based on the theoretical position of the research
- Develop codes after some initial exploration of the data
- Take a half-way position – some initial codes (possibly from the interview questions?) and refinement after exploration of the data. (Waring and Wainwright, 2008, p. 86)

According to the research aims, this research sought to understand classroom questioning practice based on teachers' perspectives utilising the theoretical framework, as proposed in Section 2.8. Consequently, this research was centred on the half-way position. Based on this, the priori codes are used to create the initial template (King, 2012). In this study, the priori codes were the main issues when the interview guide was constructed as the main instrument of data collection, discussed in Section 3.6.1 (see Appendix E for the interview guide). Then, starting with the primary codes, an inductive approach was taken, in which an initial template was built from a subset of interview questions. The development of the template consisted of a coding structure of themes that emerged from the teachers' accounts of questioning in practice.

An initial template was developed from an exploration of seven out of fifteen transcripts by identifying codes and coding. Based on the research questions and the post-lesson interview questions, codes were constructed from reading all seven transcripts several times. At this stage, the interviews were read line by line, and ideas were highlighted and written on the right-

hand side of the interview transcripts. The recurring codes and patterns emerged to become a theme. After coding the subset of transcripts, it became an initial template (for the derived initial template of this study see Appendix G).

Secondly, regarding the development of the template, coding is a way to identify codes in relation to themes from textual data. Gibbs (2007, p. 38) defines coding as "a way of indexing or categorizing the text in order to establish a framework of thematic ideas about it". The aim was to identify codes in sections emerging from the interview questions from a few words to whole paragraphs. One section, for example, was the teachers' purposes for asking a question, so that a section of text in the interviews was interpreted as an instance of code, such as "checking prior knowledge". This code was named based on keywords from the teachers' accounts, in this case, key verbs with similar meanings. In addition, there are two main ways of coding: data driven and concept driven. The analytical process of coding to develop themes can start from data and also from existing theory or practice. The initial codes from a subset of the interviews in this study were derived inductively "to pull out from the data what is happening and not impose an interpretation based on pre-existing theory" (Gibbs, 2007, p. 46).

Finally, in the final template creation, the main analytical activity consists of a modification of the template to form the final template. The development of a template as part of the analytical process is "an interactive process of applying, modifying and re-applying the initial template" (King, 2012, p. 430), during which time the template is modified to best answer the research questions. After the initial template was created, it was then applied to the rest of interview transcripts. Through this the modification of the template involved the activities of adding a new code, deleting an existing code, and changing the scope and the level of classification (King, 2004). Then the initial template was applied to the rest of the transcripts theme by theme, leading to the semi-final template. After that, each section in relation to the identified themes was re-read and recoded if necessary, to develop a clear presentation of the themes and codes. King (2004, p. 263) noted that it is difficult to say when to stop the development of the template, but at least all transcribed data in relation to the research questions should be coded. The analytical process for Thai teachers is summarized diagrammatically in Figure 3.4, and the final template resulting from this study is shown in Appendix H.
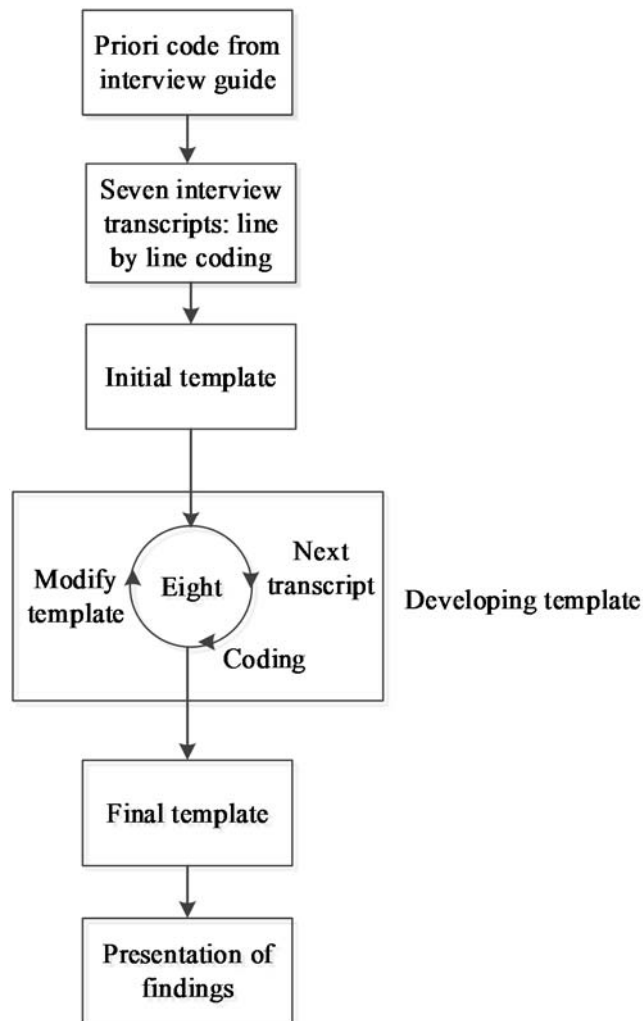
Figure 3.4: Diagrammatic representation of data analysis process using template analysis adapted from King (2012)

Nvivo was used for the purposes of data management. The main reason for using Nvivo is because the program can help "to work efficiently with complex schemes and large amounts of text" (King, 2004, p. 266). According to Gibbs (2013, p. 285),

> …thinking about the codes, writing about them (for example, writing memos about them) and manipulating them is a central part of the analytic process they go through in order to extract a coherent and novel understanding from their data. The software includes a variety of tools for the manipulation of codes that supports this kind of thinking.

Additionally, the program features for coding and retrieval allowed me to modify codes easily without losing a context. The program offers an easy way to index chunks of text to particular themes, and to retrieve all similar coded text with all the information in terms of the source of the text (Gibbs, 2007, p. 106).

After exploring individual themes on teachers' purposes in asking questions, questioning strategies, and two additional features of wait time and selection of respondents, the process of thematic analysis allowed me to find patterns or relationships between themes, and to seek themes for factors influencing teachers' understanding on their questioning practice. Moreover, the question themes derived from the mediated-interview data were analysed to link with factors derived from the interviews and documents. Consequently, they were part of a theoretical model of understanding of questioning' practices, which is the main aim of this research. It was an analytical process, and did not merely describe themes on a list. Rather, the presentation of themes were used to classify levels of Thai teachers' understanding of questioning.

3.7.3 *Video analysis*

The purpose of analysing the video data was to examine the relationship between teachers' reasons for asking questions and the types of questions used for each purpose (Research Question 2). The focus was to investigate the proportions of open and closed questions employed by Thai teachers in relation to each purpose.

In this analysis, the video data used the same dataset of 74 questions the teachers themselves had selected within the five-minute questioning extracts used in the mediated interview. As discussed in Section 2.4.2 of the Literature Review, whether a question was open or closed was based on definitions.

> Closed questions which have pre-determined answers elicit factual information. In contrast, open questions are used to stimulate children's thinking and have more than one possible answer.

In this current study, I categorised the questions based on the teacher's apparent intention, which is an approach taken by many researchers (Edwards and Westgate, 1994; Myhill and Dunkin, 2005). In this study, the development of these categories was based on the questions phrased by the teachers themselves, which did not consider the feedback to the answer. In the lesson about vinegar, one of Teacher 2's questions was: "Why does it [the egg] become white?" which was classified as an open question, as the question, potentially, had more than one possible answer of what may cause the egg's shell to dissolve (See a list of all question in Appendix I). Using description statistics (Cohen *et al.*, 2011) the percentage of use of open and closed questions (for example, checking prior knowledge) was calculated and tabulated for group comparison.

Another part of the video analysis of the nature of children's responses investigated the length of children' responses and the cognitive levels of answering. This analysis looked at the video data of the 74 questions and a Microsoft Excel used in data recording and processing. Answers from the children were written down in Thai to all the questions based on video data. In terms of children's answers, the length of the answers was counted and the calculation of word length was carried out using descriptive statistics (Cohen *et al.*, 2011). By an interpretation of children's answers the cognitive levels to the 74 questions were identified.

3.8 Trustworthiness of the research

The management of quality in qualitative research is concerned with trustworthiness. Trustworthiness refers to the validity and reliability of data and of interpretation between researcher and the researched. As this research is based on a constructivist paradigm, trustworthiness has the criteria of credibility, dependability, transferability and confirmability (Lincoln and Guba, 1985). Rolfe (2006) extends the concept of trustworthiness, which has the following forms and concepts:

> Trustworthiness has been further divided into credibility, which corresponds roughly with the positivist concept of internal validity; dependability, which relates more to reliability; transferability, which is a form of external validity; and confirmability, which is largely an issue of presentation (Rolfe, 2006, p. 305).

There are measures that help in meeting these criteria.

To ensure credibility, member-checking and peer debriefing were employed in the research process. In terms of member-checking (Bryman, 2008; Creswell, 2009), a transcript of interviews in Thai was made: pre- and post-lesson interviews were sent to teachers to recheck and validate the data collections. Another measure of peer debriefing (Creswell, 2009) was employed. Discussions with my supervisors about raw data, analysis procedures and findings of data analysis were part of the data validation. For example, during the course of the Template Analysis, the development of the codes of the initial template was exported to a table of themes: themes, codes, theme descriptions, and quotations from interviews and their translations from Thai to English. The findings with regard to the themes were discussed with my supervisory team and feedback was provided to validate the coding process.

Dependability referred to the reliability or consistency of the research approach (Gibbs, 2007). According to Yin (2009), it is important for researchers to document the research procedures of the case studies and include the steps in the research procedures in assessable ways. A case study record was employed to present my line of thought on the research procedures for peer

review. A detailed account of the data collection and analysis of this study's research findings is provided in the methodology chapter. For example, the interview transcripts and initial and final templates of this research were kept on record so that anyone can review and evaluate the findings of this research. As part of the presentation of research findings, research evidence in terms of quotations of teachers' accounts and extracts of video records were used to support research findings. This allows readers to evaluate my interpretations and the research findings of this current study.

3.9   Limitations of the study

No research is without limitations. Thus, this section is devoted to revealing some of this research's limitations. Firstly, according to the rationale and the justification of the video-mediated interviews used in this study, I selected the five-minute videos. Following the method used, the selection of some parts of videos was unavoidable, although my selective samples of the five-minute minute videos are likely to have included some bias. A field note revealed some criteria, in that I selected the five-minute videos of each lesson carefully by combining two stages of the teaching lesson, as I watched the videos of each teacher's questioning practice several times and there were instances of interaction with the children through questioning. During the interviews, no teachers complained about my selections of video episodes, which may suggest that the criteria used were acceptable to the teachers but perhaps not fully representative. Systematic sampling of a similar stage of teaching could result in a higher quality of data if it was available, but this research design was exploratory, which influenced the broader account of teachers' questioning.

Secondly, because of the research aim and the video-mediated interviews, the questions which were investigated were only those which had been selected for discussion by the teachers. Thus, the bias based on this activity is inevitable. In order to clarify the dataset of this study's findings, details of this process can be seen in Section 3.6.4 and all questions are presented in Appendix I.

Thirdly, among the fifteen teachers, it was found that the first eight teachers identified a lower number of questions (as presented in Table 4.2). This could be because of each teacher's personality, my greater understanding of teachers' questioning, and my effectiveness at doing interviews. If a higher number of teachers' questions and teachers' reflections were more extensive, a more detailed account of their practice would be received.

Fourthly, due to the data collection method used in this primary research, question purposes and questioning strategies were derived by the teachers' perspective. As a consequence, there

may be a gap between what actually do and what they said they do. Therefore, this is considered one of the limitations of this research. However, as this research utilised the video-mediated interview, it would contend that with the stimulation by the video of their questioning practice it may be possible to reduce the gap to some extent.

Fifthly, this research was conducted in the context of science classrooms in early primary teaching in state government schools in the south of Thailand using a qualitative research method. Consequently, the generalisation of the research findings to other contexts may not be possible and is subject to certain limitations. This is because I adopted a qualitative approach in conducting the research. However, as stated earlier, this research did not seek to find generalised findings. Instead, the research aimed to enhance the understanding of early primary teachers' questioning practice by gathering and analysing in-depth data. Therefore, the assurance research quality measure is the *'trustworthiness'*, which focuses on *'transferability'*. Transferring the proposed model to other contexts is possible by conducting further research.

Finally, in this research, investigation into pupil responses were very limited. As a result, no claims can be made in relation to the questions and the quality of classroom interaction.

3.10 Summary

This methodology chapter has aimed to provide the information and rationale behind qualitative case study research. The qualitative nature of this study was based on an interpretivist paradigm, to guide the study into teachers' questioning practices. This research employed three main data collection methods: video-mediated interviews, non-participant observations, and documentary data. The use of template analysis enabled an analysis of classroom practices in relation to teachers' questioning and factors influencing this classroom practice from the data collected. Ethical implications were considered and measures were taken to maximise the trustworthiness of this study.

Chapter 4   Findings

4.1   Introduction

This chapter presents the findings of this study. The investigation covered five features of teachers' questioning: the purposes in asking questions, the question types, the questioning strategies adopted, two additional features of "wait time" and the selection of respondents. All these features except for the question types were explored in video-mediated interview data of teachers' reflections. Other data such as pre-lesson interviews, field notes and documents such as lesson plans were used to supplement the mediated-interview data with regard to the classroom context.

The presentations of the findings in this chapter are organised according to these three research questions.

> 1. What purpose do Thai teachers report to have in asking questions?
> 2. How do these understandings relate to open and closed questions?
> 3. What strategies do Thai teachers identify for structuring questions?

Section 4.2 begins with an overview of the observed teaching activities to set the context of teachers' questions in this study. In Section 4.3, the findings of teachers' purposes in asking questions were reported, as derived from the video-mediated interview data, and these will be discussed in responding to the research question 1. The findings of the video data will be presented in Section 4.4 by exploring the use of teacher questions in terms of open and closed question types (4.4.1), and the nature of children's responses (4.4.2). In connection to research question 3, this will be followed by the findings associated with the reported questioning strategies and the links between the purposes of questions, and strategies used in Section 4.5. Another two related features of wait time and selection of respondent can be seen in Section 4.6. The last section will discuss factors influencing questioning practice.

In presenting the sections of this chapter, Section 4.3 will explain the dataset of the questions based on the video-mediated interview data. After that, the relevant interview questions used will be discussed, along with the findings analysed using template analysis (King, 2012), which were supported by quotations from the interviews. In terms of coding, the fifteen teachers participating in this current study are represented as "T1" to "T15". A code of "T14;E1;B" refers to the teacher, the video extract number, and the question identified by the teacher to discuss. More information about these codes is shown in Appendix I. The analysis of the findings associated with the interviews was based on teachers' reflections on their own

practices. Although these findings may differ from their actions in practice, the teacher's accounts revealed what they think they do, and provide the relevant context and the reasons to what is happening.

4.2   Learning activities

In order to contextualise the study's findings, this section will explain the context of the fifteen science lessons organised by the fifteen teachers. This includes the details of the participants, types of tasks, class sizes, and teaching topics.

- **Participants: teachers and children**

As stated in the methodology chapter in Section 3.4, fifteen early primary teachers teaching at seven state government schools were involved in this study. The schools were located in the same province in the South of Thailand. They were all female and all graduated with a minimum of a bachelor's degree, which is the minimum qualification for teachers who are normally recruited by a central organisation under the Department of Education in Thailand.

The children in the fifteen classes observed were of two age groups and mixed gender in all classes observed. Five teachers were teachers in "Anuban 1" (children aged about 4 years) and ten teachers taught at "Anuban 2" (children aged about 5 years). According to the post-lesson interview data, all teachers reported that most children had low socio-economic backgrounds due to poor living standards, low-paid jobs, educational backgrounds, or the careers of their parents, as perceived by the teachers. Many teachers claimed that one reason why children participated less in terms of answering questions is because they had little prior experience. Sylva *et al.* (2004) pointed out that the learning activities parents carry out with children at home is a key factor in their intellectual and social development rather than the parent's demographic profile. As Teacher 10 said, questioning about land animals is relevant to their prior experience as they live near the sea and also the nature of palm trees and their experience of their pets at home (T10, post-lesson interview).

- **Types of tasks**

According to the information written in the lesson plans and the teachers' handbook, the fifteen teacher participants organised the learning activities as four types: 1) experiment, 2) demonstration 3) hands-on experience and 4) group discussion (see a description of each activity in Table 4.1). These activities are called "experience enhancing activities" where teacher-led teaching is used. Eight out of fifteen activities involved science experiments in terms of demonstrations or the pupils doing them themselves. For example, Teacher 2 was

teaching a lesson on the dangers of vinegar by putting a chicken egg into vinegar and showing the class how it compared with another egg which had been prepared the previous day. Hands-on experience activities were designed by two teachers, and five others organised group discussions in their lessons. Another type of activity was group discussion, which had a focus on speaking and listening with regard to a particular topic. Teachers appeared to questioning the children to enhance their knowledge and understanding of the topic.

A description of the fifteen activities observed in this study is described in Appendix J.

Table 4.1: Types of learning activities

Type of activity	Description	Teachers
1. Experiment	An activity involves hands-on experience because children experiment themselves, observe the change, practise observing and problem-solving and promote curiosity and self-discovery	T8, T9, T14, T15
2. Demonstration	An activity requires children to be involved in observations and learn according to the steps of the activity. Sometimes teachers involve some children who have volunteered to demonstrate with the instructor, leading to practising	T1, T2, T6, T7
3. Hands-on experience	An activity involves hand-on experience in which children use the five senses	T4, T5
4. Group discussion	An activity aims to promote language development in speaking, listening, giving opinions and listening to others' views. Materials used in teaching can be real objects, models, pictures or other things	T3, T10, T11, T12, T13

- **Class size**

In terms of class size, the mean was 23 children. Teachers have large groups of children between 19 and 37 children. The highest class size of 37 children may have been because School 3 is located near the town. Whole class teaching was implemented by the teachers in the ten classes observed, and five classes were organised as a combination of whole and small group teachings. In the middle of each of these five lessons, small groups were mostly formed as the children were involved with objects to enhance experiences using some of their five senses, e.g. taste. Working in small groups encouraged them to do activities on their own whilst the teacher took the role of facilitator.

- **Teaching topics**

An analysis of the pre-lesson interviews revealed that teachers shared a common understanding of the areas of teaching in early primary education. The teachers explained that the teaching topics in all the observed lessons were related to children's lives. These teachers working for state government schools were obliged to follow a Thai early childhood curriculum (The Ministry of Education of Thailand, 2003), adapted to the local context of the school. The topics of the fifteen lessons taught can be classified into 'myself' and 'nature around me', which are two of the four content areas of the curriculum (more details in Section 1.3.2). Related to lessons about 'myself,' four teachers gave reasons for teaching: 'eating healthy food' (T1, T2 and T3) and 'understanding your body organs' (T5). Teacher 5 mentioned that "A tongue is part of their body's organs, so they learn about themselves" (T5, pre-lesson interview). In the content area of 'nature around us,' another eleven lessons included content about trees, burning, air, animals, and water.

4.3 Teachers' purposes in asking questions

Results presented in this section relate to research question 1: "What purpose do Thai teachers report to have in asking questions?" The teachers' purposes in asking questions were collected into a dataset of 74 questions selected during interview. Each teacher was asked during the video-mediated interview: "What was your purpose of asking this question?" Teachers were invited to identify a number of questions, and talk about the purpose and other influencing factors. In relation to the 74 questions identified by the fifteen teachers, eleven recurring themes and/or patterns of purpose were discovered and generated from the interview data, which will be discussed in the following section.

The dataset of teachers' questions

Before exploring the categorisation of teachers' questions, it is necessary to describe this dataset. The exploration of the nature of specific teachers' questions was mostly derived from discussions with teachers using a video-mediated interview. Whilst watching the five-minute video of their practices, teachers were invited to reflect on their practice in questioning following the interview question prompt: "What was your intention/purpose in asking each question in this questioning episode?" They identified some questions that they had asked and explained the reasons for using them within the context. As mentioned in the methodology (Section 3.6.4), during the interview discussions some questions were identified and discussed with the teachers, but not all questions were discussed. Based on transcripts of these video-mediated interviews and supplementary data of five-minute video transcripts, 74 questions

were identified and analysed, as shown in Table 4.2, and all 74 questions can be seen in Appendix I. Teacher 2 identified just two questions, whereas 11 specific questions were discussed with Teacher 12.

Table 4.2: Dataset of the identified questions by each teacher based on video-mediated interview data

Teacher	T 1	T 2	T 3	T 4	T 5	T 6	T 7	T 8	T 9	T 10	T 11	T 12	T 13	T 14	T 15	**Total number of questions**
Total number of questions	4	2	4	3	3	3	3	1	3	7	9	11	9	7	5	**74**

After undertaking a coding process, as explained in Section 3.7.2 of the methodology chapter, the interview data revealed the teachers' reasons for asking the 74 questions; I identified eleven different categories along with theme descriptions (see Table 4.3 below). The categories are discrete, as only one question belongs to each category. What follows is an account of the eleven themes discussed, from theme number 1, "Gaining attention" to theme number 11, "Encouraging pupils' thinking". The order to these purposes in Table 4.3 is based on the lowest to highest cognitive levels of the questions. These accounts will be elaborated in the remainder of this section with the use of statements made by the teachers.

In terms of the number and the proportion of question types relating to purposes, the highest proportions of question types identified by teachers was "checking prior knowledge" (approximately 22 per cent) while "hypothesizing" and "experimenting" had the second lowest and the lowest percentages at roughly 3 and 1 per cent, respectively.

Table 4.3: The categorisation of teachers' purposes in asking questions

Purpose in asking a question	Theme description	Teachers	Number of questions (%)
1. Gaining attention	To encourage children to participate in learning or activities	T1, T12, T14	3 (4%)
2. Checking if pupils could recall information	To recall factual knowledge that has been taught in the activity	T3, T10, T12, T15	7 (10%)
3. Checking prior knowledge	To check what children already know about what the teacher plans to teach	T4, T5, T6, T7, T10, T11, T2, T13	16 (22%)
4. Checking understanding	To check children's understanding of learning or of activities undertaken	T4, T5, T6, T15	4 (5%)
5. Enhancing knowledge	To enhance fundamental knowledge related to the teaching topics such as types of animals, trees, sinking and floating, or air	T3, T11, T12, T13	12 (16%)
6. Integration with other topic areas	To link their teaching to other topic areas such as maths	T3, T10, T11	4 (5%)
7. Encouraging observation	To develop children's observation skills during teaching and learning activities	T1, T2, T8, T9, T12, T15	9 (12%)
8. Hypothesizing	To stimulate children in forming a hypothesis of the experiment undertaken	T1, T14	2 (3%)
9. Experimenting	To encourage children in experiments or testing things out	T14	1 (1%)
10. Building understanding	To make meaning and understanding by verbalising	T14, T15	5 (7%)
11. Encouraging pupils' thinking	To explain their ideas or thoughts about what they are doing	T2, T6, T7, T9, T10, T12, T13, T14	11 (15%)
			74 (100%)

1. Gaining attention

In teaching, teachers can use questions to manage classroom participation and engagement when some groups of children are not paying attention. Teachers 1, 12 and 14 commented on questioning for this purpose. When asking a question: "Will it stay the same or become different?" (T01;E1;B) Teacher 1 aimed for children to observe the flower absorption: "I have

to ask new questions in order to direct the lesson." In her explanation on the posting question (T12;E2;H: What takes its turn at night?), she wanted the children to listen:

> I selected [a child's name] to respond because he is able to answer. Their friends will listen to what he says, and it is the right answer (T12, post-lesson interview).

In the lesson about floating a drinking straw to become the character 'A', Teacher 14 intended to encourage pupils to try to float the straw by posting the question (T14;E1;C: Who could do it?). She noted that "This question is used to encourage them to do the experiment" (T14, post-lesson interview).

2. Checking if pupils could recall information

This purpose in asking questions happened after teaching a theme and the posed questions were used several times with the unchanged theme during the course of teaching. Teachers' questions enable the recall of the previous teaching to aid retention. In relation to the question (T12;E1;D: When does the moon appear?), Teacher 12 explained that:

> I repeated, because they would really remember that in day time the sun rises and the moon comes out at night. I have to emphasize that for remembering (T12, post-lesson interview).

The account implies that teachers have to ask the same questions several times, resulting in the children's recall of information.

Teachers asked for a recap either at the end stage of the activity or the end of the lesson. Teacher 3, after talking about seeing and touching two types of eggs, duck and chicken eggs, asked at the end of the lesson: "What is this egg?" (T03;E2;C):

> I recap what I have taught them about comparing two types of eggs. This makes children conclude that this is a chicken's egg and that is a duck's egg. So they can explain the same and difference they can see between the chicken and the duck eggs (T3, post-lesson interview).

The above account implies that with a recap question the teacher summarised the characteristics of chicken and duck eggs taught in the lesson.

3. Checking prior knowledge

Teachers' questions aim to check children's prior knowledge. This kind of question aims to elicit what students know and then help teachers to meet their needs. In asking the question "What is the leaf colour?" (T04;E1;B) and pointing out the tree, Teacher 4 said "I have an idea

of what the leaf's colour is that they have seen." Another teacher used the question "Which part of the plant gets air?" (T13;E2;F) to check what the class knew about a tree's respiration:

> Some children may not know that the tree undergoes a respiration cycle. The students believe that the tree breathes using gills. Trees do not have any gills, however, so I asked them whether they knew how trees breathe (T13, post-lesson interview).

Their prior knowledge has been gained from their social background and the culture of where they live: their family, experiences, and learning in schools.

Teacher 5 was teaching about the recognition of chillies. She showed a chilli to the class and asked them to name it. She used this question to assess the children's current understanding, which may represent an example of questioning for formative assessment (Black *et al.*, 2003). Responses given to the teacher's questions help to assess the level of children's understanding. Most teachers asked this for the purpose of seeing if a child had prior knowledge and then they explained how they had learned about it. In a discussion of the question (T05;E1;A: What is this?), Teacher 5 rationalised:

> They are able to tell that it is a chili or ['deepree' in a local language]. This is because they have learned from their daily lives as they are used to seeing it and their families call it that (T5, post-lesson interview).

When the question (T11;E2;H: Do cats live in water?) was posted to the group of children, Teacher 11 explained that they probably learn about water from parents:

> I was eager to know children's reasons why they replied 'cats cannot breathe.' They may have had a sense of their own that they could drown or could not swim in the water. That is their prior knowledge that their parents said that if you drown in the water, you could die (T11, post-lesson interview).

The teacher's explanation implies that by asking questions teachers assess what children know because individual children may know different things.

4. Checking understanding

Checking understanding questions were asked after a certain amount of teaching had taken place. After the teaching, Teachers 4, 5 and 12 used them to check the children's understanding of the learning or activities undertaken. These questions are relevant to their learning attainment in terms of the results of activities or experiments and explaining these results. In the discussion of the question (T04;E2;C, What did I ask you to bring?) one interviewee said:

I intended to summarise their understanding, based on what they have learnt and what they have been exposed to more generally. This shows how much they understand from the components I have taught (T4, post-lesson interview).

Teacher 4's description means that she could assess how much the child had learnt from the response to her question. Their understanding is related to scientific knowledge and concepts which are specified in a lesson. Another teacher asked a question to assess what they had learnt about the sense of taste. After some children were invited to taste one of the five types of fruits and ingredients, the reason for asking questions such as (T05;E2;C: What is the taste?) was explained by Teacher 5:

This is the end of the activity … They are able to tell me what they eat and what the taste is like (T5, post-lesson interview).

In order to check the level of the children's understanding, the teachers reported that there were two situations: children's understanding from teaching, and their understanding from direct experience.

5. Enhancing knowledge

Four teachers (Teachers 3, 11, 12 and 13) responded that they intended to improve children's scientific knowledge by questioning. When Teacher 11 was teaching about animals, she noted that she aimed to teach about bird movement. The question (T11;E1;C: How does the bird get from here to there?) stimulated the learning:

I wanted the children to know how animals or living things move from here to there. That is because some animals move by walking. Others animals move by flying or crawling. Right now, my focus for asking for them to learn about how an animal moves is birds (T11, post-lesson interview).

From the teacher quotation above, she created cognitive conflict; she wanted to tell her class that the bird's movement is by flying, because some animals move by walking or crawling. The teacher additionally commented on it that she knows in the class what children's misconceptions about science are in relation to this question. In posting the question (T11;E1;D: Do they [birds] fly high or low?), Teacher 11 noted that she knows that a child thinks birds and chickens can fly but not in the same way:

This is because when I used to teach before I asked: 'what can fly?' and they replied birds and chickens. So they think that chickens fly low. Today, I want them to know the differences between them related to flying. They can both fly, but the manner of flying is far and possibly low (T11, post-lesson interview).

In connection to the former two themes of checking prior knowledge and checking understanding mentioned before, this type of question was asked after ascertaining the stage of children's knowledge. Then, the questions were asked to enhance knowledge before checking their understanding of learning at the end.

In developing a schema of knowledge, some questions were asked to encourage comparison. Teacher 11 asked the question (T11;E2;G: Is this animal land animals or animals that live in water?) for them to compare the bird's movement as mentioned above and the types of animal. Teacher 11 mentioned that, "That question I ask students is to learn types of animals and where they live. They are land animals or animals that live in water" (T11, post-lesson interview). In another lesson, Teacher 13 used the question (T13;E2;G: What are the same between humans and animals?) in order to teach a concept about living things:

> I have already told them that living things are divided into people, plants and animals. At this point, I intended for them to compare plants and animals: what they have the same, and what is different. That is because both animals and plants are alive. I want them to know that living things need some factors to survive (T13, post-lesson interview).

6. Integration with other topic areas

From the interview, interestingly teachers revealed that their questions were interrelated to subject knowledge in other curriculum areas. It is an undeniable that teaching in early primary school integrates rather than separates subjects (The Ministry of Education of Thailand, 2003). Teachers relate their questions to children's development in science, maths and Thai language. Three teachers mentioned that their questions concerned learning maths. Teacher 3 used the question (T03;E2;B: Is the egg rectangular or is the egg circular?) for children learning about shapes and colours:

> I base my teaching on children's responses. Children answered 'Oval,' which is relevant to maths: oval and rectangle; therefore, I integrate that in my teaching (T3, post-lesson interview).

In posting the question (T03;E2;D: What colour is it?), another teacher agreed that "They learn about colours as well." The interview account given from Teacher 10 said that "From their observations, they are able to work out how many legs animals have and then show the number four on their fingers. This implies that they have linked their learning to mathematics" (T10; S;E2;D: How many legs do rabbits have?)". She explained that the ability to observe is science-related and counting is maths. During the discussion on the question (T11;E1;B: Is the bird's beak long?), Teacher 11 also emphasised in the interview that "The small and large mouths of

birds are connected to mathematics". In relation to children's Thai language, they are learning vocabulary. In the conversation about the question (T11;E2;F: Where do land animals live?) about types of animals, Teacher 11 explained that:

> The word 'land' in connection to animals was new knowledge for the students so they are told that it is below. I therefore tell them that below means on the ground. Animals, that is land animals, live on the ground. For them they think it is below and what lives on top are birds (T11, post-lesson interview).

7. Encouraging observation

One of the purposes was developing children's observation skills, as mentioned by teachers that their questions asked children to observe and then to describe things. During the experiments, five teachers used questions in encouraging pupils to observe and respond about what was happening, and one teacher asked about information in pictures. They encouraged the children to look at teaching materials, such as experiments, pictures, or real objects. They were expected to able to respond about of a change in flower colour (Teacher 1), a change in an egg (Teacher 2), the result of a bubble (Teacher 8), the appearance of objects (Teacher 12), a change in salt (Teacher 9), and a change in sand (Teacher 15). For example, Teacher 1 used the question (T01;E2;C: What colour is it changing to?) for children to observe dye powers to be dissolved in hot and cold water:

> I wanted the children to observe the difference between dissolving blue dye powers in hot water and red dye powers in cold water. … It was for them to notice that the flowers absolved the blue water because the water was hot, while another flower did not change colour to turn red due to the cold water (T1, post-lesson interview).

From her explanation, children's observation and interpretations of the colour of the flower would lead to learning on the scientific concept of dissolving. This may be a key scientific skill for young children to develop. In contrast, but also for observation, the different teaching material of pictures was used when teaching about night time. Teacher 12 used the question (T12;E2;J: Is this daytime or night time?) and showed animated pictures of a night time as said, "They would see that in the picture that there was a window and it was dark, as at night, so I asked if this was day or night" (T12, post-lesson interview). This means that seeing and describing pictures was developing the concept of night time.

8. Hypothesizing

Two teachers reported that their questions aimed to encourage thinking and forming the hypothesis of an experiment. Teacher 1 encouraged children to predict the colour change of flower leaves and another teacher involved the children's thinking on the weight of paper clips.

This involved each child doing an experiment with a drinking straw, by adding paper clips. Teacher 14 asked: "One does not work, so how many clips are needed?" (T14;E1;B), for them to know that adding each paper clip caused increasing weight to the drinking straw:

> Students experiment by themselves to see how many paper clips they want to put on. It means putting clips by adding them one by one (T14, post-lesson interview).

In adding clips, teachers' questions were meant to stimulate children' thinking of an answer to how many papers clips were needed to add to the straw, to cause the drinking straw can float in the water as horizontal 'A'.

9. Experimenting

The particular purpose of teachers' questions involves children in experiments or testing things out. In a lesson about sinking and floating, children were encouraged to float a straw in the shape of an 'A', which is one of the English letters. One of the teachers asked the question (T14;E1;A: What could you do to design it [a straw] as a shape of a floating 'A'?) to encourage the children do an activity to find the answer by themselves. Teacher 14 explained:

> I was giving a learning experience for an individual child by adding a paper clip themselves from one, then two and three. By doing this themselves, they will experience how many paper clips can float or dive without sinking (T14, post-lesson interview).

The teacher thus revealed that the question guided their actions of floating a straw in the 'A' shape.

10. Building understanding

Teachers' questions led children to construct meaning and understanding by verbalising. After the children had been involved in the hands-on experience of doing an experiment, questions were used to build understanding or make meaning from simple experiments. Teachers 14 and 15 elicited what the children understood by posing questions. In order to learn about the concept of floating, individual children experimented with drinking straws in groups. The reason why Teacher 14 posted this question (T14;E2;E: How many clips are needed to get it to float?) was for children to construct the meaning of floating:

> They told me that three clips can float, but if it is not that number, can they float? I wanted them to compare what it looks like; floating flat, horizontal, or at 45 degrees. It leads to the conclusion that light objects can float on water (T14, post-lesson interview).

Another teacher in the same school, Teacher 15, used the question (T15;E2;D: When we put sand into the water, why does it not float?) to discuss the property of sand:

> I want him to understand the properties of the sand; it has weight (T15, post-lesson interview).

This type of question promoted individual understanding or the meaning of the scientific concepts through teachers' questions.

11. Encouraging pupils' thinking

Teachers posed questions for children to explain their ideas or thoughts about what they were doing. At the beginning of the lesson, the Teacher 12's question (T12;E1;B: At night. Why do they [the moon and the sun] not appear at the same time?) was asked to elicit children's thoughts about why we do not see the moon and sun together.

Developing thinking skills involves promoting children's skills in reasoning, comparisons, analogy, and decision making (Bloom, 1956; Anderson *et al.*, 2001). Teachers 2, 3 and 14 probed for children's responses to what caused the results of their experiments. Teacher 2 posted the question (T02;E2; B, Q: Why does it [the egg] become white?) and showed an egg in vinegar, and she explained "I want the children to find out the reason why the egg was white" (T2, post-lesson interview). In terms of the comparisons, this was evidence of teaching the concept of dissolving between oil, water and sands, the question: "What is lighter than the water?" (T09;E2;B) was asked for children "…to compare because of the three of them, water is the key in comparisons." Regarding another skill in developing decision making, Teacher 10 explained that "the child was asked to choose which animal headband he was wearing, on the basis of whether that animal lives on land, in water or both" (T10;E1;A: Which group will you go to?) and "choosing themselves" (T10;E1;B: Do cats live on land or in water?). As the two questions were posed directly to different children, she added, "That child [the child's name] was not clear in their response… so their decision making was not the same."

In summary, an analysis of the mediated-interview data shows that teachers' questions were utilised for eleven purposes. In the classroom, there were occasions when the learners did not pay attention, and therefore questions had to be adjusted for the purposes of engagement and participation. Regarding the stage of the children's understanding, the two purposes of checking prior knowledge and checking understanding were employed by teachers which were influenced by formative assessment. In some circumstances, questions were aimed to enhance knowledge by creating cognitive conflict and scaffolding learning, as noted by teachers. Additionally, as part of learning science, teachers' questions were considered to play a vital

role in terms of practising the skills of pupils in hypothesizing, observing and experimenting. The use for building understanding, and encouraging pupils' thinking were mentioned as being useful for developing understanding through interaction.

4.4   Teachers' use of questions

The purpose of this section is to answer research question 2: "How do these understandings relate to open and closed questions?" Based on my own analysis of the video data at a later stage, the findings on question types in terms of the teachers' purposes in relation to open and closed questions and the nature of children's responses will be presented in Sections 4.4.1 and 4.4.2. This investigation is important because asking productive questions lead to children's learning and developing thinking skills.

4.4.1   Teachers' purposes in relation to open and closed questions

Having presented the categories of eleven purposes in asking questions in the previous section, we will now move on to how each category contains open and closed questions. This will illustrate the different types of interaction and the learning of the children. As mentioned in the literature review (Section 2.4.2), according to definitions of open and closed questions (Edwards and Westgate, 1994; Myhill and Dunkin, 2005) the following definitions were adopted:

> Closed questions which have pre-determined answers elicit factual information. In contrast, open questions are used to stimulate children's thinking and have more than one possible answer

From the dataset of this study, some of the examples of each question type can be seen in Table 4.4.

An analysis of the video data on the teachers' questions as presented in Table 4.5 shows the number and percentage of each question type in terms of purposes in relation to open and closed questions. The presentation of the question purposes is ranked from the highest percentages of open questions to the lowest. One finding of this study was that three types, "Hypothesizing", "Experimenting", and "Building understanding", had a higher percentage of open questions than closed ones, at 100%, 100% and 60%, respectively. It is important to note that the total number of categories was very small so this is not representative of Thai teachers' questions. Importantly, there were no open questions for the three purposes of teachers' questions ("1. Gaining attention, 4. Checking understanding and 6. Integration with other topic areas") .

Table 4.4: The categorisation of types of teachers' questions

Type	Definition	Example
Open questions	Questions are used to stimulate children's thinking in areas such as reasoning, speculation and evaluation, and they can have more than one possible answer	Why does it [the egg] become white? Why does the moon not come out in the daytime? What makes wind come out?
Closed questions	Questions have pre-determined answers, and elicit factual information	What colour is it? When does the moon appear? How many legs do rabbits have? Do hens have chicks? Do they [birds] fly high or low?

Table 4.5: The number and percentage of teachers' purposes in asking questions in relation to open and closed questions

Purpose of asking a question	Number of questions	Open questions		Closed questions	
		Percent	Number	Percent	Number
8. Hypothesizing	2	100%	2	0%	0
9. Experimenting	1	100%	1	0%	0
10. Building understanding	5	60%	3	40%	2
11. Encouraging pupils' thinking	11	36%	4	64%	7
5. Enhancing knowledge	12	25%	3	75%	9
3. Checking prior knowledge	16	19%	3	81%	13
2. Checking if pupils could recall information	7	14%	1	86%	6
7. Encouraging observation	9	11%	1	89%	8
1. Gaining attention	3	0%	0	100%	3
4. Checking understanding	4	0%	0	100%	4
6. Integration with other topic areas	4	0%	0	100%	4
All type of purposes	74	24%	18	76%	56

Table 4.6 below presents the categorisation of questions, in terms of open and closed questions per teacher. It is worth noting that the number of closed questions was significantly higher than the number of open questions (representing 76% of closed questions and 24% of open questions). The findings clearly show that various teachers chose to discuss open questions

between 0 and 50% although five of them (T4, T5, T8, T9 and T10) did not discuss any open questions. Obviously, 100% of questions chosen for discussion by Teacher 7 were open questions.

Table 4.6: The number of each question type asked by each teacher based on video data

Teacher	T1	T2	T3	T4	T5	T6	T7	T8	T9	T 10	T 11	T 12	T 13	T 14	T 15	Total
Total	4	2	4	3	3	3	3	1	3	7	9	11	9	7	5	**74**
Open Closed	1 3	1 1	1 3	0 3	0 3	1 2	3 0	0 1	0 3	0 7	1 8	3 8	2 7	3 4	2 3	**18** **56**
Open (%) Closed (%)	25 75	50 50	25 75	0 100	0 100	33 67	100 0	0 100	0 100	0 100	11 88	27 73	22 88	43 57	40 60	**24** **76**

It was evident that 22 of the 56 closed questions (approximately 39%) required the pupils to provide an answer based on relatively few options given by the teacher to them, which can be called *forced alternative* questions (de Rivera *et al.*, 2005). For example, when Teacher 10 had a conversation with a group of children and showed a picture of an elephant, the question: "Are elephants land animals or animals that live in water?" required the answer "land animals" or "animals that live in water" – a response presenting factual knowledge about the types of animals.

In conclusion, a video analysis based on the dataset of 74 questions showed that eight of the eleven purposes of teachers' questions led to higher numbers of closed than open questions but the purposes of "hypothesizing", "experimenting", and "building understanding" led to more open questions being asked. It was also noticed that 39% of all closed questions were *forced alternative* questions, which may limit the participation of children when learning.

4.4.2   Children's responses

Findings about children's responses to the categories of question presented in the previous section are also relevant to research question 2. One way to investigate teachers' questions is to examine the nature of the children's responses. According to pedagogy on dialogic teaching (Smith and Higgins, 2006), effective teacher questions invite children's responses to promote the construction of children's knowledge and understanding. The video analysis which took place after the video-mediated interviews of children's responses attributed to the 74 questions shows some evidence of effective teacher questions in terms of the nature of children's responses and the cognitive levels of responses.

From a video analysis of children's responses to each of the 74 questions, it was found that they were short, with fewer than two words on average, ranging from zero to four words in Thai. There were a few instances in which longer responses of high levels of thinking were used when the children were asked for reasons. One word responses, which accounted for 45 out of 74 questions, were often found amongst the 74 questions, at 61%. The nature of the required responses usually involved factual information. For instance, by pointing to a real jasmine tree, some pupils' responses involved a one word response:

> T: What is the leaf colour?
> Ss: Green (T04;E1;B, Video transcript).

The description of the video transcripts can be seen in Appendix K; for example, "Ss" refers to several students at once or the whole class. There was evidence that only four questions (approximately 5%) relating to the purposes of "checking prior knowledge", "enhancing knowledge", "encouraging thinking skills" and "building understanding" led to four-word of children's responses. For example, Teacher 14 organised a lesson involving science experiments with underwater straws. After each child made a drinking straw float by adding paper clips, one by one all the children were asked to share their experience. This elicited a longer response of four words in Thai as is demonstrated in the following:

> T: How many clips are needed to get it to float?
> S1: Two or three clips float (T14;E2;E, Video transcript).

According to Bloom's (1956) taxonomy or the revised version in Anderson (2001), the children's responses could be categorised in terms of the cognitive levels of information required: lower levels of thinking and higher levels of thinking. An example of responses to the purposes of "checking prior knowledge" mentioned above was "Green", which demonstrates a knowledge level of thinking. In contrast, responses were transformed from factual into conceptual responses when the responses were elicited from children's ideas and with less expectation of correctness. In another lesson on the danger of vinegar, children looked at a demonstration of the effect of vinegar on a brown egg shell inside a transparent glass, and the teacher encouraged the children to practise observation.

> T: Why does it (the egg) become white?
> Ss: The egg shell has disappeared (T02;E2;B, Video transcript).

The conclusion regarding this instance showed that this 'why' question elicited the response at the analysis level of thinking because the question required reasoning/speculation about the causes of the experiments (Lee and Kinzie, 2012).

To summarise, an analysis of the video data indicates that 61% of children's responses to the 74 teachers' questions were very short one word responses. It is apparent that only 5% of the responses were four-word ones. These instances provided an opportunity for the children to talk in the class.

4.5   Teachers' questioning strategies

In order to answer research question 3 (What strategies do Thai teachers identify for structuring questions?), the results in this section were derived from another section of the video-mediated interview data that dealt with questioning strategies. It is important to investigate which questioning strategies the teachers considered important in scaffolding assistance (Wood *et al.*, 1976; Tharp and Gallimore, 1988; van de Pol *et al.*, 2010).

An analysis of the interview data combined with two themes of the eight questioning strategies identified, and the teachers' adaptation of questions to children's needs, will be discussed in Sections 4.5.1 and 4.5.2. Finally, in Section 4.5.3, I will present the teachers' accounts of each of the questioning strategies used in relation to particular purposes. Each strategy is described in the context of Thai early years science teaching.

4.5.1   Eight questioning strategies

Following the interview question about teachers' questions, teachers were invited to comment on questioning strategies by responding to the interview question: "What strategies do you use when asking questions?" I used probes and prompts for reasons to gain an insight into the underlying use of the strategy, such as "Can you give me an example of the strategy?" The responses enabled me to determine what questioning strategies were employed, with examples using video extracts, and why. Using a template analysis approach, relevant data from the interviews was combined and two themes were then generated: a number of teacher questioning strategies, and the reasons for using each of them.

Table 4.7: Categorisation of questioning strategies by fifteen teachers according to the interview data

Domains of child development	Questioning strategies	Definition arising from the data	Teachers
Cognitive	A. Repeating questions	A teacher question is the same or very similar to the original question	T3, T4, T5, T7, T12, T15
	B. Paraphrasing questions	A teacher question is the same as the original question but using different wording	T2, T9
	C. Giving clues: part answers	A teacher question contains a part answer to help the children answer a question they find difficult	T2, T7
	D. Changing from open to closed questions	A sequence of teacher questions changes from an open question to more closed questions, which may require 'Yes/No' answers	T1, T6
	E. Using children's responses to ask the next question	A teacher question follows a child's answer to the main question in order to probe for relevant information	T10, T11
	F. Easy to more difficult questions	Teacher questions posed at the beginning of the lesson are easier than those at the end	T14
Social	G. Linking questions to children's experience	A teacher question is related to an experience that they can recall	T8, T10, T14
Affective	H. Asking humorous questions	A teacher question is intended to understand children's thoughts, not get the correct answer. It amuses the children and maintains their interest	T12

The eight identified strategies used by the teachers will be discussed in Section 4.5.3. Table 4.7 shows these eight strategies with their definitions arising from the video-mediated interview data. The most-used strategy was Strategy A: Repeating questions, as mentioned by six teachers. From the quotations shown in Section 4.5.3, it can be seen that they emphasised the key word 'repeat' and then generated this as a strategy. The use of this strategy implies that more responses were given to the teacher. An analysis of the interview data shows that the

teachers employed an average of two strategies, as most teachers stated just one strategy but some stated two strategies. Many teachers reported that they used one strategy. Teacher 1 noted that in her lesson about dissolving artificial dye, Strategy D: Changing from open to closed questions was used, whilst another teacher, Teacher 3, mentioned Strategy A: Repeating questions in a discussion with children in learning about types of eggs. Five teachers expressed in the interviews that two questioning strategies were used. Teacher 14 said that she used two strategies, Strategy F: moving from easier questions to more difficult ones, and Strategy G: Linking questions to children's experience.

In summary, one of the findings based on discussions with teachers using videos revealed that using eight questioning strategies was identified in teacher-children interaction in early years science. The most common was repeating questions.

4.5.2   *The focus on children's needs*

During the course of the template analysis, it became clear that the strategies used for questioning were adapted to the answers provided by the children. This issue will be explained in the following paragraphs.

An analysis of teachers' accounts the use of questioning strategies indicated that all teachers (with the exception of Teacher 13) valued questioning strategies as part of the learning process in which a sequence of questions asked was tailored to children's need. The teachers pointed out that the use of questioning strategies was centred on children's needs. Any follow-up questions asked depended on the children's responses. They assessed the levels of knowledge and understanding according to the verbal responses, and may be grouped into, "no one answers", "a few children respond", and "answers not clear." Teachers 1 and 6 shared a similar understanding, in that when "no one answers", they used strategy D, which was changing from open to closed questions. For example, Teacher 1 reported that "We are learning to develop skills in observation, but sometimes the children cannot reply to questions because they do not have previous experience" (T1, post-lesson interview). Another teacher added that:

> Because children possibly do not have the concept of air, I asked some closed questions and I gave explanations. We are learning about the concept of air, which is invisible. Children need time to understand this concept (T6, post-lesson interview).

It may be concluded that teachers focused on the use of questioning strategies based on responses given from the group of children. The teachers' accounts indicate that the ability to respond was influenced by the children's prior knowledge. In an example of a conversation that Teacher 10 had with children on the colour of rabbit fur, she explained about the children's

experience: "I believe that they have prior experience of the colours of rabbits. That is because I read a fable about rabbits that have many colours. They may also watch cartoons" (T10, post-lesson interview).

With this knowledge, teachers adapted their questioning strategies according to the children's needs. Regarding the eight strategies, few teachers reported the use of the same strategies to elicit children's responses from a group of children. According to Teacher 2, "If children do not reply, then I paraphrase the question so they may able to answer" (T2, post-lesson interview). In addition to the above questioning strategies, the teachers' accounts revealed that the children's needs were related to all aspects of child development, which fell into four domains: physical, affective, social, and cognitive. Teacher 4 explained that:

> As a preschool teacher, I would develop children's cognition, but also their social development. If they are able to reply, they are knowledgeable. How about social skills? ... Do they participate in the activity with their friend in the class? (T4, post-lesson interview).

Another teacher stressed that "I simply repeat the question for the children to increase their confidence and their courage to answer" (T5, post-lesson interview).

It can be concluded, based on the interview data, that teachers' questions were used as part of scaffolding assistance, to help inform the current developmental level of children. Through such interaction, teachers were also concerned with the development of the whole child.

4.5.3   Eight questioning strategies in relation to particular purposes

The following are the teachers' accounts of the use of the eight questioning strategies to achieve particular purposes in teaching contexts, in that a sequence of questions is tailored to children's needs. These strategies can help teachers to have a greater understanding of the questioning strategies.

Strategy A: Repeating questions

The most common questioning strategy used was "Repeating questions"; six of the fifteen teachers noted in the interview that they employed this strategy. Repetition refers to an initial question, which is repeated several times, and the questions asked have similar wordings. In order to present an example of teachers' accounts on questioning strategies I will present a short video extract and a teacher's commentary, which was recorded in video-mediated interview data. An example of this strategy comes from a science lesson about the taste of fruits

or ingredients. A teacher showed an orange coloured chilli to a group of 4 year old children sitting around the teacher. She posted a question: "What is the colour of this chilli? (T05;E1;B)"

Sequence 4.1: A chilli

T: (Showing a real chilli and looking at the group) Look at the chilli. What is the colour of this chilli?
S: Pink.
Ss: Green, green.
T: (Call a child's name) What colour is it?
S: (Silence)
Ss: Red.
T: What colour is it?
Ss: Red.
T: Is that red?
Ss: Yes.
S: *Orange*. (She can see the chilli because she is sitting next to the teacher).
T: It looks like orange. That is because…
S: It is small.
T: It is not ripe. If it turns ripe, what colour would it be?
Ss: Red.
T: Umm. That would be red.
(T05, E1, Video transcript)

Teacher 5 commented on Sequence 4.1, in which she repeated a question for a child to answer what he/she saw when she showed them an orange coloured chilli:

> When they replied "red", which is wrong, I repeated the question "What colour is it?" … I showed them a chilli which was an orange colour, not a red colour. I want them to look closely in order to recognize the colour. They understand that the chilli is green and turns red (T5, post-lesson interview).

In using this same strategy, Teacher 4 stated that since some children may not listen or not be confident in answering the question, they have to repeat questions 2 or 3 times:

> When some children do not pay attention to the question I ask, I repeat the question for the second time and one who was not interested might then listen to me. It seems to me that this is a way to draw their attention back to the lesson for those who lack interest. Doing this also enables me to assess the background knowledge of those who know and those who don't know (T4, post-lesson interview).

From the above description by Teacher 4, it can be seen that children's responses in terms of whether they reply or not enable the teacher to assess the level of the children's understanding.

Strategy B: Paraphrasing questions

A few teachers (Teacher 2 and 9) mentioned that questions were rephrased after being asked. The extract was from the experiment of two examples of chicken eggs in vinegar which aims for children to learn that eating too much vinegar is dangerous for bones. A group of children looked at the two eggs to observe and the teacher asked a question: "Why does it [the egg] become white?" (T02;E2;B).

Sequence 4.2: Vinegar is an acid

T: Why does it (the egg) become white?
S: The egg's shell is gone.
T: Because…? Who knows? Who knows?
Ss: The egg's shell is gone.
T: What makes the egg's shell go?
S: Vinegar is a liquid to destroy the egg's shell.
T: (The S's name) said that vinegar has destroyed the egg's shell. That makes the colour of the egg's shell become…?
Ss: White.
(T02, E2, Video transcript)

Regarding the experiment of two examples of chicken eggs in vinegar, one teacher (Teacher 2) confirmed that "I asked some questions but they could not respond, which implies that they did not know. When I paraphrased the question, they were able to respond. Perhaps the children may not have understood the question" (T2, post-lesson interview). Based on the descriptions of children not understanding the posed questions, we can see that they need to be paraphrased. To illustrate a result of the second example, Teacher 2 explained:

> I invite knowledgeable children to answer my question. ... I called for the child [a child's name] to answer, as she understood what I was teaching. Her classmates listened to her response and then gained the knowledge (T2, post-lesson interview).

It can be said that the child's response taught other children who did not know the answer about the differences between the two eggs.

Strategy C: Giving clues

Strategy C: Giving clues that enabled children to answer, was mentioned by Teachers 2 and 7. The wording of questions contained clues for the children to reply to. An example of this strategy was a lesson about the scientific concept of air, which has pressure. The children were working on the understanding that airflow makes things move. Before this, a few children had volunteered to join the activity by hitting the box. The teacher had a conversation with the

children using the question: "Wind comes out from the box. What makes wind come out?" (T07;E2;C).

Sequence 4.3: Air pressure

T: Because wind comes out from the box. What makes wind come out?
S: We hit it.
Ss: We hit it.
T: Umm. We hit it. If we do not hit it, will wind come out or not?
Ss: It will not.
T: Because the pressure that happens when we hit the box causes the wind to come out.
T: Wind comes out, so air makes the candle…?
Ss: Go out.
T: Wind makes the table tennis ball…?
Ss: Move.
T: Move away.
(T07, E2, Video transcript)

Watching a video of Sequence 4.3, she explained that before a child was able to answer in a full sentence, she asked the child to answer just part of the sentence. After that a child could understand what they had learned at that time. Teacher 7 described the strategy and gave an example of a specific question:

> What I did was to give some parts of the answers for them to respond to, and then I repeated this again. For example, I asked that "Wind comes out, so air makes the candle…?" and then they answered that "the candle go out" (T7, post-lesson interview).

Another teacher noted the similar reason why giving clues was used. "I asked them to answer only parts of sentences to my question in order to encourage the children to fill in the answers: 'white' " (T2, post-lesson interview).

Strategy D: Changing from open to closed questions

Two teachers stated in the interview that Strategy D: Changing from open to closed questions was used. For instance, Teacher 1 demonstrated an absorption colour experiment with flowers. When they had observed the experiment, she encouraged children to seek the reason why the flowers were changing colour by asking the question: "If I put the flowers into the glass of blue water, what will happen?" (T01;E1;A).

Sequence 4.4: Prediction of the flower colour
T: Everyone, let's practise a prediction skill. If I put the flowers into the glass of blue water, what will happen? (Most students look at the experiment)
Ss: (Unclear)

T: What colour will the flowers be?
Ss: Blue.
T: How about the flowers in this glass, what will happen?
Ss: White.
T: Will it change or remain normal?
Ss: Normal.
T: Will it change or stay the same?
S: The same.
T: What will happen?
S: It will stay the same.
T: I do not know. You tell me.
(T1, E1, Video transcript)

She commented on Sequence 4.4:

> Earlier, I asked the question: 'What will happen?' and only 1-2 people responded, not everyone. They do not observe; they need to have more practice in observations. So my question had to change to a new question, to become a 'forced alternative' (T1, post-lesson interview).

The teacher's account shows that she accessed the children's understanding based on the number of children who participated in answering the posed question; she noted "Only 1-2 people responded, not everyone." A sequence of questions was adopted to be more suitable to the children's level of knowledge and understanding. She changed the questions from open types of questions to be *forced alternative* questions: "What will happen?", "Will it be the same or different?" and "Will it turn blue?" It can be said that different forms of questions were asked to suit a child's level of understanding, as the teacher taught a group of 28 children who may know different things. Another teacher, Teacher 6, confirms that questions have to be adapted to be suitable to the child's needs:

> I have to observe the pupils, perhaps because of the posed question. If I see that they are not able to respond, sometimes I have to use questions that are more closed, probably requiring answers such as 'yes/no,' 'good/not good,' probably because it is hard for them to explain (T6, post-lesson interview).

According to this account, only a few children were able to answer the posed question. The other children did not know, so the teacher modified the questions to be easier.

Strategy E: Using children's responses to ask the next question

During the course of the interview analysis, it became apparent that this strategy was different from the first four strategies as it relates to the children's responses. Two teachers (Teachers 10 and 11) stated that they used this strategy. For instance, Teacher 11 organised a lesson on land animals. She had a conversation about animals with a group of 4 year-old children using

pictures of animals. In order for the children to learn about bird movements, one of her questions was: "How does the bird get from here to there?" (T11;E1;C).

Sequence 4.5: Bird movements

T: How does the bird get from here to there? (Teacher shows a picture of a bird setting in a tree)
Ss: Fly.
T: How does it get from here to there?
Ss: Fly, fly.
T: Do they fly high or low?
Ss: (Silence)
T: Do they fly high or low? (Moves her right hand from low to high)
Ss: Fly high.
T: Let's see. Why can they fly?
Ss: Birds have wings.
T: Wow they have wings so they can fly. Chickens, can they fly?
Ss: (Inaudible)
T: Can they fly?
Ss: Yes, they can.
S: Chickens fly low. (He speaks from where he is sitting at the back of the room)
T: OK, he (the child's name) said that chickens fly low.
Ss: Yes.
    No.
T: OK, chickens fly low.

(T11, E1, Video transcript)

According Sequence 4.5 above, Teacher 11 noted that "I needed to ask the next question based on how they responded" (T11, post-lesson interview), and she gave one example of a sequence of questions: "The teacher asks why birds can fly. I tell my students, they have wings. They have wings to fly high or low" (T11, post-lesson interview). A further question was asked based on what the children's responses were; consequently, it went on to probe with another question. In doing this, the wording of the next question may contain some of the wording of the children's answers. Teacher 11, for example, stated that:

> I needed to ask the next question based on how they responded. If children are not able to respond, it leads to a new question. They do not have to feel stressed about answering. If a child's answer is wrong, I will not say so. Rather, I will find an answer from a classmate who gives the right answer (T11, post-lesson interview).

From the quotation above, the correct answers obtained from the class were emphasised to show factual knowledge that children learned. This strategy tends to allow the children to extend their knowledge from their classmates because individual children's knowledge differs.

Strategy F: Easy to more difficult questions

Another questioning strategy is F: Easy to more difficult questions. This question strategy means a sequence of teachers' questions in a lesson starts from easy and moves on to more difficult questions. As Teacher 14 stated:

> The questions I ask initially are close to the children's experience, and later on they are questions that stimulate the children to think, and that are relevant to the learning objective of this lesson. It is also about asking more open-ended questions to encourage the child's thinking (T14, post-lesson interview).

Only Teacher 14 noted that doing this aims to promote children's thinking. This finding implies that effective teachers use a sequence of questions during teaching that leads to high cognitive levels of thinking to promote children's thinking skills (Wragg and Brown, 2001).

Strategy G: Linking questioning to children's experience

Three teachers (T8, T10, and T14) described one of the questioning strategies used, Strategy G: Linking questioning to children's experience. An explanation by Teacher 14 on this strategy was that:

> The question [If you could not swim, what would you use to keep yourself afloat in the water?] relates to them and they will be able to answer, resulting in an engagement allowing them to participate in the activity (T14, post-lesson interview).

The use of this strategy is taken from the scientific lesson on types of animals. A child who was wearing a headband of cats was invited by teachers to come in the front of the class with the teacher nearby. The class was talking about cat food and the teacher posed a question: "What do cats eat as food?" (T10;E2;F).

Sequence 4.6: Cat food

T: What do cats eat as food?
Ss: Food.
T: (The child stands up) Please sit neatly.
T: What do cats eat as food?
Ss: Cat food.
T: What do cats eat apart from cat food?
Ss: Eat rice.
S: Water.
T: Let's think, what do you mix with rice for cats to eat?
Ss: Fish.
T: Right, clap your hands. Very good! Now you know that cats like eating fish and rabbits like eating cabbage. (T10, E2, Video transcript)

Teacher 10 added that: "My asking questions help the child to relate that to what they had seen, which is their prior experience" (T10, post-lesson interview). Based on their accounts, teachers were aware of children's prior knowledge. Teacher 10 gave an account of the prior knowledge of information on cat food:

> At that point I asked questions about cat food. If the children replied 'fish,' this implies that they could imagine that when their mothers feed cats there is fish mixed with rice.

The account implies that asking questions about children's experience helps in making connections between previous and new knowledge.

Strategy H: Asking humorous questions

The last questioning strategy was Strategy H: Asking humorous questions mentioned by only one teacher. An example of this strategy is illustrated in Sequence 4.7, in which the children were encouraged to say their ideas about the moon and the sun. Teachers asked a question: "Why do they not appear at the same time?" (T12;E1;B).

Sequence 4.7: The sun and the moon

T: Why do they not appear at the same time?
Ss: (Silence).
T: In the daytime which can you see?
Ss: The sun.
T: The sun appears. What does the moon do?
S: The moon at night.
T: What does the moon do, (Call a child's name)?
Ss: The moon…
S1: The moon goes travelling.
S2: The moon goes to sleep.
T: (Looks at the child)
S2: The moon goes to sleep.
T: The moon goes to sleep, (the S2's name) said.

(T12, E1, Video data)

The teacher is concerned about an affective aspect of the child' needs:

> Most of the time my style of asking questions is mixed with play: learning through play. I ask some funny questions which they enjoy. I may ask questions in the form of a joke for them to respond to and laugh. I want them to enjoy answering my questions. They do not have to think much and won't become stressed (T12, post-lesson interview).

It can be said that asking humorous questions helps in maintaining children's attention and thus classroom participation. She stated an example of her questions (Why does the moon not come out in the daytime?) about the moon expecting to elicit children's thinking and laughing at her answer as she said: "The moon went to bed".

Reported purposes related to the strategies used

Figure 4.1 below presents the relationship between particular purposes and relevant strategies, as discussed in the previous section. It was found based on video-mediated interview data that teachers had eight varied purposes for using these strategies (see Table 4.7).

An analysis of the interview data revealed that the Thai teachers reported using the eight questioning strategies for nine reasons in the context. Figure 4.1 shows that the most frequently used was Strategy A, Repeating questions, and this was mostly intended to check prior knowledge on the teaching topics. Only one teacher reported that she used Strategy F: Easy to more difficult questions for the development of pupils' thinking, in an experiment with straws. One teacher shared her understanding with regard to using Strategy H: Asking humorous questions for encouraging pupils' thinking, when there was a concern about stress and boredom. It may be important to note that each of the 17 arrows was based on one teacher's answer.

To sum up, teachers who participated in the survey explained what questioning strategies they used in the context of their teaching. They usually reported two different strategies from the eight questioning strategies. Most strategies were related to the cognitive development of children and two of them were more important to the social and affective domains. It is apparent that, according to the teaching purposes, the children's answers to the questions informed all of the other strategies. In doing this, the teacher decided to elicit or extend the conversation by adopting one or more of the questioning strategies.
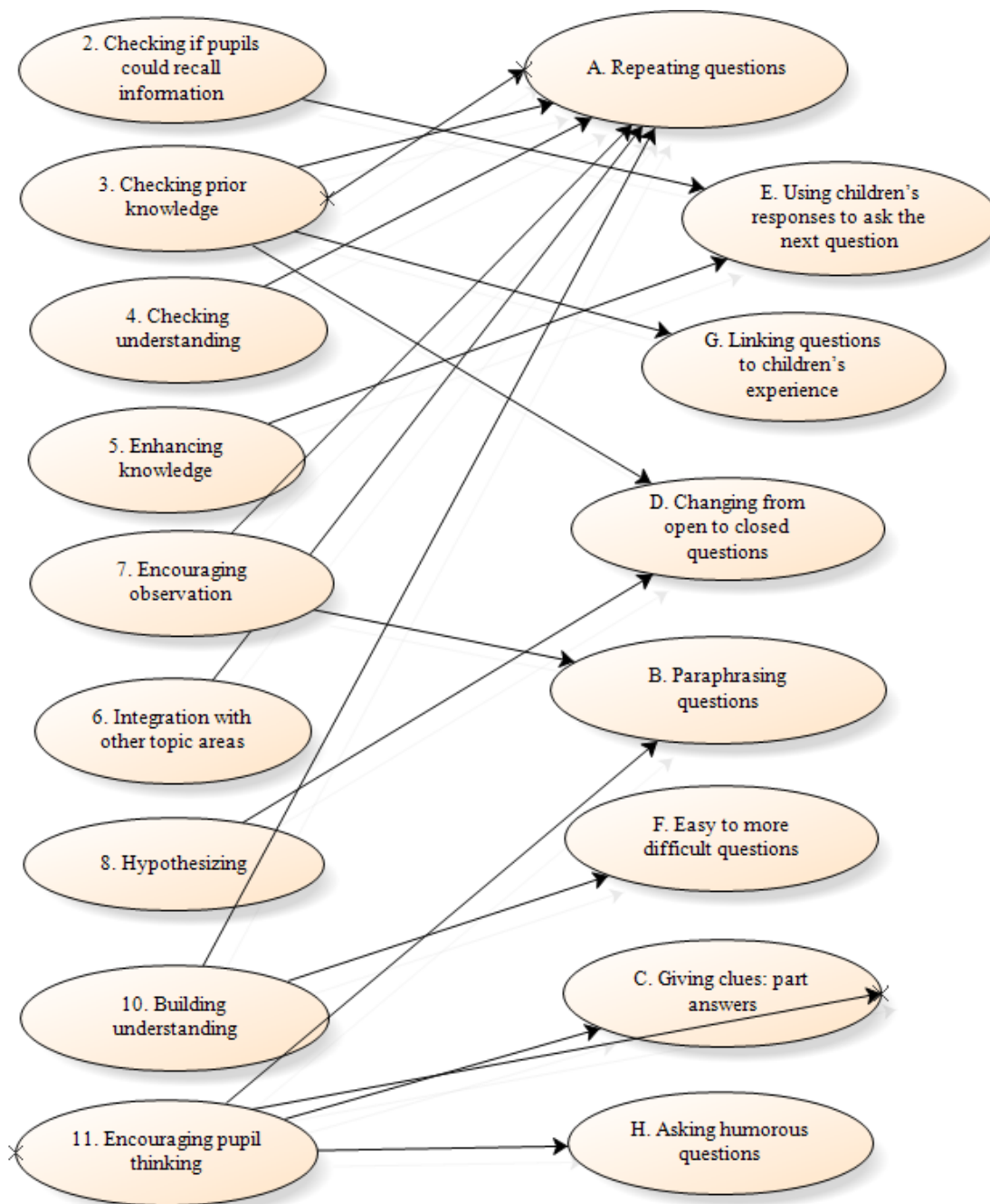
Figure 4.1: Questioning strategies and purposes combined

4.6 Additional features related to questioning: wait time, and selection of respondents

The themes with regard to the reasons for using wait time and the selection of respondents will be discussed in this section. Both features are related to the questions teachers discussed as the teachers can use them to encourage student participation. As stated in literature review, Section 2.4.2, the former feature could increase the length and quality of children's responses (Tobin

and Capie, 1982; Rowe, 1986), and implementing the latter feature specifies who is expected to answer.

The following findings were part of the template analysis but these data were general interviews about wait time and selection of respondents based on the literature review. In conducting the interview, I indicated a teacher's observed practice using the phrase "I noticed… . How did you use wait time?" to encourage teachers to provide examples and enquired for reasons by using prompts and probes. As a consequence, the interview data indicated that most teachers which I will present below shared a similar understanding that waiting time and employing response in unison were used to encourage classroom participant.

Wait time

Twelve teachers stated that they used waiting time in their lessons to encourage participation and engagement, but also to check understanding. Most teachers mentioned that there was a very short wait time (less than 3 seconds) because the questions were simple and pupils were able to answer. However, it was not clear from the interview data whether teachers referred to one child, some, or all children. They further pointed out that sometimes, when asking some questions, they had to wait to encourage pupils (Teachers 3, 7, 12 and 13), and/or when asking challenging questions (Teachers 9 and 15). In the former teaching situations, waiting time enabled those pupils who needed some time to think of an answer to respond to the questions posed. Teacher 3 said that waiting time was used in asking the question: 'What kinds of eggs do you know?' (T03;E1;A), as follows:

> Therefore, I had to wait because anyone who wanted to answer would have a chance to answer. If I pose a question and answer it quickly, the faster thinkers will answer. It will always be the same ones, but if I give them a chance, and wait some time, the slower thinkers will have a chance to answer (T3, post-lesson interview).

Selection of respondents

Another category of additional features relating to questioning is the selection of respondents. All teachers except for T10 noted that they intended for children to respond in unison when answering questions. After this, they occasionally selected a few knowledgeable children to confirm a fact or concept to the class again. Teacher 1 explained why she preferred answering together for children to express their opinions.

> So saying anything or repeating a friend's words is the way they express their opinions. If I forced them to raise their hands to answer one by one, they would not be confident enough to talk (T1, post-lesson interview).

A closer scrutiny also revealed that the main reason was that everyone was encouraged to express their own ideas as well as develop their self-confidence:

> By answering the posed question with their friends in class, they become brave enough to answer. This develops the child's self-confidence" (T05, post-lesson interview).

According to the teachers' responses, children become more confident every time they answer. In addition, not only does answering questions help learning, but also sometimes modelling answers and learning with their friends helps them to learn. Four teachers revealed that, after the class answers, a few knowledgeable children are selected to confirm the key concepts:

> Because I want the children who have not paid attention to see the success of their friends in answering, to listen to the answers which their friends offer. It is for them to compare that answer with their own answer in their mind, which they may not be brave enough to supply. I let them see that their own answer is the same as their friends (T15, post-lesson interview).

I will return to this practice of answering in unison in the discussion chapter, Section 5.6.2.

This section has described the reasons for using waiting time and the selection of respondents. Eight teachers said that they used waiting time to encourage participation and engagement, and subsequently to check understanding. The most surprising aspect in terms of the selection of respondents was that all pupils were expected to answer in unison, in order to develop the children's confidence, and afterwards a few knowledgeable children were selected to model the correct answer. According to Groisser (1964 cited in Good and Brophy, 1973), effective selection of respondents is shown by an even distribution of students' responses. The finding shows that allowing students to respond collectively may cause one agreed answer (Wragg and Brown, 2001).

4.7 Factors influencing teachers' understanding of their questioning practices

As part of this research's aim to understand teachers' questioning practice, I will present the teachers' accounts of some factors that help explain this questioning practice. The analysis of data gathering in the video-mediated interviews revealed some emerging themes and/or patterns, as presented in this section.

4.7.1 Teachers' teaching principles

Some teachers reported the importance of the concepts of formative assessment and enquiry-based learning in early primary science, which may result in the identification of certain purposes with regard to asking questions.

- **Formative assessment**

During the video-mediated interviews, some teachers (Teachers 4, 5, 11) mentioned that the questions asked for "checking prior knowledge" were influenced by the pedagogical concept of formative assessment. This was related to the belief that in order to provide the next step in the learning process, the teacher had to be able to determine their prior knowledge from their responses to such questions. Based on the children's responses, they could tell how much the children knew. Teacher 5 stated the reason for asking questions:

> When I ask questions, with children's answers I can assess the current knowledge of the child. I will then be able to provide an activity for them to ensure learning in the next step. This will achieve the objectives of the planned activity (T5, post-lesson interview).

This quotation indicates the relationship between the current and the new learning of the lesson in order for the children to learn. Another teacher added that "In case children already know, I can probably ascertain what they know to confirm their understanding of what they think is right" (T4, post-lesson interview). In order to teach a particular concept, when teachers know the children's prior knowledge, the next learning step can be developed.

In addition, questioning for *checking understanding* at the end of the lesson informed the understanding of the children, and connected it to the learning in subsequent lessons. Based on the weekly teaching topic on trees, Teacher 4 stated how she planned to teach the class in relation to the questions asked during the current week:

> He/she could bring a part of a weed [which is an example of a tree] and could answer the questions asked by me. This shows that he/she understands. … Next day, I will continue teaching about the growth of the tree, and types of trees. (T4, post-lesson interview).

As part of formative assessment, at the end of the teaching week on Friday, teachers and students summarised what they have learned. The children's responses to the teacher's questions could be used to assess their learning throughout the week.

- **Enquiry-based learning**

According to the analysis of the pre-lesson and post-lesson interviews, one finding showed that due to the recent changes, in-service training teachers had adopted an enquiry-based approach (Nanmeebooks, 2016) in which experimenting was organised in early primary education. The teachers teaching science to young children were taking part in a project entitled "Little scientists" (Princess Maha Chakri Sirindhorn Anthropology Centre, 2009). After the training,

teachers implemented twenty activities with the children as a condition of the membership of this project. The training provided the practical training and teaching materials. Therefore, most teachers, with the exception of Teacher 1, taught experimenting as they had been trained. The in-service training appeared to be an important factor in the pedagogical use of questioning related to scientific concepts, processes and skills. Among the eight teachers organising an experimental activity, those teachers who had attended the in-service training appeared to ask questions to develop enquiry skills.

4.7.2   4 to 5 year old children

The teachers explained in post-lesson interviews that when they asked questions about abstract words in order to check prior knowledge, and to explain the causes of experiments relating to the purposes of reasoning skills, the questions posed were too difficult for their pupils. Therefore, the questions asked have to be suitable for the children. Some teachers (Teachers 1, 2, 4 and 11) related their questions to the abilities of the children in their classes in that young children (aged 4 to 5 years old) are able to talk about concrete things, but not abstract ones. Although the lesson aimed to relate a change of colours to eating habits, Teacher 1 noted the cognitive abilities of the children in her class aged about 4 years old:

> He replies that if he drinks the blue water he may become blue, or maybe red. He imagined it as he moved from the concrete to the abstract. Now he only knows what he can see (T1, post-lesson interview).

This may be one of the reasons why teachers ask many factual questions. In a similar lesson teaching about what caused the removal of the egg shell, Teacher 2 added that although she asked questions in order to give reasons, they were unable to answer because they did not know.

Furthermore, teachers mentioned that the words used in the questions aimed at young children have to be understandable. For example, in conversations about bird movements, Teacher 11 stated that she used "come and go" instead of "move" for them to understand what she meant:

> In terms of animals' movements, students may know that birds can fly but they do not understand the word: "move" yet. Therefore, I used the words: "come and go". If I ask the question: "How do birds move?", they would not understand because "move" is a new word for them (T11, post-lesson interview).

It can clearly be seen that this group of children may not understand the word "move", and therefore the word "come and go" was used in the question asked.

4.7.3 *School curriculum*

The school curriculum in terms of types of tasks, assessment methods, and school policy was found to be of particular use in terms of questioning purposes, as explained in the following sections.

- **Types of task**

According to the four types of tasks (see details in Table 4.1), each task seems to define certain purposes when it comes to asking questions. Teachers (T8, T9, T14, T15) set up experiments and chose with the aim of teaching process skills in science such as observation, hypothesizing, experimenting and reasoning. Relating to the purpose of hypothesizing, Teacher 14 asked a question: "One does not work, so how many clips are needed?" (T14;E1;B). Children have to set up hypotheses regarding how many clips were needed to float and that answer could be 2, 3 or 4 paper clips. After the experimenting, the teacher gathered the whole class to discuss the possible reasons for floating. Her actual question aimed at inviting an individual child to talk was "Who knows why it sinks?" (T14;E2;D).

The designed experimental activity, whether a demonstration by the teacher or independent experimenting, aimed to promote particular scientific concepts and process skills. Teachers explained in the post-lesson interviews that the five process skills were 1) hypothesizing 2) experimenting 3) gathering data 4) findings 5) reasoning.

In terms of the group discussion activity, five teachers asked questions relating to knowledge of the teaching topic. For example, Teacher 11 stated that she asked questions about animals resulting in the students learning about bird movement, the two types of animals which are land animals and animals living in water, and relevant new words (T11, post-lesson interview). Clearly, she emphasised the importance of knowledge which is the foundation of the teaching topic with regard to types of animals, despite the fact that the main goal of group discussion is to enhance the ability to communicate.

- **Assessment methods**

In early primary education, questioning was one of the assessment methods, whilst examinations were used in primary education. Two of the teachers (T5 and T6) noted that the methods of assessment in the early years consisted of observation based on the children's behaviour, in which teachers' questioning plays an important role. They valued the importance of questions for their role in the assessment of the children's learning, rather than in terms of the guidance of children's learning. They were able to assess the degree of learning from the

children's responses after teaching. As Teacher 6 said, after children were involved in learning, they were assessed through asking questions:

> I asked many questions in order to evaluate them with regard to what I have taught, how much they have learned, understood, and know. Some children are able to answer that air is around us, and the air is burned which means they understand (T6, post-lesson interview).

They assessed the extent of learning against the learning objectives of the lesson, based on the children's responses. An assessment form that recorded the learning of the individual learner was used. This was designed in terms of three levels of learning: very good, good and fair. This is one of the possible explanations why teachers had to ask questions for the purposes of *checking prior knowledge* and *checking understanding*. Their use of questions seems to be useful in assessment and is part of their teaching duties, whereby they assess learning on three levels.

- **School policy**

School vision and pedagogical practice, which are regulated by the school principal, could influence teachers' questioning practices. In the context of School Seven (see Table 3.2), two teachers (Teachers 14 and 15) reported that because their school principal valued thinking skills, which indicate the school's vision and teachers' pedagogical practice, they tried to use questions to foster children's thinking. In the video-mediated interviews, Teacher 14 stated that, "This school principal orders us to copy out the book: 'Questions for thinking: 108 questions' in our own handwriting". The teachers were asked to do this at the end of the academic year in order to reflect on their practice of asking questions; for example, 'What type of questions do you most often ask the children?' As a consequence, their use of questions with children may have fostered the use of some open questions, which aims to promote thinking skills:

> I try to not use questions asking children to describe things: what is this and that? But I want them to develop critical thinking (T14, post-lesson interview).

One possible explanation why these teachers ask open questions to promote thinking skills may be because of the influence of the school principal.

4.8   Summary

This chapter has presented the findings on teachers' questioning based on the teachers' reflections explored in video mediated-interview data and from my analysis of video data. The main findings on teacher's views on the five features relating to questioning practice is shown

in Table 4.8. These features were: the purposes for using each question, the questions types, questioning strategies, and the two additional features of wait time and the selection of respondents. It was concluded that the teachers' views were more closely in line with the concept of scaffolding assistance in social constructivism because teachers reported that some purposes of asking questions assisted learning and were linked to some questioning strategies used. These main findings will be discussed in conjunction with those of previous studies and in terms of social constructivist theory in the following chapter.

Table 4.8: Summary of Thai teachers' views on questioning practice

Research questions	Features of teachers' questioning	Teachers' views
1. What purpose do Thai teachers report to have in asking questions?	Purposes in asking questions	• Most teachers stated the purposes of asking questions for checking prior knowledge as well as encouraging pupils' thinking • Among them, nine teachers mentioned the purposes of building understandings or encouraging thinking which elicited children's ideas of the learning undertaken • Seven teachers (T1, T2, T8, T9, T12, T14 and T15) expressed that they used some questions for doing activities. By doing that, they emphasised the importance of questions for observing and experimenting • Some questions were used by a few teachers (T3, T10, T12 and T15) for recall purposes
2. How do these understandings relate to open and closed questions?	Purposes in relation to open and closed questions	• The first three purposes that had the highest percentages of open questions rather than closed ones was hypothesizing,

		• experimenting and building understanding
		• The majority of the children's responses (approximately 61 percent) to the 74 teachers' questions were very short one word answers
3. What strategies do Thai teachers identify for structuring questions?	Questioning strategies	• Teachers' responses in the interview were categorised into eight strategies used in terms of scaffolding assistance
		• These strategies were tailored to children's needs for formulating answers
		• No questioning strategies included talk amongst the children
		• Strategy E: Using children's responses to ask the next question seems to extend responses
	Wait time	• Twelve teachers mentioned that they used wait time in order to encourage participation and engagement
	Selection of respondent	• All teacher participants with the exception of T10 noted that they expected children to answer in unison to the questions asked. Ten of them added that they selected a few knowledgeable pupils to model the correct answer
		• Eight of them stated that the reason for their preferring

	answering in unison was to encourage the pupils to express their ideas as well as to gain self-confidence

Chapter 5   Discussion

5.1   Introduction

The purpose of this chapter is to discuss and explain the main findings presented in the previous chapter and to compare these findings with those of relevant previous studies, as well as to address the aims of this research (as stated in Chapter One). The research questions are as follows:

> 1. What purpose do Thai teachers report to have in asking questions?
> 2. How do these understandings relate to open and closed questions?
> 3. What strategies do Thai teachers identify for structuring questions?

In order to achieve this study's aim, the outcome of the discussions based on the theoretical framework may assist educational practitioners and academics in shedding new light on the classroom questioning practices of the teachers of young children in the Thai context.

This chapter is organised as follows. In relation to the research findings presented in the previous chapter, the first four sections (Sections 5.2, 5.3, 5.4 and 5.5) relate to the discussion of the issue of teachers' questioning practices based on their reflections, whereas Section 5.6 relates to discussions on the factors influencing teachers' classroom questioning. The purposes of questions asked by teachers in the classroom, the question types, and the questioning strategies as part of the scaffolding process are discussed in Sections 5.2, 5.3 and 5.4, respectively. In Section 5.5, understanding of teachers' questioning and their roles from the point of view of social constructivism will be examined. Furthermore, in Section 5.6 the discussions with regard to the three main groups of factors, namely teachers' cognition, social and cultural factors, and contextual factors, are assessed. Finally, a summary of this chapter is provided in Section 5.7. This section also includes the proposed conceptual model aimed at enhancing our understanding of teachers' questioning in early primary teaching in Thailand, which is considered to be the main contribution of this study.

5.2   The teachers' purposes in asking questions

This study aims to provide a better understanding of teachers' views regarding purposes in asking questions (Dillon, 1988; Biesta, 2013). Based on the perspective of social constructivism, the purposes of questions, which represent teachers' views of how children learn and what should be taught through questioning, will be explained.

In relation to research question 1, "What purpose do Thai teachers report to have in asking questions?", an analysis of the interview data showed eleven varieties of teachers' purposes in

asking questions when teaching science in early primary education in Thailand, as described in the Findings Chapter, Section 4.3. Although the context of their study was literacy in Year 2, and different from this current study's findings, most purposes of asking questions are in line with the study of Myhill and Dunkin (2005). One distinct purpose of the questions from the study, which was specific to the early primary teaching in Thailand, was the "integration with other curriculum subjects" owing to teaching as it is viewed as integrating, not separating, subjects (The Ministry of Education of Thailand, 2003). However, children's abilities related to "talk for learning" (Mercer, 2000; Mercer *et al.*, 2004) were not mentioned. In Kawalkar and Vijapurkar's study (2011), comparisons were made of the questioning of Grade 7 teachers in traditional and enquiry classrooms. They coded categories of teachers' questions in both types of classrooms for intended purposes using classroom and video observations. A sequence of question categories was examined and the number of questions asked in each category was counted; therefore, a comparison of two types of classrooms was possible. Teachers' questions in the enquiry classrooms usually led to discussion and debate between the teacher and the children, which was not the case in the present study.

This current study found that some of the purposes in asking questions noted by the teachers could be relevant to the pedagogical concept of formative assessment in social constructivism in learning. One of the interview findings showed that eight teachers asked questions for "checking prior knowledge" before they provided teaching and learning activities for children. One of them, Teacher 4, who aimed for the children to learn about a tree's components, explicitly expressed that she intended to check the prior knowledge of colours in order to provide a suitable experience in the teaching lesson. This finding may be related to the pedagogical concept of formative assessment in that the teachers use the children's prior knowledge to plan their teaching and organise the following learning for children (Black and Wiliam, 1998a; Black *et al.*, 2003):

> Teachers need to establish children's prior knowledge and understanding in order to develop their learning and understanding of new information and concepts effectively (Myhill and Brackley, 2004, p. 273).

Prior knowledge reveals the children's understanding according to their responses to the questions asked. In fact, based on the children's responses, the teachers may uncover the children's understandings or misunderstandings (Burns and Myhill, 2004). However, such formative assessment practices contrast with the practice of answering in unison, as will be discussed in Section 5.6.2.

The purposes of questions relating to formative assessment are representative of the teaching approach of Nuffield Science (Nuffield-Chelsea Curriculum Trust, 1993). Following Nuffield Science in England (see Section 2.3 in the Literature Review), which applies a social constructivist approach in teaching science, three of the five pedagogical roles of teachers are finding out children' ideas, supporting process skills, and assessing change in learning. Evidence on the two purposes of "checking prior knowledge" and "checking understanding" as mentioned before, may be similar to the first and last pedagogical roles recommended by Nuffield Science. This finding suggests that using questions as part of formative assessment is very useful because information is provided to adjust the teaching and learning (Black and Harrison, 2001). In addition, the three purposes in asking questions found in this current study were "hypothesizing", "encouraging observation" and "experimenting", which were used to enhance process skills. They may be related to the second pedagogical role.

Apart from the purposes relating to formative assessment, it was found that teachers provided opportunities for children to construct knowledge and understanding through questioning. The two related purposes of questions were "enhancing knowledge" and "integration with other topic areas." One interesting finding is that the teachers (T3, T11, T12 and T13) said that they promoted the learning of children in terms of scientific concepts by creating cognitive conflict together with using questions to scaffold learning to the children's need. In terms of scientific knowledge, they aimed for children to construct knowledge on types of eggs (T3), bird movement (T11), warnings about sunlight (T12), and common factors of humans and animals (T13) through the interaction. Their explanations may be in line with the Piagetian concept of cognitive conflicts and the concept of scaffolding (Wood *et al.*, 1976), as discussed in the Literature Review in Sections 2.2.2 and 2.3.

This current study further found that seven teachers (see Table 4.3) expressed that they used some questions for engagement in doing activities. By doing these activities, they emphasised the importance of questions in making an "observation" and "experimentation" whilst they were demonstrating experiments, as well as self-experimenting. This finding seemed to be in line with the constructivist view of learning. In relation to learning by doing, teachers organised opportunities for first-hand experience. The children were using the sense of seeing in the former situation and the latter involved the sense of touching. These results are likely to demonstrate a constructivist view of learning. According to Piagetian theory, learning is an active process and children actively construct their understanding of the learning by interaction with their environments (Davis, 1991; Wood, 1997):

The assumption underlying learning was that children would spontaneously 'discover' the laws of science by being presented with the right materials in the right environment by the teacher, acting in the role of 'facilitator' (Collier *et al.*, 2011, p. 78).

It is possible that through teachers' questioning, they develop scientific skills such as observation and experimentation.

Another finding in this current study was that some of the questions were identified by a few of the teachers (T3, T10, T12 and T15) for the purpose of recall. Although these teachers used questions for other purposes, "checking if pupils could recall information" was also mentioned. They reported that children could remember information due to recalling the same knowledge several times in the lesson, which may be matched with transmission models of teaching. This finding confirms the findings of previous studies on teachers' questioning (Myhill and Dunkin, 2005; Kawalkar and Vijapurkar, 2011). Kawalkar and Vijapurkar (2011, p. 2017) concluded that in traditional science classrooms most of the questions that appeared were for factual recall. It is well-known that such questions for recalling could be influenced by a transmission model of teaching. Asking questions focuses on the recitation of facts as the expected correct responses from children (Cohen *et al.*, 2004). It is important for teachers to realise that recall may promote the learning of new vocabulary or facts relating to the learning topic but constructions of knowledge and building on understandings may be not achieved.

Although the recent literature on classroom interaction emphasises the importance of the role of talk or sustaining a classroom dialogue in promoting learning science in England, there is no explicit evidence on questioning purposes relating to "talk for learning" (Mercer, 2003; Alexander, 2008). Researchers (Mercer, 2003; Alexander, 2008) have suggested that a teacher's questions may be used to foster the children's learning by both extended and reflective talk, as characterised by dialogic talk. Rojas-Drummond and Mercer (2003) note that teachers' questions could encourage the students to pose questions of their own. This current study suggests that the next step forward for teachers is to encourage "talk for learning" (Mercer, 2003; Alexander, 2008).

In conclusion, an analysis of the interview data indicates that the eleven purposes of asking questions mentioned by Thai teachers may be in line with pedagogical concepts of formative assessment, scaffolding learning, learning by doing, and rote learning. Under the social constructivist view of teaching and learning, their current purposes of formative assessment and scaffolding are supportive to the learning of children, but this study suggests that teachers could further promote "talk for learning" to provide a greater opportunities for learning (Mercer, 2003; Alexander, 2008).

5.3   The teachers' questions

Although the findings on teachers' purposes in asking questions were discussed in the previous section, the discussion in this section will examine the extent to which open and closed questions were used for each question purpose. According to this study's aim, research question 2 was: "How do these understandings relate to open and closed questions?" Many researchers (Mercer and Littleton, 2007; Alexander, 2008) have suggested that the use of "open questions" may lead to classroom interaction between the teachers and the students and that helps promote learning.

One of this current study's findings was that, of the eleven purposes, the highest percentages in purposes in asking questions was "checking prior knowledge" (approximately 22%), as 19% were classed to be in the form of open questions and 81% were closed (see Table 4.5). This high percentage of closed questions was due to the fact that this purpose requires factual information on how much children know about teaching topics. In contrast, the findings show that the purpose of "hypothesizing" was composed of only open questions, which is because these questions require speculation. These findings support Newton's concept of "focused questions" which means that "It is not a matter of *one* kind of question being better than another but of recognising *which* kind is needed and knowing how to use it to good effect" (Newton, 2013, p. 11, original emphasis).

This current study found that 18 of the 74 teachers' questions (approximately 24%) in early primary classrooms were open questions (see Table 4.6). This finding confirms the results of previous studies in primary classrooms in England (Brown and Edmondson, 1984; Galton *et al.*, 1999b; Harrop and Swinson, 2003) that the number of open questions asked was considerably less than the number of closed questions. In fact, the greater number of open questions in this current study than in previous studies may have been because of the dataset of questions identified by teachers in the video-mediated interview and the definitions used, as explained in Sections 4.3 and 4.4.1. In addition, it was evident that, although responses to the questions asked were two words on average, some of the open questions asked by the teachers in this current study elicited varied or relatively long responses (see Section 4.4.2). An example of a response made up of several words may help the child to develop reasoning, which may contribute to the development of higher thinking skills (Galton *et al.*, 1999b; Alexander, 2000). The reason why open questions help promote learning is relevant to the learning concept in social constructivism (as discussed in Section 2.2.3) in that an individual learner constructs the meaning of what they have learned through interaction.

It was expected that teachers would ask more closed than open questions as reported in previous studies. Our findings (see Table 4.6) showed that, based on the dataset of 74 questions, the majority (about 76%) of the questions posed by the teachers to four to five year-old children were closed. The results of this current study are consistent with the previous findings (Brown and Edmondson, 1984; Galton *et al.*, 1999b; Harrop and Swinson, 2003) where, in England, teachers in primary schools asked a great number of closed questions. Siraj-Blatchford and Manni (2008) found that the pre-school teachers involved in the REPEY project used only 5.1% open questions, whilst 94.9% of the questions were closed. In answering teachers' questions classified as closed questions, the teacher may tend to request correct responses to pre-determined answers (Kerry, 2002; MacNaughton and Williams, 2009). This may encourage children to participate in a "guessing game" to guess what answer the teacher is looking for (Wilson and Haugh, 1995; Haworth, 2001; Mercer and Littleton, 2007).

Based on the findings presented in Chapter 4, 39% of the closed questions found in this study were *forced alternative* questions. Researchers (Wittmer and Honig, 1991; de Rivera *et al.*, 2005) have suggested that *forced alternative* questions place a number of constraints on pupils when it comes to responding, because children select an answer from the choices available. In contrast, open questions invite the children to formulate their own responses. It is not surprising that the children's responses to the 74 questions asked by the fifteen teachers were very short, of two words on average, and usually involved facts (see Section 4.4.2). The results with regard to *forced alternative* questions suggest that these questions may invite children to guess the answers from the possible answers provided (Edwards and Furlong, 1978; Fisher, 1995). It can be said that the overuse of this question could limit opportunities for children to talk as part of the learning process.

Although it is important to ask "the right question at the right time" (Myhill *et al.*, 2006), any purposes of questions were found to be beneficial for learning. Newton (2013, p. 11) notes that "All are useful productive questions but are stronger in their use if focused on particular stages in a lesson." However, according to social constructivism, learning is perceived as co-constructions of knowledge through interaction, with an effective use of questions to help children connect new experiences with prior knowledge. In order to do this, the role of sustaining dialogues, which are usually initiated by teachers' questions, will allow participation and learning. Teachers' questions may promote better opportunities for learning and pupils' understanding as teachers invite children to share their ideas, as they are required to formulate their ideas in words. In order to improve the quality of teachers' questions for learning, researchers (Mercer and Littleton, 2007; Alexander, 2008 to name a few) have encouraged

teachers to use "dialogic talk" (Alexander, 2008) where teachers' questions may be used to guide the children's learning.

For teachers to develop higher thinking in children, instead of asking quick fire questions, effective questions elicit higher cognitive responses. According to Bloom (1956), the taxonomy of questions or higher-order questions which invite the pupils to give reasons, speculations or make an argument will develop higher-order thinking. In Bloom's cognitive level of analysis, one of the teachers' questions, "Why does it [the egg] become white?", will promote reasoning as the various ideas and many different responses given by the children are welcomed.

In summary, based on this study's dataset of 74 questions, Thai teachers reported eleven questioning purposes. Apparently the purpose of hypothesizing comprised all the open questions. This finding on the use of open question may invite a longer response of children's ideas for developing understanding. There is a need for teachers in this present study to raise the quality of asking open questions of high levels of thinking when they aim to achieve particular purposes.

5.4   The use of questioning strategies as part of scaffolding assistance

According to the concept on scaffolding in teacher-children interaction, one of the findings in this current study was that my categories of eight questioning strategies could be characterised as scaffolding means and functions (Wood *et al.*, 1976; Tharp and Gallimore, 1988; van de Pol *et al.*, 2010), which teachers employ to provide supports by reducing cognitive demands on children in solving a task. This current study provides a detailed account of teachers' views on the use on questioning strategies. In the following sections, the questioning strategies in relation to the pedagogical concepts of scaffolding and the possible impact of the use of the strategies on children's learning will be discussed.

Research question 3 was "What strategies do Thai teachers identify for structuring questions?" One video-mediated interview finding based on teachers' accounts was the eight categories of questioning strategies used in teacher-child interaction, which is initiated by teachers' questions to foster learning in the areas of cognitive, social and affective development (see Table 4.7).

A. Repeating questions

B. Paraphrasing questions

C. Giving cues: part answers

D. Changing from open to closed questions

E. Using children's responses to ask the next question

F. Easy to more difficult questions

G. Linking questions to children's experience

H. Asking humorous questions.

In their science activities, the teachers helped the young children with cognitive development by using the first six questioning strategies (from A to F). These strategies are commonly seen in the findings of previous studies (Mehan, 1979; Wragg and Brown, 2001), in that if question initiation does not receive a reply from children, teachers may employ them to elicit children's responses. Another two strategies were: G. Linking questions to children's experience and H. Asking humorous questions, which seem to relate to social and affective development, respectively. Based on the pedagogical concept of scaffolding in social constructivism, the teachers can assist the learners through the use of one of these questioning strategies (from A to H) within the ZPD in dealing with the task. The teacher plays a vital role in being more knowledgeable than others, and without the teacher the children may not be able to finish on their own (Tharp and Gallimore, 1988; Wood, 1991; Mercer, 1995). According to Vygotsky, language (in this case the use of questioning strategies by Thai teachers) is a psychological tool for the development of mental functions (Daniels, 2001).

Based on the concept of scaffolding in the ZPDs as discussed in Literature Review chapter, in order to use questioning strategies effectively, teachers must use them in terms of "contingency management" in a way that is suited to the children's needs (Wood *et al.*, 1976; van de Pol *et al.*, 2010). The six strategies (from A to F) found in this current study may be categorised as prompting and probing (Wragg and Brown, 2001; Cohen *et al.*, 2004), which are follow-up moves to be employed if children do not reply promptly. Following Wragg and Brown (2001, p. 33), the definitions of prompting and probing refer to prompts providing clues or more help in answering questions, while probing requires extended answers for students to think more deeply. Four types of prompting are represented in questioning strategies (Strategies A, B, C and D) and only Strategy E is a type of probing. As presented in Chapter 4, all teachers (except for Teacher 13) identified one or two questioning strategies, of which Repeating Questions was the most often used strategy. Between the two strategies (i.e. repeating questions and paraphrasing questions), undoubtedly paraphrasing questions may be more effective because the teacher is phrasing the question with new, simpler, words to adapt to the children's needs (Wragg and Brown, 2001; Cohen *et al.*, 2004).

Strategy D, Changing from open to closed questions was the most supportive strategy in prompting strategies, as follow-up questions were tailored to the children's needs of the ZPD. For the instruction roles of the four strategies, the teachers applied the first three strategies

when there were negative children's responses. The follow-up questions were adapted to the children's needs as teachers in this current study reduced linguistic or cognitive demands on children (van Merrienboer *et al.*, 2003; Myhill and Warren, 2005). This finding on teachers' adjustments to question initiations is similar to the findings of Nathan and Kim (2009), Myhill and Warren (2005), and Mehan (1979). Nathan and Kim (2009, p. 109) found that "there is evidence that the teacher adjusts his elicitations in a manner that appears to be responsive to students' statements." The finding of this current study was based on teachers' views on the use of questioning strategies, but such studies (Mehan, 1979; Myhill and Warren, 2005; Nathan and Kim, 2009) were based on the classroom discourses of what the teacher and children actually said to each other.

One interesting finding shows that two types of open and closed questions, as discussed in the section above, were adjusted to the needs of the children in the class. This current study found that 36% of closed questions were *forced alternative* questions. In discussing their question's purpose, some teachers (Teachers 1 and 6) reflected on their use of *forced alternatives*, which was a consequence of children being unable to answer the posed question before. Teacher 1 described their use of three levels of questions to be adjusted to children's prior knowledge, as can be seen in Findings Chapter, Section 4.5.3. They were "What will happen?", "Will it the same or difference?" and "Will it turn blue?" An appropriate use of questioning types should be contingent on the level of children's ability. Some authors (Wittmer and Honig, 1991; de Rivera *et al.*, 2005) noted that *forced alternatives* limit answers from children. The current study argues that *forced alternatives* may be appropriate if such questions are closer to a child's needs than other question types. Several studies have reported (Galton *et al.*, 1999a; Harrop and Swinson, 2003) that the level of schooling seems to be unrelated to the predominant use of closed questions asked in classrooms. Harrop and Swinson (2003) concluded that among four types of questions (closed, open, task supervision, and routine), teachers of infants and in the primary and secondary classroom employed similar proportions of closed questions. This accounted for approximately 47% of all questions.

In contrast, the questioning strategies for probing applied by teachers enabled the extended responses of the children and greater interactive interaction. One questioning strategy (E. Using children's responses to ask the next question) found in this present study is a form of probing. Two teachers said that they employed this strategy to extend children's responses (see the Findings Chapter, Section 4.5.3). This present study found that children's responses were extended (see Sequence 4.5 in Section 4.5.3) because talk created a construction of knowledge on a learning topic such as bird movement. Probing may be the most useful strategy in

developing children's thinking (Wragg and Brown, 2001). In a study conducted by Smith *et al.* (2004), in English primary classrooms of teachers teaching literacy and numeracy, probing is used less often than closed and repeating questions, in about 11% of exchanges. There is a need for teachers to use probing regularly in order to create classroom talk.

When thinking levels are raised by questions, this can promote the learning of the children. Relating to the sequencing of questions in the lesson, Strategy F (easy to more difficult questions) was found to cause the development of higher levels of thinking as stated in Section 4.5.3. According to Bloom's taxonomy (1956) or its revised version of Anderson (2001) the teacher's role in questioning is to foster a child's higher levels of thinking. It was found that Teacher 14 expressed this strategy for the purpose of promoting high levels of thinking. This strategy confirms that of Nathan and Kim (2009), who found that "teachers tend to move toward higher levels of prompting when students successfully respond to CE [Choice elicitation] and PE [Product elicitation] questions" (p. 104). Importantly, in the lesson, a series of questions asked by teachers leading to questions with higher-order thinking can promote children's higher levels of thinking.

In the teacher-children interaction, there was not only a focus on the cognitive domain but also on the social and affective domains of child development. A number of teachers explained that they had a concern for prior experience and the feelings of the children that they taught. The two strategies: G. linking questions to children's experience and H. asking humorous questions, were related to such concerns. Firstly, Strategy G maintains asking and answering questions that the class were able to answer. The teachers stressed the importance of participation for pupils to interact with the teachers and their friends, rather than cognitive development. Secondly, Strategy H concerned the maintenance of children's interests in the activity they were involved in. It was clearly shown in her intentions for the questioning that "I ask some humorous questions, which they enjoy." (T12, post-lesson interview). These questioning strategies can be used in instruction, which is similar to the findings of Wood *et al.* (1976), who provided guiding strategies of "recruitment" and "frustration control" in the completion of a 3D puzzle (see Section 2.3). Recruitment focuses on the encouragement of a child's interest in the task and frustration control means that the task the child is set does not cause the child to feel stress or danger (Wood *et al.*, 1976).

To sum up, all teachers, except Teacher 13, thought that questioning strategies are important to employ in their interactions with the children and one or two strategies were described by each teacher. It was evident that the teachers adapted their questions to the children's needs, as they valued the use of eight questioning strategies (e.g. Strategy D. Changing from open to closed

questions). This current study suggests that teachers may promote better learning for children if they use questioning strategies in the form of probing regularly to extend children' response (Nassaji and Wells, 2000; Smith and Higgins, 2006).

So far, this chapter has discussed classroom questioning practice based on teachers' reflection. The discussed issues are the research findings which have emerged from this research as presented in the previous chapter. The issues comprise of teachers' questioning purposes, the types of questions used by teachers, and their questioning strategies. This is summarised in Figure 5.1.

Social constructivism

- Teachers' purposes in asking questions
- Open and closed questions
- The use of questioning strategies as scaffolding
  - Cognitive domain: prompting and probing
  - Social domain
  - Affective domain
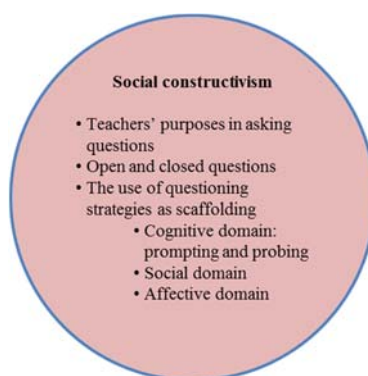
Figure 5.1: Classroom questioning practice based on teachers' reflections

5.5   Teachers' understanding on their questioning practice

Based on this current study's findings and the theoretical concepts of pedagogy in social constructivism, this section discusses how the teachers perceived the use of questions and how this could be characterised by the pedagogical concepts of scaffolding and co-construction of understandings (Jordan, 2009; MacNaughton and Williams, 2009). These concepts could be viewed as part of the pedagogy in early primary teaching.

Based on the findings found in this current study teachers appeared to use questions to support children's learning; the teachers' questions were contingent with children's needs, which would create interaction and then children's learning. There is clear evidence of questioning purposes and questioning strategies to support that the teachers asked questions daily and intentionally for a variety of purposes (see all purposes in Table 4.3). When the children seemed to be unable to answer the questions asked, all the teachers except Teacher 13 explained that they used one or two questioning strategies (see Table 4.7). The teachers' accounts of these findings, as discussed previously, confirmed Vygotsky's concept of instruction (see Section 2.2.3):

> Instruction is only useful when it moves ahead of development (Vygotsky, 1987, cited in Daniels, 2001, p. 54).

In successful teaching, they stressed the purposes of questions for checking prior knowledge and understanding to provide future teaching at the level of the potential development that the child could achieve. The benefits of gaining a repository of question strategies would mean that the teacher could apply the most suitable one at the right time (Myhill, 2006). As reviewed in Section 2.2.2, the teachers who held a cognitive constructivist view of learning would not intervene in the children's learning. However, from a social constructivist point of view, the teacher's role in providing scaffolding assistance through questioning is perceived to be a very useful tool or effective instruction in supporting learning.

This current study's findings may be interpreted as showing that the teachers' understanding of their questioning practice is in accord with the concept of scaffolding, rather than the concept of the co-construction of knowledge in social constructivism, as will be discussed. This is because they reported that they asked questions for varied purposes and often used one or two of questioning strategies in scaffolding learning. In fact, no teacher described questioning purposes relating to "talk for learning" (Mercer, 2003; Alexander, 2008) and only one strategy of follow-up moves to extend children' responses was stated by teachers. Based on social constructivism, the teacher's role is vital to foster children's learning through interaction (Vygotsky, 1978; Tharp and Gallimore, 1988; Wells, 1999; Burns and Myhill, 2004; Smith and Higgins, 2006; Mercer and Littleton, 2007; Alexander, 2008). The interaction allows the construction of knowledge in which talk is co-constructed between the teacher and the class.

Consistently, it was ascertained that through questioning, teachers appear to employ varied questioning strategies to support children's learning about science concepts, its processes and skills. Their use of questioning was largely related to Bruner's instructional concept of scaffolding (see Section 2.3). Jordon (2009) proposed three models of teacher-child interaction, each with a differing perspective on the level of participation. This current study will use Jordon's (2009) model of "adult-direct interactions" to make sense of the Thai teachers' reflections on the pedagogical role of questioning, which is described as a "questioning technique, with a particular knowledge outcome in the teacher's head" (Jordan, 2009, p. 49). Teachers explained that their questions allowed an assessment of the children's prior knowledge, presented opportunities for scaffolding learning (particularly with regard to scientific concepts) and an opportunity to develop understandings what the teacher had taught. In this teacher-led interaction, the teacher's role is understood as being more knowledgeable and the child/student as less knowledgeable.

A review of the literature revealed that two concepts need to be distinguished (Jordan, 2009), those of scaffolding and of co-constructing understandings. Similarly, the role of questions as part of the teacher-child interaction can be clear in use when they are related to these concepts. Bruner et al.'s (1978) description of "scaffolding" emphasises the process of instructional intent to support a child in solving a problem with a defined goal. The ultimate purpose of questioning, they explained, was to provide an assessment of a child's state of learning. In this sense, teachers value questions as a method of scaffolding learning for children (see Table 4.7), as questions were described as useful in the scaffolding process. From an analysis of video-mediated interview data, it may be useful to note that when asking questions, teachers also use other means of scaffolding such as modelling. For instance, Teacher 7, in asking a question about the colours of tree leaves that the children had seen, modelled the way leaves fall down by waving her hands. In this sense, the use of questioning and modelling by teachers occurs within the context of the instructional process of scaffolding.

According to the pedagogical concept of co-constructing understandings with children, there was little evidence from this current study to suggest that the teachers aimed to ask questions for the co-construction of knowledge. Asking questions as part of this concept was rare, possibly due to the fact that the interaction needed to operate in an equal sharing of meaning and power (Malaguzzi, 1993; Jordan, 2009; MacNaughton and Williams, 2009). Questions to construct meanings can be defined as "staff and children forming meaning and building knowledge about the world with each other" (MacNaughton and Williams, 2009, p. 177). This concept supports the importance of teachers' questioning for children's learning. One important finding of questioning strategies in this current study shows that a few teachers (T10 and T11) mentioned using Strategy E (Using children's responses to ask the next question) and this is part of probing, as discussed in Section 5.4. Researchers (Nassaji and Wells, 2000; Smith and Higgins, 2006) suggest that teachers use strategies relating to follow-up moves in order to create classroom interaction (see Section 2.4.1). This strategy is a way to support children's learning because extended responses may be elicited and peers are invited to talk in class.

In summary, there is sufficient evidence to suggest that early primary teachers in this study had a fragmented knowledge on questioning practice as they explained that they used questions for varied purposes and often employed one or two questioning strategies employed in teaching science. The teachers' understanding of their questioning practice was closely in line with the concept of scaffolding, rather than co-construction of knowledge.

5.6   Factors influencing teachers' understanding of their questioning practice

The subsequent three sections of this chapter are a discussion of the factors influencing teachers' questioning practices. The factors are categorised into three main groups: teachers' cognition, sociocultural factors, and contextual factors. The individual types of factors will be presented in each section, respectively.

5.6.1   *Cognitive factors based on teacher cognition*

This research found that teachers' cognition plays a vital role on teachers' questioning in the classroom. This section will discuss the factors relating to teachers' cognition. These factors include: teaching principles, educational courses and teaching experience, as shown in Figure 5.2.
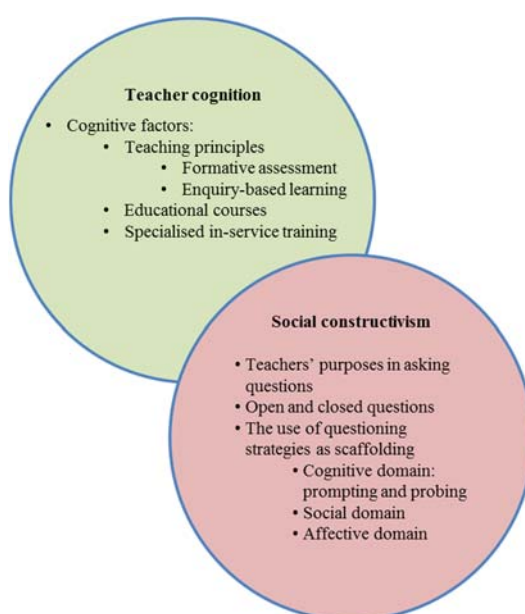
Figure 5.2: Teachers' cognition influencing Thai teachers' classroom questioning practice

- **Teaching principles**

Teacher cognition of teaching principles, including approaches, certainly plays a part in the pedagogical practice of teachers' questioning (Anning, 1988; Ekasingh, 1992). A possible explanation why some teachers who graduated in education seem to be skilful in questioning in comparison to teachers in other fields (who graduated in Home Economics, Librarianship, the Psychology of Guidance, and Agriculture) is because they adopt some teaching principles of constructivism. It was found that a few teachers (Teachers 4, 5, 11) clearly mentioned that formative assessment as an underpinning concept influenced the purpose of checking prior knowledge, which often took the form of closed questions (as presented in Sections 4.4.1 and

4.7.1). In terms of teaching approaches in early year teaching, this current study found that most teachers with the exception of Teacher 1 adopted and taught their lessons in terms of activities of experiments and demonstrations, as they had been trained. A focus on developing scientific skills as part of enquiry-based learning in science may lead them to use the three types of questioning purposes: encouraging observations, hypothesizing, and experimenting. Developing such skills seems to lead to asking questions for such purposes. This implies that with the pedagogical goals of lessons, they used questions to develop enquiry skills in science. This finding confirms those of several other studies, such as Anning (1988), who found that beliefs in teaching and learning highly influences their pedagogical practice.

- **Educational courses**

Although teachers' accounts regarding questioning practice were varied, this current study found that teachers who had earned a bachelor's degree in other fields apart from Education (T3, T8, T9 and T13) tended to raise example questions in the closed, rather than open form. Perhaps, it is unsurprising because Vartuli (1999) stated that teachers with knowledge in early childhood education appeared to adopt developmentally appropriate practices, in which one of the principles is promoting learning mainly through interactions with adults or peers. Therefore, those teachers who tend to focus more on providing appropriate guidance for whole child development, rather than teaching content, may be more successful. In addition, two teachers (T1 and T14) with a masters degree used questions for the specific purposes of forming a hypothesis and they held an understanding of the effective use of questioning strategies concerned, which were contingent on a child's needs. They may have developed that understanding by attending education programmes or by attending special training programmes. It was found that Teacher 14 was the only teacher who had attended specialised in-service training in teaching science in early primary education.

5.6.2 *Social and cultural factors based on socio-cultural theory*

Apart from the discussion on the factors in relation to teachers' cognition, this section will discuss the social and cultural factors that influence Thai teachers' questioning. Such factors include answering in unison and collectivism (as illustrated in Figure 5.3).
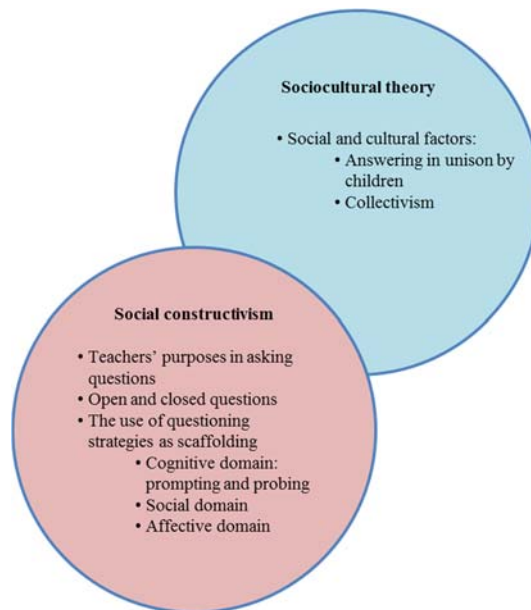
Figure 5.3: Social and cultural factors influencing Thai teachers' classroom questioning practice

- **Answering in unison**

It is known that ground rules in classrooms are implicit and control children's behaviour in terms of participation and responses (Mercer and Dawes, 2008). It appears that most teachers in the current study expected children to reply to questions by answering in unison. This may be a reason why several purposes in asking questions aimed to enquire knowledge; for example, the highest percentage (22%) of purposes was "checking prior knowledge". As the interaction rule was answering in unison, this may imply that only the right answers were accepted by the teacher and agreed by the group. Wragg and Brown (2001, p. 31) noted that chorus answers lead to a child's loss of interest in the teacher's questioning. This rule seems to lead to convergent responses from the group of children. This rule of answering in unison is consistent with Mercer's ground rules in traditional classrooms, one rule of which is "Pupils should not speak freely when a teacher asks a question, but should raise their hands and wait to be nominated" (Mercer and Dawes, 2008, p. 58). Even though the children in this current study were allowed to answer in unison, this led to only one acceptable right answer. In fact, based on sociocultural perspectives, *answering in unison* is a cultural tool, which is used by teachers in the classroom because collectivism (Hofstede, 1986; Triandis, 2001) is a main feature of Thai society because this society values group decisions, rather than individual opinions. Teachers use it to interact with the children.

- **Collectivism**

Additionally, the Thai culture of collectivism could explain why the 74 questions identified by teachers to discuss elicited fairly short answers of two words on average. According to Hofstede (1986), Thai students tend to speak when they are personally called by teachers but British students would tend to talk in response to general invitations. When Thai children are asked to answer the teachers' questions, they reply with short responses and the conversation tends to end quickly. Mercer (1995) proposed the characteristics of *exploratory talk*, which promotes varied responses in children's learning. Their ideas and reasoning should be shared and created from individual children in the class (Mercer, 1995). This finding suggests that ground rules need to be made explicit if they differ from what the Thai children are used to so they may share more ideas in class. This is supported by the result of the Thinking Together programme conducted in UK, which shows that when talk rules were explicitly established in science learning for Year 5 children, this resulted in improved abilities of talk when compared with the control group of children (Mercer *et al.*, 2004). Their talk had many features of exploratory talk: "They ask each other for information and opinions, seek reasons and provide them, share their thoughts, and evaluate proposals that are made" (Mercer *et al.*, 2004, p. 369).

5.6.3 *Contextual factors based on the Thai context*

As found in this research, there are several factors that influence teachers' classroom questioning which relate to the contextual factor category (Fang, 1996; Sahin *et al.*, 2002), as shown in Figure 5.4. After the discussion of the factors in relation to teachers' cognition and social and cultural factors, the contextual factors discussed in this section include factors relating to the class size of children, their ages, and the Thai early childhood curriculum. They were specific to the context of early primary education in Thailand, as explained in Section 1.3.2. A more detailed discussion follows with regard to particular factors.

- **Large classes of children**

Teaching a large class of children may limit teachers when it comes to asking particular types of questions for the co-constructing of meaning (Jordan, 2009; MacNaughton and Williams, 2009), such as hypothesizing, building understanding, and encouraging pupils' thinking. The findings indicate that teachers tended to aim questions at the whole class, with an average of 23 children, each of whom may know different things. One teacher (T1) stated that the questions she asked focussed on her whole class of 28 children, each of whom may have different levels of knowledge and understanding. Myhill and Dunkin (2005, p. 425) asked in

their study whether the whole class setting, where teachers cater for 30 children, is suitable for asking conceptual questions that develop higher-order thinking, because teachers have to maintain the children's interest, behaviour, and responses.
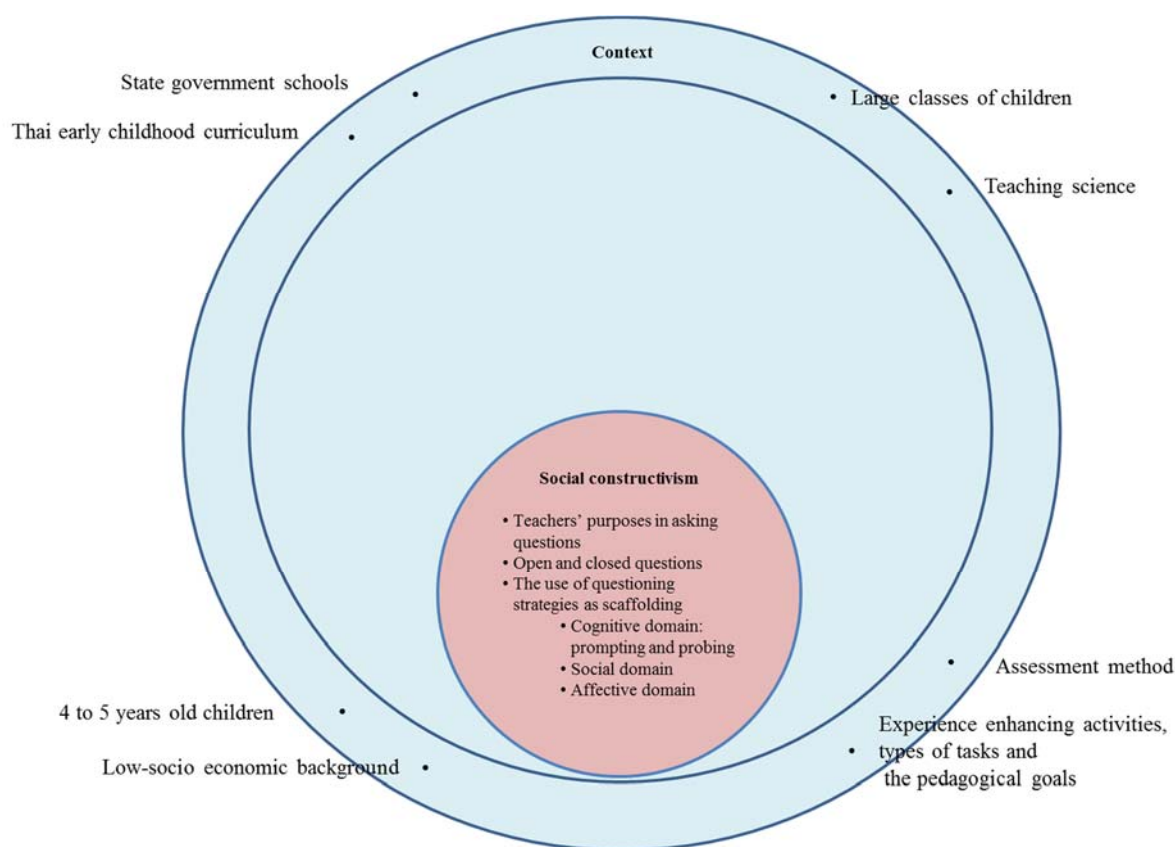
Figure 5.4: Contextual factors influencing Thai teachers' classroom questioning practice

- **4 to 5 year old children**

Relating to teachers' purposes of questions mentioned previously in Section 5.2, teachers' use of many questions in eliciting factual information may be influenced by the cognitive development of 4-5 year olds. The findings show that 76% were closed questions which required factual information, with 36% being *forced alternatives*. Are *forced alternatives* appropriate to ask with young children? An analysis of the interviews showed that four of the fifteen teachers said their questions needed to be appropriate for children's ability in answering questions, in that young children are able to talk about concrete, but not abstract words or concepts (see Section 4.7.2). This understanding could be related to the pre-operational stages of Piaget's theory of cognitive development (see Table 2.1). Their abilities when it comes to answering questions may be limited by their own perspectives where concrete and meaningful objects appear, and to non-logical reasoning. For example, Teacher 6's questions was, "Why did the candle go out?" (T06;E2;C), and a child replied that "the candle was touched by the

transparent glass." The child's response was that the objects there were the candle and glass, whilst the scientific answer was a burning process in which oxygen is burned by heat.

- **Thai early childhood curriculum**

As discussed in the Introduction Chapter, the Thai Early Childhood Curriculum emphasises child-centredness (Angeles-Bantista, 2004; Pinyoanuntapong, 2013). The curriculum focuses on learners and learning, rather than teachers and teaching. In both the "Thai National Early Childhood Curriculum" (The Ministry of Education of Thailand, 2003) and "The Learning Experience Plan in Early Childhood Education" (Department of Local Administration of Thailand, 2004), teachers are conceptualised as planners and facilitators in a child's educational journey of learning through play (see Section 1.3.2). There is an emphasis on "hands-on experience" that could be influenced by the Piagetian perspective on teaching, whereby teachers are facilitators. However, this approach seems to underestimate teachers' role as *teachers* in terms of the scaffolding and constructions of learning (Jordan, 2009). Teaching strategies—especially questioning—are not explicitly mentioned in the document, which provides guidance for how teachers can successfully promote children's learning. It is therefore suggested that there is a need for policy makers to pay attention to the vital role of teachers and teaching in providing effective guidance, especially questioning.

- **Assessment methods**

This current study found that teachers valued the importance of questions for their role in the assessment of the lesson, based on children's responses (see the findings in Section 4.7.1). The teachers interpreted a child's responses to a question to assess the child's ability, according to the learning objectives of each lesson. One of the current study's findings was that teachers (T5 and T6) explained that their use of questions helped in the assessment of children's learning by observing a child's behaviour. Children's answers enabled them to assess their understanding before and after teaching the lesson. There is evidence to suggest that the observation method was influenced by the method of assessment in Thai early primary teaching. As part of early primary education in Thailand, the assessment of children's learning and development is based on observations of children's behaviour and their work (The Ministry of Education of Thailand, 2003). Therefore, it can be concluded that asking questions for the purposes of checking prior knowledge and checking understanding may be due to the assessment requirements.

- **Experience enhancing activities, types of task, and pedagogical goals**

Among the four types of tasks, teachers reported that questions for science learning were often asked in an experimental setting (as reported in Section 4.7.3). The teachers who organised tasks in terms of experimenting, rather than tasks with group discussions or tasks with hand-on experience, tended to ask some questions to promote enquiry skills. These results are in accordance with recent studies (Turnbull *et al.*, 2009; Lee and Kinzie, 2012), indicating that teachers' use of the questions is relevant to contextual factors in terms of the various types of activities. This finding confirms that of Lee and Kinzie (2012), that a greater number of teachers ask high thinking levels of questions in the context of an experimental activity, as these are designed to encourage speculation and reasoning.

5.7   Summary

This chapter has discussed Thai teachers' questioning in terms of purposes of questions, open and closed questions, and the strategies used for questioning in relation to previous studies based on the theoretical framework of this study, as summarised in Figure 5.5. This study found that teachers reported varied purposes for the questions identified for discussion in the teaching context. It was also found that almost every teacher referred to using one or two questioning strategies in the interaction with the children. Therefore, it can be concluded that to a great extent Thai teachers applied questioning to support learning, according to the learning objectives of the teaching lesson, which could be related to the process of scaffolding within the ZPDs of children in the class.

Figure 5.5 shows that teachers explained their use of questioning strategies as part of the scaffolding process for learning. The teachers' questions helped ascertain prior knowledge, and then promoted understanding in science. Questions for understanding aim to foster the conceptual, procedural, situational and casual understandings of situations (Newton, 2000; Newton, 2001). Asking questions helps children to articulate their prior knowledge, to discuss the topic with the teacher or their peers, and then construct understanding. Unlike the memorisation of facts, understanding a situation refers to having a mental model of it such as in the case of birds (Johnson-Laird, 1983; Newton, 2000; Newton, 2001). In fact, from the social constructivist point of view, teachers or peers play a vital role in their role as more able persons to scaffold learning through questioning.

It can be concluded that teachers in the use of questioning in this current study supported mental model development. I perceive cognitive constructivism and social constructivism belonging to social constructivism within the model about questioning practices. As reviewed in Sections

2.2.2 and 2.2.3, in terms of both theories, learning is caused by mental model development (Pritchard, 2009, p. 17) and that development can be explained by the inferencing process (Johnson-Laird, 1983; Fincher-Kiefer, 1992; Newton, 1996). Therefore, for teachers to support a child's mental model development, new information or learning experience (e.g. carrying out an experiment) provided by the teachers have to be relevant to the child's prior knowledge and experience. Such experience can support mental development because, based on cognitive constructivism, the child learns best through interaction with his or her environment. Undoubtedly, the use of questioning is an important tool for teachers in order to scaffold learning as supported by social constructivist theory. I would argue that social interaction as normally initiated by questioning, strongly influences the development of mental models.
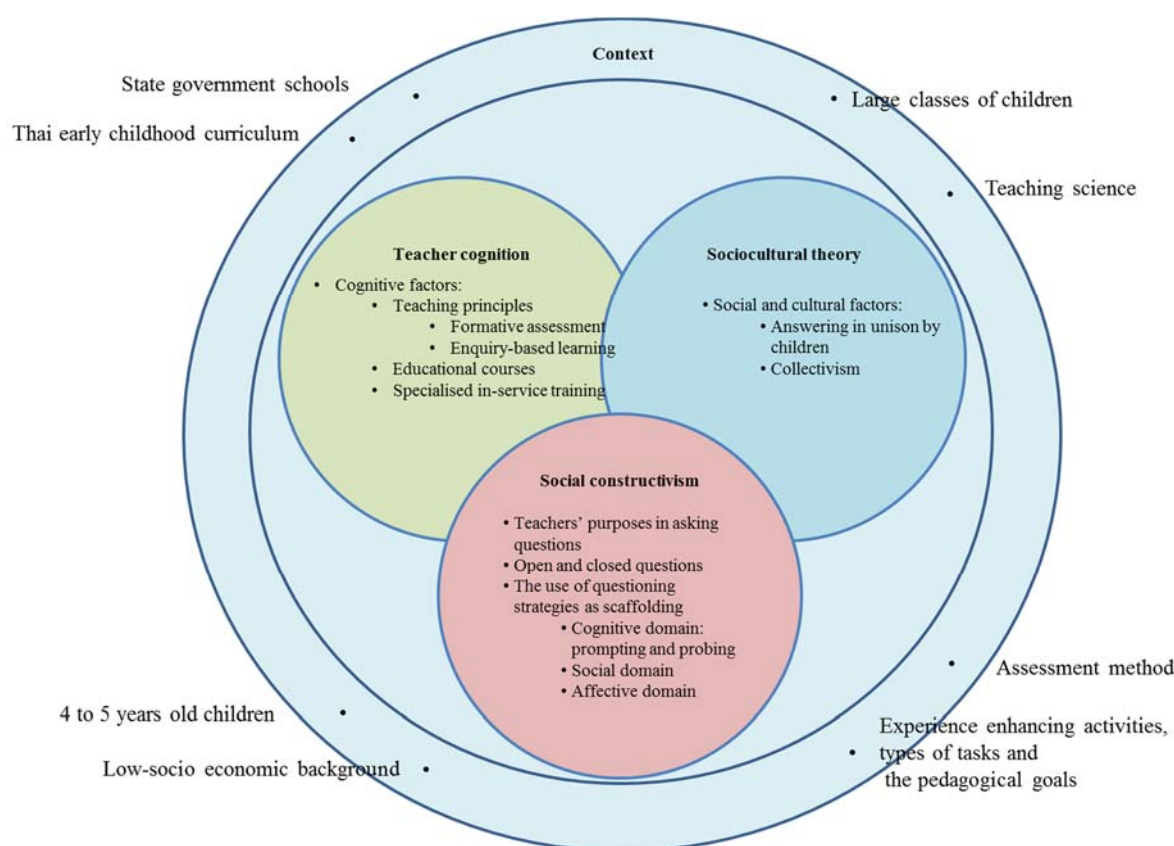
Figure 5.5: Proposed conceptual model of Thai teachers' classroom questioning practice and influencing factors

In summary, this chapter has proposed a theoretical model to understand Thai teacher questioning practices in science classrooms in early years schooling (see Figure 5.5). This model is considered to be a significant contribution to knowledge in this field, which helps to fill the gap in knowledge previously noted in the literature review (Chapter Two), where it was noted that teacher questioning in early primary teaching is under-researched in Thailand. The

model was based on the discussed issues that were derived from these research findings, the research context, and the relevant literature. Regarding the proposed conceptual model, there were three main groups of factors that influenced the teachers' questioning in classroom (as mentioned above). They were: teachers' cognition, sociocultural factors, and contextual factors. Moreover, this model also revealed the complexity of factors influencing teachers' classroom questioning by illustrating the potential of the social and cultural factors that may influence teachers' cognition, which, in turn, may also impact the way teachers use questions in the classroom. This is also in the same vein of the contextual factors that may affect both teachers' cognition and cultures, apart from directly influencing the classroom questioning of teachers.

The next chapter contains the research conclusions, and provides a summary of this study, including the main research findings, the practical implications, and the contribution to knowledge of this research. Furthermore, it also includes some recommendations for educational stakeholders, such as early primary teachers and policy makers, and for future research.

Chapter 6   Conclusions

6.1   Introduction

After conducting an extensive literature review in relation to learning theories and questioning in classrooms, the emerging issue of the science classroom in early primary education was selected as the research topic for this study (see Chapters 1 and 2). The purpose of the current study was to investigate teachers' understanding of their questioning in scientific lessons with young children in state government schools in Surat Thani, Thailand. This chapter presents the conclusions of the research by summarising and discussing the issues, based on the research process, findings, and discussion.

In Section 6.2, the main research findings are explained, as they are related to the research questions, which were set up in the earlier stages of the study. Equally important as this is doctoral research are the contributions to knowledge, both in terms of content and methodology, which are explicitly expressed in Section 6.3. The implications of the current research for Thai education with regard to early primary teachers, academics, and policy makers are given in Section 6.4. Finally, the recommendations for future researchers are presented in Section 6.5.

6.2   Main findings

The questions posed at the beginning of this study now make it possible to state that all the relevant issues of this research were addressed. The methodology and methods chapter demonstrates how I arrived at answers to the individual research questions.

Research Question 1: What purpose do Thai teachers report to have in asking questions?

Teachers' accounts were categorised into eleven purposes in asking questions (see Table 4.3). Two purposes in terms of checking prior knowledge and checking understanding were stated by teachers, which could be related to formative assessment. Undoubtedly, this practice can help promote better learning because the teaching might possibly support the connected learning experience of the children (Myhill and Brackley, 2004).

Another finding was that teachers explained that questions were considered useful in terms of enhancing knowledge by creating cognitive conflict. As part of learning science, teachers' questions were considered to play a vital role in scaffolding learning for the development of skills in observing, experimenting, and thinking.

From all the purposes identified, developing children's understanding by encouraging "talk for learning" (Mercer, 2003; Alexander, 2008) was not mentioned by the teachers. For children to build an understanding, teachers could ask questions to extend answers, talk with peers, and reflect on their learning. As a result, this learning experience would promote a greater understanding of what they have learned.

This study has shown, relating to classroom rules (Mercer and Dawes, 2008), that social and cultural factors on answering in unison and collectivism may result in a dominant use of asking closed questions, which require factual information.

This study found that there are links between their teaching principles and approaches, and the use of particular purposes in asking questions. Some teachers (T4, T5 and T11) reported that their purposes of checking prior knowledge and checking understanding were influenced by the principle of formative assessment.

Research Question 2: How do these understandings relate to open and closed questions?

An analysis of video data showed that three purposes in asking questions: hypothesizing, experimenting, building understanding, and encouraging pupils' thinking were useful for promoting children's understanding and developing the thinking skills of young children. This study showed that asking these question types tended to be in the form of open questions (see Table 4.4).

This study showed that questions used for the five purposes of checking if pupils could recall information, checking prior knowledge, checking understanding, enhancing knowledge and integration with other topic areas had more than or equal to 75% of closed questions. It is a fact that these purposes require facts in the answers to the question posed, to determine the extent to which they relate to predetermined answers.

When considering the closed questions, this study found that approximately 36% of the closed questions were of a *forced alternative* type (22 out of 56 closed questions). This refers to questions that children reply to by selecting one of two, or sometimes three, answers. The overuse of this type of question could be explained by the cognitive abilities of 4-5 year old children.

Although the children's responses was not a focus of this study, the features of their responses were primarily analysed to investigate any positive impact of questions on children's learning in terms of their responses. Regarding the children's responses to the questions, this research

also found that the responses to the 74 questions asked were very short, with an average of two words.

Research Question 3: What strategies do Thai teachers identify for structuring questions?

Based on concepts of scaffolding and the co-construction of knowledge within the ZPD, the findings show that one or two of the eight questioning strategies were generally mentioned by each teacher (see Table 4.7).

It was found that of the six strategies (Strategy A to Strategy F) relating to cognitive development, four strategies were a form of prompting, in that the question initiations were tailored to the children's needs in terms of prior knowledge and experience. Another strategy (Strategy E, Using children's responses to ask the next question) could be referred to as probing. Importantly, probing may be the most useful strategy due to the fact that classroom interaction and extended children's responses could be developed as a result. The difference between prompting and probing was explained in Section 5.4.

This study found that four teachers (T8, T10, T12 and T14) mentioned questioning strategies (Strategy F and Strategy G) concerning the child's development of social and affective domains. This finding seems to be different from the findings of studies in classroom discourse, and therefore it may be important to note that these areas of development are equally important with the development of cognition (The Ministry of Education of Thailand, 2003).

6.3   Contributions to knowledge

The findings from this study make a contribution to current knowledge, based on the research findings, as well as the research methodology used.

6.3.1   Contributions to existing work

Regarding the existing literature, there is a lack of studies on teachers' questioning in scientific classrooms at the level of early primary teaching, particularly in the context of the south of Thailand (see the gap in knowledge of this research in Section 2.9). Therefore, the conceptual model emerging from this research is considered to be the main contribution to knowledge. These findings enhance our understanding of teachers' questioning in scientific classrooms in early primary education.

This model was developed based on the selected questioning features of the three major elements: purposes in asking questions, the question types, and the strategies used in the interaction. In the proposed conceptual model of this research (as shown in Figure 5.5), three

levels of factors on teacher cognition, social and cultural factors and contextual factors influencing the use of questioning are shown. Teachers' cognition of the teaching principles of formative assessment and enquiry-based learning in early primary science had a direct impact on the questioning practice. Relating to another level of social and cultural factors, an expectation of answering in unison and Thai culture of collectivism brought constraints in the use of questioning. Additionally, teaching large class sizes, children aged 4 to 5 year olds and the Thai context of early primary education had some constraints on the use of questioning.

The proposed model may enable early primary education stakeholders, such as teachers, school principals, teacher trainers, and policymakers, to enhance teachers' questioning practices and enable educational researchers to facilitate their research by testing or extending the model, or proposing a solution to progressing teachers' questioning practices. As a consequence, these may result in an improvement of teachers' questioning practices in the early primary education, which, in turn, may lead to an advance in children's learning outcomes.

Additionally, the conceptual model could be applied to other similar contexts or *'transferability'*. Transferability is the conceptual model of understanding the complex phenomenon of how teachers use questioning in the classroom, which can be adapted to state government primary schools in other regions in Thailand, or other developing countries which have similar contexts. The findings of this research could claim to be generalizable, in the context and time that the research was conducted (time and context bound working hypotheses). The research participants came from the seven state government schools in Surat Thani province, which is not representative of the whole population of early primary teachers in Thailand. Therefore, the research results might not be transferable to the entire Thai early primary teacher population. However, they might be adaptable to other early primary teachers who have similar contexts to the schools in this research.

Apart from the proposed conceptual model, the findings of this study may contribute to the previous literature on pedagogical practice and questioning. However, because much of the literature consulted was based on studies conducted in the UK, it identified a dominant use of closed questions asked to test knowledge (Rojas-Drummond and Mercer, 2003) and the results of this study showed that this phenomenon also happened in classrooms in Thailand.

Firstly, one of the most significant findings to emerge from this study is that eleven purposes of asking questions were reported (see Table 4.3). Although similar findings have been found from other studies on the later stages of primary education, this research's findings contribute to the literature on questioning purposes in early primary education and/or in the context of

Thailand. Based on social constructivist perspectives, the relevant purposes were related to the pedagogical concepts of formative assessment and scaffolding and also, relatively, to the co-construction of knowledge. However, there is limited use of questions for "talk for learning" (Mercer, 2003; Alexander, 2008), in which children are invited to talk about their learning.

Secondly, the study showed that in the dataset of 74 questions identified by teachers to discuss in the video-mediated interview, most of the teachers identified questions with varied purposes in teaching science; moreover, the percentage of closed questions was usually higher than the open. Therefore, teachers tended to value the questions which aimed to enhance children's knowledge more than to promote understanding on the learning topic. This study has shown, relating to classroom rules (Mercer and Dawes, 2008), social and cultural factors on answering in unison and collectivism resulted in a dominant use of asking closed questions to test knowledge. There is a need to advise teachers to make talking rules explicit if they are different from the traditional Thai classroom rules and to develop a co-construction of knowledge. Based on the social constructivist approach, children are encouraged by questions to construct knowledge and understanding.

Thirdly, this study has also shown that most teachers reported using questioning strategies to promote classroom talk, even though that did not happen (see Section 4.5). Two strategies focusing on the social and affective areas of the child's development, extends the literature of questioning strategies used by teachers in the science classroom and/or in early primary education in the Thai context. According to the concept of scaffolding, the use of the eight questioning strategies was centred on the child's needs, and this provides empirical evidence of "contingent management" (Wood *et al.*, 1976; van Merrienboer *et al.*, 2003; Myhill and Warren, 2005; van de Pol *et al.*, 2010). This function of scaffolding is crucial for the effectiveness of supporting children's learning. Adaptation of a sequence of questions to the children's needs would result in learning through interaction.

Finally, this study found that there are some links between their teaching principles and approaches and the use of particular teachers' purposes of questions. Questions asked for checking prior knowledge were influenced by a concept of formative assessment. The teaching approach of enquiry-based learning in early primary science was found to foster process skills in learning science, as these questions were aimed to produce encouraging observations, hypothesizing, and experimenting, as discussed in Section 5.6.1. These findings suggest that teacher cognition of particular principles and approaches may be the main factor in questioning practice.

6.3.2 Methodological contributions

The use of video-mediated interviews employed in data collection was found to be useful in the study of teachers' questioning practice. The teachers were invited to do a reflective practice on their purposes of asking questions. Sahin *et al.* (2002) pointed out that teachers have difficulty in the articulation of their questioning practice. The method of the video-mediated interviews adopted in this study enabled most teachers to explain the use of questions in teaching. It can be said that even though they knew very well about their practice in the more detailed accounts, teachers were unfamiliar with talking about their practices, which showed in the lack of metalanguage in their responses concerning educational terms. Learning to be critical in "reflection-in-action" (Schön, 1987) of their practice would lead to continuing professional development. The benefits of this method was engaging participation (Harper, 2002; Woolner *et al.*, 2009; Hadfield and Haw, 2012) that enabled this study to have a greater understanding of the use of questions within the context.

6.4 Implications of the study

This study's findings have several important implications for practitioners, academics and policy makers in Thailand. Implications regarding Thai teachers' questioning could contribute to teacher education, professional development, and indirectly to children in classes.

- **Implications of the proposed model of Thai teachers' questioning practice for stakeholders in Thai education**

The proposed model for understanding may enable stakeholders in Thai education (such as practitioners, academics and policy makers) to gain a better understanding of the complexity of teachers' questioning in practice. The three main elements of the questioning practice were: the derived purposes, the question types, and the strategies used in the interaction with the children in the context of teaching. Three layers of factors influenced the use of questioning, which were: the teacher's cognition on formative assessment and enquiry-based learning, the social and cultural factors relating the classroom rules on answering in unison and Thai culture of collectivism, and the contextual factors relating to the large classes of children, cognitive abilities of 4-5 year children and the Thai early childhood curriculum. By gaining an understanding of the current situation of questioning, stakeholders may use this information to provide some action for the benefit of children's learning.

Regarding practitioners, it is clear that the ones who gain the most benefit from this study are teachers themselves. This is because, with a range of questioning purposes and strategies

derived from this exploratory research, teachers can enhance their skills in questioning. Although the majority of them know how to ask questions in a classroom, the fragmentation of purposes in asking questions and strategies in scaffolding learning is evidence that there is room for them to improve their skills. Thus, a more comprehensive understanding in questioning, from the results of this study, may improve their questioning performance.

In terms of policy makers, it is clear that several factors influencing teachers' questioning practices found in this research are beyond the control of individual teachers. For example, training is needed to enhance teachers' skills in questioning as they mostly gain this skill from experience rather than official training. As a consequence, policy makers play an important role in the improvement of Thai teachers' questioning skills as a whole. Therefore, the findings of this study may result in policy makers gaining a better understanding in Thai teachers' questioning, which may, in turn, lead to the introduction of a clear policy to promote classroom questioning for Thai teachers.

Some of the recommendations for policy makers are shown here. Asking better questions and developing questioning strategies may be some of the tools that can lead to this achievement in the quality of Thai education as mentioned in the Introduction (Section 1.2.2). Therefore, the formal training of teachers for questioning in classrooms may be the solution. Moreover, based on the literature review, this study found that guidance on pedagogy in early primary teaching was missing in government documents. The guidance on teachers' questions for promoting children's learning should be featured in the curriculum guidance, which is to be published by the government. An example of good teachers' questioning should be revealed as a model to be developed.

- **Pedagogical implications for early primary teachers and teacher educators**

This study has found that teachers' understanding of pedagogical practice on questioning appears fragmented according to the questioning purposes, varied types, and strategies used by each teacher. Enhancing teachers' understanding on questioning purpose, types, and strategies may extend a repository of questioning. Alternative and more effective ways of using the questions and strategies could be adopted in teaching contexts. The findings about the categories of eight questioning strategies, as shown in Table 4.7, and the existing literature, present comprehensive strategies that could be used as follow-up questions in order to extend children's responses and sustain classroom dialogues (Dillon, 1988; Wood, 1991; Nassaji and Wells, 2000; Smith and Higgins, 2006). This can be done by the pre-service and in-service teacher trainers. A comprehensive course on teachers' questioning should be included in the

curriculum of teacher education in Thailand, due to the fact that questioning is an important skill for every teacher (Harrop and Swinson, 2003).

This study has found that Thai teachers ask varied types of questions in terms of teachers' purposes in asking questions, but tend to elicit very short answers of two words on average. The question types asked and their impact on children's learning needs to be focused on. This can be communicated to the teachers and followed up by self-reflections as part of attending their in-service training. The findings regarding the actual questions, in terms of particular purposes of questions as discussed in Section 4.3, may be used as examples. In addition, there is a need for teachers to plan questions asked before teaching. For educational purposes of promoting children learning and their thinking skills, teachers may need to learn to ask more purposeful questions. Planning what questions are to be asked in a lesson may be a next step forward (Wragg and Brown, 2001; Myhill, 2006). Wragg and Brown (2001, p. 21) suggested that, in order to ask questions for children to think, we ought to plan what questions need to be asked.

It was found that two teachers were influenced by the school principal, as presented in Section 4.7.3, and other teachers reported no experience on reflective practice on asking questions. Reflective practice on the use of questions may result in a greater understanding for teachers in their questioning practice. Individual early primary teachers should be provided with working hours per school term for an opportunity to perform reflective practice for professional development. In order to improve the questioning, reflective practices, such as mentoring, coaching and writing would be very useful. Walsh (2006), suggested that watching videos would raise the teachers' language awareness, which would be applicable to their teacher questioning practice. Similar to the Self Evaluation of Teacher Talk (SETT) framework in language teacher education, three aspects of teachers' questioning, for example, the purposes, types of questions and questioning strategies, may be used as focus points for reflection. With an aim of improving children's learning, teachers may improve their practices by testing out new ideas. Raising an awareness of why the questions are asked would help to promote questioning practices.

Apart from pedagogical knowledge as discussed previously, a teacher's own subject knowledge may influence the quality of his or her questions. In this current study most teachers in early primary education taught all subjects in the curriculum, so generally they were not specialised in science. Questions tends to aim for formative assessment and scaffolding, rather than the co-construction of understandings (as discussed in Section 5.5). One of the reasons may be a lack of knowledge in science so "those who lacked content knowledge tended to emphasise the

recall of facts and propagate their own misunderstandings" (Newton and Newton, 2001, p. 370). In Newton and Newton's study (2000) on subject content knowledge in Key Stage 2 primary science lessons in England, teachers with scientific backgrounds tended to ask more questions in order to promote casual understanding than did non-science teachers.

> One way of achieving this might be by providing an *organising structure* for the teachers' science knowledge, by developing *skills of information management*, and by *contextualising pedagogical knowledge*" (Newton and Newton, 2001, p. 375, original emphasis).

The subject content knowledge raises teachers' confidence in teaching science (Harlen and Holroyd, 1997).

6.5   Recommendations for further research

Further studies regarding the role of questioning in learning would be interesting in several aspects. There are five main areas that can be pursued as future research resulting from this study.

Firstly, one of the areas as future research is the role of questions in bringing about classroom dialogue and teaching thinking skills. Although it is beyond the boundary of this research, according to the research aims previously stated in the Introduction Chapter, it is still interesting to investigate this issue. This is because teachers' questions play a crucial role in classroom dialogue due to the fact that the dialogue is normally initiated by the teachers' questions. This study investigated teachers' purposes in asking questions. The future research could examine its explicit roles of questions as part of classroom dialogues, which can lead to a good effect on children's thinking skills.

Secondly, because of the nature of the qualitative research of this study, we cannot make a generalisation regarding Thai early primary teachers because the participants involved in this research represented a small population. The wider scope and the context of the future studies could improve the rigor and provide a generalization of the findings. This research focused on state government schools, which are the majority of schools in Thailand. Thus, it would be an opportunity to enrich the findings of this research by using the proposed conceptual model of this study to scrutinise such a new context. Furthermore, since this research was conducted in the early primary education, other levels of education, such as primary and secondary schools, could also be considered for future work. In doing so, this would lead to the benefit of transferring the proposed model to other contexts, as well as comparing the new research results

to those of the current research. Additionally, future research similar to this study can be conducted in the other subjects apart from science, such as mathematics and literacy.

Thirdly, further studies on teachers' reflections of the complexity of teacher questioning could be conducted by gathering data several times during the academic year. A longitudinal study on teachers' questions could lead to more detailed data and a greater understanding of teachers' questioning. The greater picture of teachers' questioning to investigate the relationships between, the questioning purposes and the derived question types, the questioning strategies used and any other influencing factors could be obtained. Hence, the number of participants needs to be small (about five teachers) to give a greater understanding of teachers' questioning practice and a clearer picture of each teacher, and the whole team. Due to the time constraints and the scope of the study, this research gained a broader picture of fifteen teachers teaching at seven state movement schools.

Fourthly, this research may serve as a basis for future studies, in terms of the improvement of questioning in the science classroom and/or in the early primary education in the Thai context. This is because these findings enhance our understanding of questioning practice by teachers in state government schools. Within this research, the question purposes, types and strategies employed by teachers for questioning were explored and discussed and the influencing factors such as answering in unison were identified. Hence, as further research, it is possible to evaluate a particular questioning purpose, introduce a specific novel strategy or to investigate an effectiveness of answering in unison to the classrooms in this context.

Finally, further research may compare the quality of questions asked by specialised and non-specialised teachers in science. One important factor that influences the quality of teachers' questions was a teacher's subject knowledge. Providing categories of questions in terms of knowledge and understanding can indicate the quality of questions asked by the two groups of teachers. This investigation would raise the importance of subject knowledge in terms of the quality of questions in science lessons and in oral discussions as a means of supporting learning. The appropriate way to provide training to non-specialised teachers about science could be explored.

References

Abd-Kadir, J. and Hardman, F. (2007) 'The discourse of whole class teaching: a comparative study of Kenyan and Nigerian primary English lessons', *Language and Education*, 21(1), pp. 1-15.

Alexander, R. (2000) *Culture and Pedagogy: International Comparisons in Primary Education*. Oxford: Blackwell Publishers.

Alexander, R. (2008) *Towards Dialogic Teaching: Rethinking Classroom Talk*. 4th edn. Thirsk: Dialogos.

Alexander, R. (ed.) (2010) *Children, Their World, Their Education: Final Report and Recommendations of the Cambridge Primary Review*. London: Routledge.

Anderson, L.W., Krathwohl, D.R., Airasian, P.W., Cruikshank, K.A., Mayer, R.E., Pintrich, P.R., Raths, J. and Wittrock, M.C. (2001) *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*. New York: Longman.

Angeles-Bantista, F.D. (2004) *Early childhood care and education in South-East Asia: Working for access, quality and inclusion in Thailand, the Philippines and Viet Nam*. UNESCO Bangkok.

Anning, A. (1988) 'Teachers' theories about children's learning', in Calderhead, J. (ed.) *Teachers' Professional Learning*. London: Falmer Press, pp. 128-145.

Arthur, J. and Cremin, T. (2010) *Learning to Teach in the Primary School*. 2nd edn. London: Routledge.

Athey, C. (2007) *Extending Thought in Young Children: A Parent-Teacher Partnership*. London: Sage.

Banks, M. (2001) *Visual Methods in Social Research*. London: Sage.

Baumfield, V. and Mroz, M. (2002) 'Investigating pupils' questions in the primary classroom', *Educational Research*, 44(2), pp. 129-140.

Bell, D. (2008) 'Engaging teachers, engaging pupils, engaging science: are we learning our lessons?', *Education Today*, 58(3), pp. 1-12.

Biesta, G. (2013) *The Beautiful Risk of Education*. Boulder: Paradigm Publishers.

Black, P. and Harrison, C. (2001) 'Feedback in questioning and marking: the science teacher's role in formative assessment', *School Science Review*, 82(301), pp. 55-61.

Black , P., Harrison, C., Lee, C., Marshall, B. and Wiliam, D. (2003) *Assessment for Learning: Putting It into Practice*. Maidenhead: Open University Press

Black, P. and Wiliam, D. (1998a) 'Assessment and classroom learning', *Assessment in Education: Principles, Policy & Practice*, 5(1), pp. 7-74.

Black, P. and Wiliam, D. (1998b) 'Inside the black box: Raising standards through classroom assessment', *Phi Delta Kappan*, 80(2), pp. 139-148.

Bloom, B.S. (1956) *Taxonomy of Educational Objectives, Handbook 1: Cognitive Domain*. New York: McKay.

Borg, S. (2003) 'Teacher cognition in language teaching: a review of research on what language teachers think, know, believe, and do', *Language Teaching*, 36(2), pp. 81-109.

Borg, S. (2006) *Teacher Cognition and Language Education: Research and Practice*. London: Continuum.

Brown, G. and Edmondson, R. (1984) 'Asking questions', in Wragg, E. (ed.) *Classroom Teaching Skills: The Research Findings of the Teacher Education Project* London: Routledge, pp. 97-120.

Bruner, J. (1978) 'Learnign to do things with words', in Bruner, J. and Garton, A. (eds.) *Human Growth and Development*. Oxford: Clarendon Press, pp. 62-84.

Bryman, A. (2008) *Social Research Methods* 3edn. Oxford; New York: Oxford University Press.

Bureau of International Cooperation (2008) *Towards a learning society in thailand: an introduction to education in Thailand*. Ministry of Education, Thailand. [Online]. Available at: http://www.bic.moe.go.th/newth/images/stories/book/ed-eng-series/intro-ed08.pdf (Accessed: 26 March, 2015).

Burns, C. and Myhill, D. (2004) 'Interactive or inactive? a consideration of the nature of interaction in whole class teaching', *Cambridge Journal of Education*, 34(1), pp. 35-49.

Calderhead, J. (1989) 'Reflective teaching and teacher education', *Teaching and teacher education*, 5(1), pp. 43-51.

Calderhead, J. (1996) 'Teachers: beliefs and knowledge', in Berliner, D. and Calfee, R.C. (eds.) *Handbook of Educational Psychology*. New York: Macmillan, pp. 709-725.

Chanbanchong, C. (2014) 'Education and care for early childhood in Thailand: an overview and the observation of six kindergartens', *Presented at Benedek Elek Faculty of Pedagogy, University of West*. Sopron, Hungary, 7 April 2014. pp. 1-12. Available at: http://www.bpk.nyme.hu/uploads/media/Education_and_Care_for_Early_Childhood_in_Thailand.pdf.

Charlesworth, R., Hart, C., Burts, D., Thomasson, R., Mosley, J. and Fleege, P. (1993) 'Measuring the developmental appropriateness of kindergarten teachers' beliefs and practices', *Early Childhood Research Quarterly*, 8(3), pp. 255-276.

Clark, C.M. and Peterson, P.L. (1986) 'Teachers' thought processes', in Wittrock, M.C. (ed.) *Handbook of Research on Teaching*. 3rd edn. New York: Macmillan, pp. 255-296.

Clark, J., Laing, K., Tiplady, L. and Woolner, P. (2013) *Making connections: theory and practice of using visual methods to aid participation in research*. Research Centre for Learning and Teaching, Newcastle University.

Cohen, L., Manion, L. and Morrison, K. (2004) *A Guide to Teaching Practice*. 5th edn. London: Routledge.

Cohen, L., Manion, L. and Morrison, K. (2011) *Research Methods in Education*. 7th edn. Oxon: Routledge.

Cole, M. and Wertsch, J. (1996) 'Beyond the individual-social antinomy in discussions of Piaget and Vygotsky', *Human Development*, 39(5), pp. 250-256.

Collier, C., Davies, D., Howe, A. and McMahon, K. (2011) *The Primary Science and Technology Encyclopedia*. London; New York: Routledge.

Coltman, P. (2000) 'The growth and development of Science in the Early Years', in Warwick, P. and Linfield, R.S. (eds.) *Science 3-13: The Past, the Present and Possible Futures*. London: Routledge, pp. 22-36.

Coltman, P. (2008) ''How many toes has a newt?' Science in the Early Years', in Whitebread, D. and Coltman, P. (eds.) *Teaching and Learning in the Early Years*. 3rd edn. London: Routledge, pp. 309-322.

Creswell, J.W. (2007) *Qualitative Inquiry & Research Design: Choosing Among Five Approaches*. 2nd edn. Thousand Oaks: Sage.

Creswell, J.W. (2009) *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. California: Sage.

Crotty, M. (1998) *The Foundations of Social Research: Meaning and Perspective in the Research Process*. London: Sage.

Daniels, H. (2001) *Vygotsky and Pedagogy*. London: Routledge.

David, T. (1999) 'Changing minds: young children learning', in David, T. (ed.) *Young Children Learning*. London: Paul Chapman, pp. 1-12.

Davis, A. (1991) 'Peaget, teachers and education: into the 1990s', in Light, P., Sheldon, S. and Woodhead, M. (eds.) *Learning to Think*. London: Routledge, pp. 16-31.

de Rivera, C., Girolametto, L., Greenberg, J. and Weitzman, E. (2005) 'Children's responses to educators' questions in day care play groups', *American Journal of Speech-Language Pathology*, 14(1), pp. 14-26.

Denzin, N.K. and Lincoln, Y.S. (2008) 'Introduction: the discipline and practice of qualitative research', in Denzin, N.K. and Lincoln, Y.S. (eds.) *Strategies of Qualitative Inquiry*. 3rd edn. Los Angeles: Sage.

Department for Education (2014) *Statutory framework for the early years foundation stage*. Available at: https://www.gov.uk/government/publications/early-years-foundation-stage-framework--2 (Accessed: 13 March 2015).

Department of Local Administration of Thailand (2004) *The Learning Experience Plan in Early Childhood Education*. Thailand: Curusaphaladproa.

Dewey, J. (1933) *How We Think: A Restatement Of The Relation Of Reflective Thinking To The Educative Process*. Boston: Heath.

Dillon, J. (1988) *Questioning and Teaching: A Manual of Practice*. London: Croom Helm.

Donaldson, M. (1987) *Children's Minds*. London: Fontana Press.

Driver, R. (1983) *The Pupil as Scientist?* Milton Keynes: Open University Press.

Driver, R. and Oldham, V. (1986) 'A constructivist approach to curriculum development in science', *Studies in Science Education*, 13(1), pp. 105-122.

Dumteeb, N. (2009) *Teachers' Questioning Techniques and Students' Critical Thinking Skills: English Language Classroom in the Thai Context*. PhD thesis. Oklahoma State University, USA.

Dunne, M. and Peacock, A. (2012) *Primary Science: a Guide to Teaching Practice*. London: Sage.

Edwards, A. and Furlong, V. (1978) *The Language of Teaching: Meaning in Classroom Interaction*. London: Heinemann Educational.

Edwards, A. and Westgate, D. (1994) *Investigating Classroom Talk*. London: Falmer Press.

Edwards, D. and Mercer, N. (1987) *Common Knowledge: the development of understanding in the classroom*. London: Methuen.

Ekasingh, S. (1992) *Teacher Talk: The Language of Normative Teacher in Thai EFL Classrooms*. PhD thesis. University of California, USA.

English, E. (2001) 'Teaching for understanding: Curriculum guidance for the Foundation Stage', *Evaluation & Research in Education*, 15(3), pp. 197-204.

Esposito, N. (2001) 'From meaning to meaning: The influence of translation techniques on non-English focus group research', *Qualitative Health Research*, 11(4), pp. 568-579.

Fang, Z. (1996) 'A review of research on teacher beliefs and practices', *Educational Research*, 38(1), pp. 47-65.

Fenstermacher, G. (1994) 'The knower and the known: The nature of knowledge in research on teaching', *Review of Research in Education*, 20, pp. 1-54.

Fincher-Kiefer, R. (1992) 'The role of prior knowledge in inferential processing', *Journal of Research in Reading*, 15(1), pp. 12-27.

Fisher, R. (1995) *Teaching Children to Learn*. Cheltenham: Stanley Thornes.

Fisher, R. (1999) 'Thinking Skills to Thinking Schools: Ways to Develop Children's Thinking and Learning', *Early Child Development and Care*, 153(1), pp. 51-63.

Flick, U. (2009) *An Introduction to Qualitative Research*. 4th edn. London: Sage.

Gall, M.D., Borg, W.R. and Gall, J.P. (2003) *Educational Research: An Introduction*. 7th edn. Boston: Allyn and Bacon.

Galton, M., Hargreaves, L., Comber, C., Wall, D. and Pell, A. (1999a) 'Changes in patterns of teacher interaction in primary classrooms: 1976-96', *British Educational Research Journal*, 25(1), pp. 23-37.

Galton, M., Hargreaves, L., Comber, C., Wall, D. and Pell, A. (1999b) *Inside the Primary Classroom: 20 Years on*. London: Routledge.

Gibbs, G. (2007) *Analyzing Qualitative Data*. Los Angeles; London: Sage.

Gibbs, G. (2013) 'Using software in qualitative analysis', in Uwe, F. (ed.) *The Sage Handbook of Qualitative Data Analysis*. Los Angeles: Sage, pp. 277-296.

Gonzalez-DeHass, A. and Willems, P. (2012) *Theories in Educational Psychology: Concise Guide to Meaning and Practice*. Plymouth: Rowman & Littlefield Education.

Good, T. and Brophy, J. (1973) *Looking in Classrooms*. New York: Harper & Row

Graham, S. (2010) 'Critical thinking', *Bangkokpost* (January 12th, 2010 edn). [Online] Available at: http://www.bangkokpost.com/learning/education-features/30887/critical-thinking (Accessed: 5 January 2016).

Gray, D. (2009) *Doing Research in the Real World*. 2nd edn. London: Sage.

Hadfield, M. and Haw, K. (2012) 'Video: modalities and methodologies', *International Journal of Research & Method in Education*, 35(3), pp. 311-324.

Hallinger, P., Chantarapanya, P., Sriboonma, U. and Kantamara, P. (2000) 'The challenge of educational reform in Thailand: Jing Jai, Jing Jung, Nae Norn', in Townsend, T. and Cheng, Y.C. (eds.) *Educational Change and Development in the Asia-Pacific Region: Challenges for the Future*. The Netherlands: Swets & Zeitsinger, pp. 208-226.

Halpenny, A. and Pettersen, J. (2013) *Introducing Piaget: A Guide for Practitioners and Students in Early Years Education*. London: Routledge.

Hardman, F. (2008) 'Teachers' use of feedback in whole-class and group-based talk', in Mercer, N. and Hodgkinson, S. (eds.) *Exploring Talk in School: Inspired by the Work of Douglas Barnes*. London: Sage, pp. 131-150.

Harlen, W. (2007) 'The SPACE legacy', *Primary Science Review*, 97, pp. 13-15.

Harlen, W. and Holroyd, C. (1997) 'Primary teachers' understanding of concepts of science: impact on confidence and teaching', *International Journal of Science Education*, 19(1), pp. 93-105.

Harlen, W. and Qualter, A. (2004) *The Teaching of Science in Primary Schools*. 4th edn. London: David Fulton.

Harper, D. (2002) 'Talking about pictures: A case for photo elicitation', *Visual Studies*, 17(1), pp. 13-26.

Harrop, A. and Swinson, J. (2003) 'Teachers' questions in the infant, junior and secondary school', *Educational Studies*, 29(1), pp. 49-57.

Haworth, A. (2001) 'The re-positioning of oracy: a millennium project?', *Cambridge Journal of Education*, 31(1), pp. 11-23.

Higgins, S., Baumfield, V. and Leat, D. (2001) *Thinking through Primary Teaching*. Cambridge: Chris Kington Publishing.

Hofstede, G. (1986) 'Cultural differences in teaching and learning', *International Journal of Intercultural Relations*, 10(3), pp. 301-320.

Holmes, H., Suchada, T. and Tomizawa, R. (1995) *Working with the Thais: a guide to managing in Thailand*. Bangkok, Thailand: White Lotus.

Ingram, J. and Elliott, V. (2015) 'A critical analysis of the role of wait time in classroom interactions and the effects on student and teacher interactional behaviours', *Cambridge Journal of Education*, pp. 1-17.

Isaacs, S. (1936) *Intellectual Growth in Young Children*. London: Routledge.

Johnson-Laird, P.N. (1983) *Mental Models: Towards a Cognitive Science of Language, Inference, and Consciousness*. Cambridge: Harvard University Press.

Jordan, A., Carlile, O. and Stack, A. (2008) *Approaches to Learning: A Guide for Teachers*. Maidenhead: Open University Press.

Jordan, B. (2009) 'Scaffolding learning and co-constructing understanding', in Anning, A., Cullen, J. and Fleer, M. (eds.) *Early Childhood Education: Society and Culture*. 2nd edn. London: Sage, pp. 39-52.

Kawalkar, A. and Vijapurkar, J. (2011) 'Scaffolding science talk: the role of teachers' questions in the inquiry classroom', *International Journal of Science Education*, 35(12), pp. 2004-2027.

Kerry, T. (2002) *Explaining and Questioning*. Cheltenham: Nelson Thornes

King, N. (2004) 'Using templates in the thematic analysis of text', in Symon, G. and Cassell, C. (eds.) *Essential Guide to Qualitative Methods in Organizational Research*. London; Thousand Oaks: Sage, pp. 256-270.

King, N. (2012) 'Doing template analysis', in Symon, G. and Cassell, C. (eds.) *Qualitative Organizational Research: Core Methods and Current Challenges*. Los Angeles; London: Sage, pp. 426-450.

King, N. and Horrocks, C. (2010) *Interviews in Qualitative Research*. Los Angeles; London: Sage.

Kozulin, A. (2003) 'Psychological tools and mediated learning', in Kozulin, A., Gindis, B., Ageyev, V. and Miller, S. (eds.) *Vygotsky's Educational Theory in Cultural Context*. Cambridge University Press, pp. 15-38.

Kutnick, P. and Manson, I. (2000) 'Enabling children to learn in groups', in Whitebread, D. (ed.) *The Psychology of Teaching and Learning in the Primary School*. London: RoutledgeFalmer, pp. 78-96.

Lee, L. (1965) *Cider with Rosie*. The Hogarth Press.

Lee, Y. and Kinzie, M. (2012) 'Teacher question and student response with regard to cognition and language use', *Instructional Science*, 40(6), pp. 857-874.

Lemke, J. (1990) *Talking Science: Language, Learning, And Values*. Norwood: Ablex.

Light, P. and Littleton, K. (1999) *Social Processes in Children's Learning*. Cambridge: Cambridge University Press.

Lincoln, Y.S. and Guba, E.G. (1985) *Naturalistic Inquiry*. London: Sage.

MacNaughton, G. and Williams, J. (2009) *Teaching Young Children: Choices in Theory and Practice*. 2nd edn. Maidenhead: Open University Press.

Malaguzzi, L. (1993) 'For an education based on relationships', *Young Children*, 49(1), pp. 9-12.

Marcon, R.A. (1999) 'Differential impact of preschool models on development and early learning of inner-city children: A three-cohort study', *Developmental Psychology*, 35(2), pp. 358-375.

Mauigoa-tekene, L. (2006) 'Enhancing teachers' questioning skills to improve children's learning and thinking in pacific island early childhood centres', *New zealand journal of teachers' work*, 3(1), pp. 12-23.

Maybin, J., Mercer, N. and Stierer, B. (1992) ''Scaffolding' learning in the classroom', in Norman, K. (ed.) *Thinking Voices: The Work of the National Oracy Project*. London: Hodder & Stoughton, pp. 186-195.

Mayer, R.E. (1989) 'Models for understanding', *Review of Educational Research*, 59(1), pp. 43-64.

McLachlan-Smith, C. and St. George, A. (2000) 'Children learn by doing: teachers' beliefs about learning, teaching and literacy in New Zealand kindergartens', *New Zealand Journal of Educational Studie*, 35(1), pp. 37-47.

Mehan, H. (1979) ''What time is it, Denise?': Asking known information questions in classroom discourse', *Theory Into Practice*, 18(4), pp. 285-294.

Meijer, P., Verloop, N. and Beijaard, D. (2001) 'Similarities and differences in teachers' practical knowledge about teaching reading comprehension', *The Journal of Educational Research*, 94(3), pp. 171-184.

Meng, J., Zhao, T. and Chattouphonexay, A. (2012) 'Teacher questions in a content-based classroom for EFL young learners', *Theory and Practice in Language Studies*, 2(12), pp. 2603-2610.

Mercer, N. (1995) *The Guided Construction of Knowledge: Talk amongst Teachers and Learners*. Clevedon: Multilingual Matters

Mercer, N. (2000) *Words and Minds: How We Use Language to Think Together*. London: Routledge.

Mercer, N. (2003) 'The educational value of dialogic talk in whole class dialogue', in *New Perspectives on Spoken English in the Classroom: Discussion Papers*. London: Qualifications and Curriculum Authority, pp. 73- 76.

Mercer, N. and Dawes, L. (2008) 'The value of exploratory talk', in Mercer, N. and Hodgkinson, S. (eds.) *Exploring Talk in School: Inspired by the Work of Douglas Barnes*. London: Sage, pp. 55-90.

Mercer, N., Dawes, L., Wegerif, R. and Sams, C. (2004) 'Reasoning as a scientist: Ways of helping children to use language to learn science', *British Educational Research Journal*, 30(3), pp. 359-377.

Mercer, N. and Littleton, K. (2007) *Dialogue and the Development of Children's Thinking: A Sociocultural Approach*. London; New York: Routledge.

Merriam, S.B. (1998) *Qualitative Research and Case Study Applications in Education*. San Francisco: Jossey-Bass.

Mertens, D.M. (2010) *Research and Evaluation in Education and Psychology: Integrating Diversity with Quantitative, Qualitative, and Mixed Methods*. 3rd edn. Los Angeles: Sage.

Moon, J. (1999) *Reflection In Learning Andprofessional Development*. London: KoganPage Limited.

Morgan, N. and Saxton, J. (2006) *Asking Better Questions*. 2nd edn. Ontario: Pembroke.

Mortimer, F. and Scott, P. (2003) *Meaning Making in Secondary Science Classrooms*. Maidenhead, England: Open University Press.

Moss, P. and Penn, H. (1996) *Transforming Nursery Education*. London: Paul Chapman.

Mulder, N. (1996) *Inside Thai Society: Interpretations of Everyday Life*. Amsterdam: Pepin Press.

Mulder, N. (2000) *Inside Thai Society: Religion, Everyday Life, Change*. Chiang Mai, Thailand: Silkworm Books.

Myhill, D. (2006) 'Talk, talk, talk: Teaching and learning in whole class discourse', *Research Papers in Education*, 21(1), pp. 19-41.

Myhill, D. and Brackley, M. (2004) 'Making connections: teachers' use of children's prior knowledge in whole class discourse', *British Journal of Educational Studies*, 52(3), pp. 263-275.

Myhill, D. and Dunkin, F. (2005) 'Questioning learning', *Language and Education*, 19(5), pp. 415-427.

Myhill, D., Hopper, R. and Jones, S. (2006) *Talking, Listening, Learning: Effective Talk in the Primary Classroom*. Maidenhead: Open University Press.

Myhill, D. and Warren, P. (2005) 'Scaffolds or straitjackets? critical moments in classroom discourse', *Educational Review*, 57(1), pp. 55-69.

Nanmeebooks (2016) *Little sciencets in Thailand plans to develop early primary teaching in Thailand including more than 15,000 schools*. Available at: http://www.nanmeebooks.com/reader/news_inside.php?newsid=1504 (Accessed: 11 March 2016).

Nassaji, H. and Wells, G. (2000) 'What's the use of 'triadic dialogue'?: An investigation of teacher-student interaction', *Applied Linguistics*, 21(3), pp. 376-406.

Nathan, M.J. and Kim, S. (2009) 'Regulation of teacher elicitations in the mathematics classroom', *Cognition and Instruction*, 27(2), pp. 91-120.

National Statistical Office (2014) *Introduction to Surat Thani province*. Statistical Office at Surat Thani, Thailand. [Online]. Available at: http://surat.nso.go.th/images/attachments/article/159/surathani.pdf (Accessed: 10 January 2016).

New, R. and Cochran, M. (eds.) (2007) *Early Childhood Education: An International Encyclopedia*. Westport: Greenword Publishing.

Newton, D. (2000) *Teaching for Understanding: What It Is and How to Do It*. London: Routledge.

Newton, D. (2012) *Teaching for Understanding: What It Is and How to Do It*. 2nd edn. Abingdon: Routledge.

Newton, D. and Newton, L. (2000) 'Do teachers support causal understanding through their discourse when teaching primary science?', *British Educational Research Journal*, 26(5), pp. 599-613.

Newton, D. and Newton, L. (2001) 'Subject content knowledge and teacher talk in the primary science classroom', *European Journal of Teacher Education*, 24(3), pp. 369-379.

Newton, L. (1996) *Teachers' Questioning in Primary School Science: Developing Children's Causal Understanding through a Mental Model Approach*. PhD thesis. Newcastle Universtiy.

Newton, L. (2001) 'Teaching for understanding in primary science', *Evaluation and Research in Education*, 15(3), pp. 143-153.

Newton, L. (2013) 'Teachers' questions: Can they support understanding and higher-level thinking?', *Research Journal*, 1(13), pp. 6-17.

Nickerson, R.S. (1985) 'Understanding understanding', *American Journal of Education*, 93(2), pp. 201-239.

Nuffield-Chelsea Curriculum Trust (1993) *Nuffield Primary Science: Teachers' Handbook*. London: Collins Educational.

Office of the Education Council (2008) *Education in Thailand 2007*. [Online]. Available at: http://onec.go.th/onec_backoffice/uploads/Book/759-file.pdf (Accessed: 31 October 2015).

Office of the National Education Commission (1999) *National Education Act of B.E. 2542 (1999)*. [Online]. Available at: http://planipolis.iiep.unesco.org/upload/Thailand/Thailand_Education_Act_1999.pdf (Accessed: 31 October 2015).

Office of the National Education Commission (2004) *National Education Act B.E. 2542 (1999) and Amendments (Second National Education Act B.E. 2545 (2002)*. [Online]. Available at: http://www.ptcn.ac.th/ebook/pdf/law2545/pdf.pdf (Accessed: 31 October 2015).

Pajares, M.F. (1992) 'Teachers' beliefs and educational research: Cleaning up a messy construct', *Review of Educational Research*, 62(3), pp. 307-332.

Pinyoanuntapong, S. (2013) 'The development of Thai early childhood education curriculum to promote desirable characteristics of preschool children', *Procedia - Social and Behavioral Sciences*, 88, pp. 321-327.

PISA Thailand (2014) *PISA Thailand 2012 Results in Mathematics, Reading and Science: what students know and what they can do?* The institute for the Promotion of Teaching Science and Technology, Thailand. [Online]. Available at: https://drive.google.com/file/d/0BwqFSkq5b7zSSWk4QkxseVVPT0E/view?pref=2&pli=1 (Accessed: 5 January 2015).

Piumsomboon, P. (2015) 'Warn the Ministry of Educaiton about the imporvment of science teaching appraches', *Dailynews*edn), August 10, 2015. [Online] Available at: http://www.dailynews.co.th/education/340645 (Accessed: 18 January 2016).

Plowden (1967) *Children and their primary schools*. London: Her Majesty's Stationery Office.

Princess Maha Chakri Sirindhorn Anthropology Centre (2009) *Little scientists in Thailand*. Available at: http://www.littlescientistshouse.com/about/ (Accessed: 11 March 2015).

Pritchard, A. (2009) *Ways of Learning: Learning Theories and Learning Styles in the Classroom*. 2nd edn. Abingdon; New York: Routledge.

Prosser, J. (1998) *Image-Based Research*. London: Routledge Falmer.

Pugh, G. (2010) 'Improving outcomes for young children: Can we narrow the gap?', *Early Years*, 30(1), pp. 5-14.

Roberts-Holmes, G. (2012) ''It's the bread and butter of our practice': Experiencing the Early Years Foundation Stage', *International Journal of Early Years Education*, 20(1), pp. 30-42.

Robson, C. (2011) *Real World Research: A Resource for Users of Social Research Methods in Applied Settings*. 3rd edn. Chichester: Wiley.

Robson, S. and Moseley, D. (2005) 'An integrated framework for thinking about learning ', *Gifted Education International*, 20(1), pp. 36-50.

Rojas-Drummond, S. and Mercer, N. (2003) 'Scaffolding the development of effective collaboration and learning', *International Journal of Educational Research*, 39(1–2), pp. 99-111.

Rolfe, G. (2006) 'Validity, trustworthiness and rigour: Quality and the idea of qualitative research', *Journal of Advanced Nursing*, 53(3), pp. 304-310.

Rowe, M.B. (1986) 'Wait time: Slowing down may be a way of speeding up!', *Journal of Teacher Education*, 37(1), pp. 43-50.

Sahin, C., Bullock, K. and Stables, A. (2002) 'Teachers' beliefs and practices in relation to their beliefs about questioning at Key Stage 2', *Educational Studies*, 28(4), pp. 371-384.

Schön, D. (1983) *The Reflective Practitioner: How Professionals Think in Action*. New York: Basic Books.

Schön, D. (1987) *Educating the Reflective Practitioner*. San Francisco: Jossey-Bass.

Scott, P. and Ametller, J. (2007) 'Teaching science in a meaningful way: Striking a balance between 'opening up' and' closing down' classroom talk', *School Science Review*, 88(324), pp. 77-83.

Shepard, L. (2005) 'Linking formative assessment to scaffolding', *Educational Leadership*, 63(3), pp. 66-70.

Sinclair, J. and Coulthard, M. (1975) *Towards an Analysis of Discourse: The English Used by Teachers and Pupils*. London: Oxford University Press.

Siraj-Blatchford, I. (2009) 'Conceptualising progression in the pedagogy of play and sustained shared thinking in early childhood education: A Vygotskian perspective', *Education and Child Psychology*, 26(2), pp. 77-89.

Siraj-Blatchford, I. and Manni, L. (2008) ''Would you like to tidy up now?': An analysis of adult questioning in the English Foundation Stage', *Early Years*, 28(1), pp. 5-22.

Smith, F., Hardman, F., Wall, K. and Mroz, M. (2004) 'Interactive whole class teaching in the National Literacy and Numercy Strategies', *British Educational Research Journal*, 30(3), pp. 395-411.

Smith, H. and Higgins, S. (2006) 'Opening classroom interaction: the importance of feedback', *Cambridge Journal of Education*, 36(4), pp. 485-502.

Sylva, K., Melhuish, E., Sammons, P., Siraj-Blatchford, I. and Taggart, B. (2004) *The Effective Provision of Pre-school Education (EPPE) Project: findings from pre-school to end of Key Stage 1*. London: Institute of Education, University of London.

Taylor, I. and Taylor, M. (1990) *Psycholinguistics: Learning and Using Language*. London: Prentice-Hall International.

Tharp, R. and Gallimore, R. (1988) *Rousing Minds to Life: Teaching, Learning, and Schooling in Social Context*. Cambridge: Cambridge University Press.

The Ministry of Education of Thailand (2003) *Thai National Early Childhood Curriculum*. Bangkok: Curusaphaladproa.

Tobin, K. (1987) 'The role of wait time in higher cognitive level learning', *Review of Educational Research*, 57(1), pp. 69-95.

Tobin, K. and Capie, W. (1982) 'Relationships between classroom process variables and middle-school science achievement', *Journal of Educational Psychology*, 74(3), pp. 441-454.

Triandis, H.C. (2001) 'Individualism-collectivism and personality', *Journal of Personality*, 69(6), pp. 907-924.

Turnbull, K.P., Anthony, A.B., Justice, L. and Bowles, R. (2009) 'Preschoolers' exposure to language stimulation in classrooms serving at-risk children: the contribution of group size and activity context', *Early Education and Development*, 20(1), pp. 53-79.

UNESCO (2011) *UNESCO National Education Support Strategy (UNESS), Thailand 2010-2015* [Online]. Available at: http://doc.iiep.unesco.org (Accessed: 30 October 2015).

van de Pol, J., Volman, M. and Beishuizen, J. (2010) 'Scaffolding in teacher–student interaction: a decade of research', *Educational Psychology Review*, 22(3), pp. 271-296.

van Merrienboer, J.J.G., Kirschner, P.A. and Kester, L. (2003) 'Taking the load off a learner's mind: instructional design for complex learning', *Educational Psychologist*, 38(1), pp. 5-13.

Vartuli, S. (1999) 'How early childhood teacher beliefs vary across grade level', *Early Childhood Research Quarterly*, 14(4), pp. 489-514.

Venville, G., Adey, P., Larkin, S., Robertson, A. and Fulham, H. (2003) 'Fostering thinking through science in the early years of schooling', *International Journal of Science Education*, 25(11), pp. 1313-1331.

Vygotsky, L. (1978) *Mind in Society: the Development of Higher Psychological Processes*. Cambridge: Harvard University Press.

Walsh, J. and Sattes, B. (2005) *Quality Questioning: Research-Based Practice to Engage Every Learner*. Thousand Oaks, California: Sage.

Walsh, S. (2006) *Investigating Classroom Discourse*. London: Routledge.

Waring, T. and Wainwright, D. (2008) 'Issues and challenges in the use of template analysis: two comparative case studies from the field', *The Electronic Journal of Business Research Methods* 6(1), pp. 85-94.

Wells, G. (1999) *Dialogic inquiry: Towards a Sociocultural Practice and Theory of Education*. Cambridge: Cambridge University Press.

Whitebread, D. (2000) 'Teaching children to think, reason, solve problems and be creative', in Whitebread, D. (ed.) *The Psychology of Teaching and Learning in the Primary School*. London: RoutledgeFalmer, pp. 140-164.

Whitebread, D. (2008) 'Introduction: young children learning and early years teaching', in Whitebread, D. and Coltman, P. (eds.) *Teaching and Learning in the Early Years*. 3rd edn. London: Routledge, pp. 1-22.

Wilson, E. (2000) 'Learning concepts', in Warwick, P. and Linfield, R. (eds.) *Science 3-13: the past, the present and possible futures*. London; New York: Routledge, pp. 22-36.

Wilson, J. and Haugh, B. (1995) 'Collaborative modelling and talk in the classroom', *Language and Education*, 9(4), pp. 265-281.

Wittmer, D.S. and Honig, A.S. (1991) 'Convergent or divergent? teacher questions to three-year-old children in day care 1', *Early Child Development and Care*, 68(1), pp. 141-147.

Wood, D. (1991) 'Aspects of teaching and learning', in Light, P., Sheldon, S. and Woodhead, M. (eds.) *Learning to Think*. London: Routledge in association with the Open University, pp. 97-120.

Wood, D. (1992) 'Teaching talk: how modes of teacher talk affect pupil participation', in Norman, K. (ed.) *Thinking Voices: The Work of the National Oracy Project*. London: Hodder & Stoughton, pp. 203-214.

Wood, D. (1997) *How Children Think and Learn*. 2nd edn. Oxford: Blackwell.

Wood, D., Bruner, J. and Ross, G. (1976) 'The role of tutoring in problem solving', *Journal of Child Psychology and Psychiatry*, 17(2), pp. 89-100.

Woolner, P., Thomas, U., Todd, L. and Cummings, C. (2009) 'How do visually mediated encounters differ from traditional interviews? ', *1st International Visual Methods Conference*. Leeds, UK, September. pp. 1-10.

Wragg, E. and Brown, G. (2001) *Questioning in the Primary School*. London: Routledge Falmer.

Yin, R. (2009) *Case Study Research: Design and Methods*. 4th edn. Los Angeles: Sage.

Appendices

Appendix A: Letters to Schools

Research Centre for Learning and Teaching (CfLaT)
School of Education, Communication and Language Science
Newcastle University
Newcastle upon Tyne, NE1 7RU

8th May 2013

Dear Principal/Supervisor,

Requesting for Conducting Research

My name is Miss Chalita Cheewaviriyanon, I am currently pursuing a PhD at the School of Education and Communication, Newcastle University. I am writing this letter to request permission for conducting the research project with pre-school teachers (who teach 4-6 years old) at your school. Under the supervision of Dr Elaine Hall and Dr Hanneke Jones, I am conducting a research project entitled: "An Exploration of Teachers' Questioning in Early Childhood Practices in Thailand".

The main aim of the research is to explore teachers' questioning practices and their development of this skill; it is not my purpose, however, to evaluate or judge practice. Participating pre-school teachers will gain an understanding of their own questioning practices and will have ideas to develop their questioning skills. The results of this research project will be significant contribution to the development of teacher training in questioning in Thai early childhood education as a whole.

In involving with this research project, pre-school teachers will mainly be asked to participate in two research activities: a classroom observation of one science teaching lesson, and an interview about their questioning practices. The research project will take place in term 1, between May 2013 and September 2013. All ethical guidelines and procedures (as defined by Newcastle University) relating to research data confidentiality will be followed.

Thank you very much for your kind consideration and support.

Yours sincerely,

Miss Chalita Cheewaviriyanon	Dr Elaine Hall
IPhD student	Principal Supervisor
Newcastle University	Newcastle University
Email: c.cheewaviriyanon@ncl.ac.uk	Email: elaine.hall@ncl.ac.uk
Telephone: +44 (0) 741 124 7465	Telephone: +44 (0) 191 222 6371

Newcastle
University

Participant Information Sheet

Dear Teachers,

I am a PhD student in Education and Communication at Newcastle University in United Kingdom. Now, I am doing a qualitative research project in the topic of "An Exploration of Teachers' Questioning in Early Childhood Practices in Thailand". My area of interest is classroom questioning. High-quality questions and questioning strategies are key tools in helping teachers to stimulate children's thinking and to guide their learning. High quality questions posed by teachers are likely to facilitate children's deeper understanding about the topic taught as well as helping them to complete assigned tasks. The aim of this project is to explore teachers' questioning practices and their development of this skill; it is not my purpose, however, to evaluate or judge practice.

The benefit of being involved in the research is that the participating pre-school teachers will gain an understanding of their own questioning practices and will have an opportunity to develop their questioning skills. The researcher and the teacher will work collaboratively to understand the nature of the questions asked in classrooms and the development of questioning skills.

The research project will take place in term 1, between May 2013 and September 2013. About 15 pre-school teachers, who teach children aged 4 to 6 years old at state government schools, will participate in the research. The volunteer participants will mainly be asked to participate in

- a classroom observation of one science teaching lesson (for example, an experiment or a story telling, involving individual, small group and whole class teaching), lasting no more than one hour
- an interview about their questioning practices which will last no more than two hours.

The observed lesson will be audio and video recorded and the interview will be audio recorded. The audio and video files will be stored in a secure place; only the researcher and the teacher will be permitted to access them and they will be deleted permanently after the research is completed. All data and information collected will be managed confidentially. The name of the school will not be disclosed and each participant will remain anonymous. A written summary of the research findings will be posed to you. The university staff member who is supervising my research is:

Dr Elaine Hall
Room 2.54 KGVI, School of Education, Communication and Language Sciences, King George VI Building, Newcastle University, Queen Victoria Road, Newcastle upon Tyne, NE1 7RU
Email: elaine.hall@ncl.ac.uk, Telephone: +44 (0) 191 222 6371.

Yours sincerely,

Miss Chalita Cheewaviriyanon

School of Education, Communication and Language Sciences, King George VI Building, Newcastle University, Queen Victoria Road, Newcastle upon Tyne, NE1 7RU, Email: c.cheewaviriyanon@ncl.ac.uk, Telephone: +66 (0) 91 041 3317 (Thailand); +44 (0) 741 124 7465 (UK)

Appendix C: Consent Form for Participation in Research

Consent Form

The Title of the Research Project:

An Exploration of Teachers' Questioning in Early Childhood Practices in Thailand

Please read carefully the statements below and tick box as appropriate.

1. I have read and understood the information about the project, as provided in the Participant Information Sheet. ☐

2. I have been given an opportunity to ask questions about the project and my participation, including the collection, use and storage of video and audio recordings. ☐

3. I voluntarily agree to participate in the project. ☐

4. I understand that I can withdraw from the project:
    - at any time and
    - without having to give a reason for withdrawing and
    - without affecting my position in the school. ☐

5. I agree to be video- and audio-taped whilst teaching a science lesson and to be interviewed about this lesson and audiotaped during the interview. ☐

The university staff member who is supervising my research is Dr Elaine Hall
Room 2.54 KGVI, School of Education, Communication and Language Sciences, King George VI Building, Newcastle University, Queen Victoria Road, Newcastle upon Tyne, NE1 7RU
Email: elaine.hall@ncl.ac.uk, Telephone: +44 (0) 191 222 6371.

Participant:

_____   _____   _____

Name of Participant   Signature   Date

Researcher:

_____   _____   _____

Name of Researcher   Signature   Date

Appendix D: Parent and Carer Information Sheet

Parent and Carer Information Sheet

Dear Parent/Carer,

I am a PhD student in Education and Communication at Newcastle University in United Kingdom. Now, I am doing a qualitative research project in the topic of "An Exploration of Teachers' Questioning in Early Childhood Practices in Thailand". My area of interest is classroom questioning. High-quality questions and questioning strategies are key tools in helping teachers to stimulate children's thinking and to guide their learning. High quality questions posed by teachers are likely to facilitate children's deeper understanding about the topic taught as well as helping them to complete assigned tasks. The aim of this project is to explore teachers' questioning practices and their development of this skill; it is not my purpose, however, to evaluate or judge practice.

Your child's teacher has agreed to take part in my research. By taking part, she/he will be reflecting on the practice of questioning in the class and seeking to improve the learning experience for your child.

What will happen?
1. I will visit your child' class and meet the teacher and children.
2. I will return and make a video recording of the teacher while she/he is teaching a science lesson. The video will focus on the teacher and her use of questions, though of course the children will appear as they work with the teacher.
3. I will look at the video and then have an interview with the teacher where we will discuss the questions used to teach science.

Who will see this video?
Only myself and the teacher will see the video. It will be stored securely while I am completing my PhD and after that it will be destroyed.

What if I don't want my child to take part?
It will be possible for your child to spend the time in another class in the school while the video lesson is taking place. If you want to withdraw your child from the lesson please you could contact me via my email or phone (Thailand) below.

Who else can I talk to about this research?
The university staff member who is supervising my research is Dr Elaine Hall
Room 2.54 KGVI, School of Education, Communication and Language Sciences, King George VI Building, Newcastle University, Queen Victoria Road, Newcastle upon Tyne, NE1 7RU
Email: elaine.hall@ncl.ac.uk, Telephone: +44 (0) 191 222 6371 (UK).

Yours sincerely,

Miss Chalita Cheewaviriyanon
School of Education, Communication and Language Sciences, King George VI Building,
Newcastle University, Queen Victoria Road, Newcastle upon Tyne, NE1 7RU
Email: c.cheewaviriyanon@ncl.ac.uk, Telephone: +66 (0) 91 041 3317 (Thailand); +44 (0)
741 124 7465 (UK).

Appendix E: Interview Guide

Interview questions	Objectives	Literature
Guide questions for pre-lesson interviews		
1. What do you aim to teach children about science in this lesson? Probe: Why it is important for children to learn this? What influences your teaching? 2. How do you plan to teach them? • Teaching approaches, • Teaching materials, • Teachers' roles and • Students' roles	To enquire about the context of the lesson that may help to explain teachers' questioning practice	Learning theories and teaching approaches
Guide questions for post-lesson interviews		
Note: Watching a five-minute extract of the observed lesson with the teacher Guide questions about purposes in asking questions: 1. Please select a number of questions. What was your purpose in asking this question? Prompt: Can you tell me more about other questions you asked? I am interested in your questioning. Can you explain to me why you asked them? Probe: Why did you ask that question?; What are you thinking when you ask this question?; Do you mean you asked that question for…? Can you say more about that?	To investigate teachers' purposes in asking questions during teaching and factors influencing the use of such questions	An importance of teachers' purposes in asking questions and Vygotsky's theory of Zone of Proximal Development
Guide questions about questioning strategies: Note: Triggering or inviting a teacher to talk about questioning strategies during or after watching the five-minute extract.	To investigate teachers' understanding about questioning	An importance of questioning strategies to create classroom interaction and

2. What questioning strategies do you use in asking questions? Prompt: How did you help a child/a group of children to answer this question? What else did you use? Probe: Why did you use that questioning strategy? Can you give me examples of this strategy?	strategies to help children's learning	Bruner's concept of Scaffolding
Guide questions about respondent selection and wait time: Note: I indicated a teacher's observed practice using the phrase "I noticed… .". 3. How did you select respondents? Why did you select respondents in this way? 4. How did you use wait time? Why did you wait or not wait for children to think after asking a question and/or getting a response?	To investigate teachers' understandings on wait time and selection of respondent and teacher's reasons for using them.	Literature reviews on the impact of waiting times and selection of respondents on teachers' teaching and pupils' learning
Guide questions about reflective practice: 5. What do you think about your questioning practices? 6. What have you learned from this?	To enquire about their thoughts and feeling about their experience of reflective practice	Theory about reflexive practice

Appendix F: Demographic Information of the Participants

No. .... Alias Name: ....

Demographic Information of the Participants

Directions: Please circle the appropriate letter and/or fill in your personal information

Part one: your personal Information and education background

1. What is your gender?
    a. Male   b. Female
2. How old are you?
    .... years
3. What is your nationality?
    a. Thai   b. Chinese   c. Malaysian
    d. Others (Please specify) ....
4. What is you religious?
    a. Buddhism   b. Christian   c. Islam
    d. Others (Please specify) ....
5. Highest level of academic qualification
    a. Master Degree
    b. Bachelor Degree
    c. Diploma from a Polytechnic
    d. Others (Please specify) ....

    Major: .... University Name: ....

6. Professional Training/Certificate
    a. Diploma in Early Childhood Education   Part-time or Full-time: ....
    b. Diploma in Teaching Profession   Part-time or Full-time: ....
    c. Diploma in Science Teaching Profession Part-time or Full-time: ....
    d. Others: (Please specify) ....

Part two: working and training experience

7. How many years have you been teaching?
    .... years
8. How many years have you been teaching at kindergarten levels?
    .... years
9. Have you attended training programmes in the last two years such as conferences, seminars, field trips, and short courses
    a. No (please go to the question number 10)
    b. Yes, Please specify

----

10. Other professional experiences (such as previous working experience)

----

11. Awards/certificates you have gained during working as a teacher

----

Appendix G: Initial Template

Themes	Codes
1. Purpose in asking a question	1.1 Gaining attention 1.2 Checking if pupils could recall information 1.3 Checking prior knowledge 1.4 Checking understanding 1.5 Enhancing knowledge 1.6 Integration with other topic areas 1.7 Encouraging observation 1.8 Experimenting 1.9 Encouraging pupils' thinking
2. Questioning strategies	2.1 Repeating questions 2.2 Paraphrasing questions 2.3 Giving clues: part answers 2.4 Changing from open to closed questions 2.5 Using children's responses to ask the next question 2.6 Easy to more difficult questions 2.7 Linking questions to children's experience 2.8 Asking humorous questions
3. Wait time	3.1 Wait 3.2 Not wait
4. Selection of respondents	4.1 Answering in unison 4.2. Calling the child's names

5. Factors influencing questioning practices	5.1 4 to 5 year old children
	5.2 School curriculum
	    5.3.1 Types of task
	    5.3.2 Assessment methods

Appendix H: Final Template

Themes	Codes
1. Purpose in asking a question	1.1 Gaining attention
	1.2 Checking if pupils could recall information
	1.3 Checking prior knowledge
	1.4 Checking understanding
	1.5 Enhancing knowledge
	1.6 Integration with other topic areas
	1.7 Encouraging observation
	1.8 Hypothesizing
	1.9 Experimenting
	1.10 Building understanding
	1.11 Encouraging pupils' thinking
2. Questioning strategies	2.1 Repeating questions
	2.2 Paraphrasing questions
	2.3 Giving clues: part answers
	2.4 Changing from open to closed questions
	2.5 Using children's responses to ask the next question
	2.6 Easy to more difficult questions
	2.7 Linking questions to children's experience
	2.8 Asking humorous questions
3. Wait time	3.1 Wait
	3.1.1 Encouraging participation
	3.1.2 Checking understanding
	3.2 Not wait
	3.2.1 Off task
4. Selection of respondents	4.1 Answering in unison
	4.1.1 Gaining attention
	4.1.2 Checking understanding
	4.1.3 Expressing children' opinions
	4.2. Calling the child's names
	4.2.1 Encouraging children's participation
5. Factors influencing questioning practices	5.1 Teachers' teaching principles
	5.1.1 Formative assessment
	5.2.2 Enquiry-based learning
	5.2 4 to 5 year old children
	5.3 School curriculum
	5.3.1 Types of task
	5.3.2 Assessment methods
	5.3.3 School policy

Appendix I: Dataset of the 74 Questions

Three parts of codes (T01;E1;A) that use to identify each questions is defined as below.

"T01" refers to the teacher from Teacher 1 to Teacher 15.

"E1" or "E2" refers to the video extract number that used during the interviews.

"A" refers to the question that selected by the teacher to discuss with me during video-mediated interviews. A number of questions identified by each teacher has a sequence form A, B, C and so on.

No.	Teacher Participant	Teachers' Questions	Reported purpose	Types of questions
1	T01;E1;A	Let's predict! If the flower is white, and I put artificial blue dye in the water, what will happen?	Hypothesizing	Open
2	T01;E1;B	Will it stay the same or become different?	Gaining attention	Closed
3	T01;E2;C	What colour is it changing to?	Encouraging observation	Closed
4	T01;E2;D	Oh! It seems that the flower absorbs the blue water. What is happening?	Encouraging observation	Closed
5	T02;E1;A	It [the egg] has already changed. What happened?	Encouraging observation	Closed
6	T02;E2;B	Why does it [the egg] become white?	Encouraging pupils' thinking	Open
7	T03;E1;A	What kinds of eggs do you know?	Enhancing knowledge	Open
8	T03;E2;B	Is the egg rectangular or is the egg circular?	Integration with other topic areas	Closed
9	T03;E2;C	What is this egg?	Recalling	Closed
10	T03;E2;D	What colour is it?	Integration with other topic areas	Closed
11	T04;E1;A	What is this?	Checking prior knowledge	Closed
12	T04;E1;B	What is the leaf colour?	Checking prior knowledge	Closed
13	T04;E2;C	For this group, what did I ask you to bring?	Checking understanding	Closed
14	T05;E1;A	What is this?	Checking prior knowledge	Closed

15	T05;E1;B	It tests hot. This is a chilli as you can see. What is the colour of this chilli? (to all)	Checking prior knowledge	Closed
16	T05;E2;C	What is the taste?	Checking understanding	Closed
17	T06;E1;A	Umm, let's see. Before pouring water, what else is inside?	Checking prior knowledge	Closed
18	T06;E1;B	Do you know which glass contains more air?	Checking understanding	Closed
19	T06;E2;C	Why did the candle go out?	Encouraging pupils' thinking	Open
20	T07;E1;A	When the wind is blowing, what do you see moving?	Checking prior knowledge	Open
21	T07;E1;B	What is the colour of leaves that have fallen? (models)	Checking prior knowledge	Open
22	T07;E2;C	Wind comes out from the box. What makes wind come out?	Encouraging pupils' thinking	Open
23	T08;E1;A	What is going up that sounds like 'pud pud' [A sound of bubbles]?	Encouraging observation	Closed
24	T09;E1;A	Let's see. Everyone can see the beaker. Has the salt dissolved yet?	Encouraging observation	Closed
25	T09;E2;B	Let's see the water. What is lighter than the water?	Encouraging pupils' thinking	Closed
26	T09;E2;C	What is the lightest? (point to the object)	Encouraging pupils' thinking	Closed
27	T10;E1;A	Let's see. Which group will you go to?	Encouraging pupils' thinking	Closed
28	T10;E1;B	Do cats live on land or in water?	Encouraging pupils' thinking	Closed
29	T10;E1;C	Who thinks you are aquatic? Go to the aquatic group.	Encouraging pupils' thinking	Closed
30	T10;E2;D	How many legs do rabbits have?	Integration with other topic areas	Closed
31	T10;E2;E	Ok. That child please come here. Come here. Apart from carrots, what else do rabbits eat?	Recalling	Closed
32	T10;E2;F	What do cats eat as food?	Checking prior knowledge	Closed
33	T10;E2;G	Let's think! What does your mother mix with rice for cats to eat?	Recalling	Closed
34	T11;E1;A	Ok. Who has seen it? [A type of bird]	Checking prior knowledge	Closed
35	T11;E1;B	Is the bird's beak long?	Integration with other topic areas	Closed

36	T11;E1;C	How does the bird get from here to there?	Enhancing knowledge	Closed
37	T11;E1;D	Do they [birds] fly high or low? (move a hand to high)	Enhancing knowledge	Closed
38	T11;E2;E	Are elephants land animals or animals that live in water?	Checking prior knowledge	Closed
39	T11;E2;F	Land animals. Where do land animals live?	Enhancing knowledge	Closed
40	T11;E2;G	Land animals. Is this animal land animals or animals that live in water?	Enhancing knowledge	Closed
41	T11;E2;H	Do cats live in water?	Checking prior knowledge	Closed
42	T11;E2;I	Why do you know it lives in water?	Checking prior knowledge	Open
43	T12;E1;A	Where is the sun?	Encouraging observation	Closed
44	T12;E1;B	At night. Why do they not appear at the same time?	Encouraging pupils' thinking	Open
45	T12;E1;C	Why does the moon not come out in the daytime?	Recalling	Open
46	T12;E1;D	When does the moon appear?	Recalling	Closed
47	T12;E1;E	Does the sunlight damage your eyes?	Enhancing knowledge	Closed
48	T12;E1;F	What things appear at night?	Encouraging observation	Open
49	T12;E2;G	Can we see the moon at night?	Recalling	Closed
50	T12;E2;H	We don't have the sun at night. The sun rises in the morning. What takes its place at night?	Gaining attention	Closed
51	T12;E2;I	There is the moon and what else? What has a sparkling light?	Checking prior knowledge	Closed
52	T12;E2;J	Is this daytime or night time?	Encouraging observation	Closed
53	T12;E2;K	At night what do you do?	Enhancing knowledge	Closed
54	T13;E1;A	Look! This is a plant or a tree. What are this tree's parts?	Enhancing knowledge	Closed
55	T13;E1;B	Tree. What are the parts of the tree?	Enhancing knowledge	Closed
56	T13;E1;C	Ok. It becomes a big tree. Is this tree alive?	Checking prior knowledge	Closed
57	T13;E1;D	It is alive. How do you know that it is alive?	Enhancing knowledge	Open

58	T13;E2;E	If a human child grows up to be an adult, do they breathe?	Enhancing knowledge	Closed
59	T13;E2;F	Which part of the plant gets air?	Checking prior knowledge	Closed
60	T13;E2;G	What are the same between humans and animals?	Enhancing knowledge	Open
61	T13;E2;H	Can animals have baby animals?	Checking prior knowledge	Closed
62	T13;E2;I	Do hens have chicks?	Encouraging pupils' thinking	Closed
63	T14;E1;A	What could you do to design it [a straw] as a shape of a floating 'A'?	Experimenting	Open
64	T14;E1;B	Let's think! One does not work, so how many clips are needed?	Hypothesizing	Open
65	T14;E1;C	Who could do it?	Gaining attention	Closed
66	T14;E2;D	I am going to ask you individually. Who knows why it sinks?	Building understanding	Open
67	T14;E2;E	How many clips are needed to get it to float?	Building understanding	Closed
68	T14;E2;F	When you used one clip, what happened?	Encouraging pupils' thinking	Closed
69	T14;E2;G	Does it work with four clips?	Building understanding	Closed
70	T15;E1;A	Please tell me what we just put in the beaker?	Recalling	Closed
71	T15;E1;B	What is at the bottom of the beaker: water, sand or oil?	Encouraging observation	Closed
72	T15;E1;C	Please sit down! Which part is the water?	Checking understanding	Closed
73	T15;E2;D	When we put sand into the water, why does it not float? (why-why?)	Building understanding	Open
74	T15;E2;E	When we put oil into the water, why does the oil not sink?	Building understanding	Open

Appendix J: Activity Descriptions and Types

Participant	Activity name	Description	Types of activity
T1	Dissolving artificial colours in liquids and flower absorption	There were four glasses of liquids with different temperatures (room-temperature water, cold water, warm water and milk) and vases with flowers were put on the table in the front of the classroom. A blue artificial dye was dissolved in the glass of warm water whilst the red dye was mixed in the glass of cold water for the group of children to observe and compare how the white flowers inside the glass were absorbed the water differently. The one with hot water was better than the ones with cold water.	Science demonstration by teachers
T2	The danger of vinegar	The teacher did an experiment by putting a chicken egg into a glass of vinegar. This was for pupils to observe and compare with another glass which had been prepared on the previous day.	Science demonstration by teachers
T3	Types of eggs and of egg food	Chicken and duck eggs were brought by children to explore in the classroom using some of their five senses such as seeing, touching and smelling. Some pictures of other eggs and foods are used in teaching. The pupils sat in rows.	Whole group-discussion
T4	Tree components	A tree chart and a flower pot containing a jasmine tree were used in the whole group discussion. In addition, weeds were used for the children to explore in small groups. The lesson ended with one member of each group bringing one	Hands-on experience

		component of the weed to the teacher in front of the class.	
T5	Tasting with your tongs	Five fruits or ingredients: lime, sugar, salt, cucumber and chili were used to allow whole group discussion. They were put on the table in front of the class. Then five children volunteered to taste one of them and tell their friends what it was.	Hands-on experience
T6	Burning process	Two sets of candles, transparent glasses, dishes and matches were used in the activity. The candle was lit by the teacher and then covered with the glass. The group of children observed what happened to the candle (it stopped burning) and this was discussed in the class. During the experiment a few children were selected to do an experiment.	Science demonstration by teachers
T7	Air has pressure	Teaching materials were put on the table in front of the class. After the teacher demonstrated the experiment, a few children were selected to do the experiment. A medium-size paper box was hit to create air pressure which blowed out to make things move. Four things were used - a table tennis ball, a handkerchief, a candle and joss sticks.	Science demonstration by teachers
T8	Air occupies space	The pupils involved in three activities which orgainsed by the teacher: 1) The teacher poured water into a glass of soil and a glass of rocks for children to observe what happens 2) A child made a paper fan and waved it up and down to create wind and 3) A child blown up a balloon and	Science experiment

		released it to observe what happens.	
T9	Some substances can be dissolved in water	The group of children were involved in two experiments. First, two small groups of children put salts, sugar and/or green beans into a glass bottle of water. This was stirred to observe how they dissolved. The next experiment was demonstrated by the teacher to observe the dissolving of three substances: water, sand and cooking oil when they were poured into the bottle. This was discussed in class.	Science experiment (small and whole group)
T10	Types of animals, focusing on land animals	The activity involved children recognising and identifying the type of animal headband they were wearing. Then the child was asked to walk to one of the three groups of land, water and amphibian. Two of them told about their experience with regard to their pets.	Whole group discussion with pictures
T11	Land animals	The teacher talked with a group of children using a set of coloured pictures of animals from land, water and an amphibian environment. The activity also involved groups of children looking at one picture and talking with friends.	Whole group discussion with pictures
T12	Day time and night time	The teacher had a conversation with a group of children involving three activities. First, two pictures of the sun and the moon were used to talk about daytime and nightime. Secondly, a fable about a clown, the moon and the sun was used to talk about their duties. Thirdly, a poem about children's activities in daytime and in nightime was told.	Whole group discussion with pictures

T13	Living things and non-living things	Three activities were organized by the teacher. The teacher started with a discussion with children using a picture book of a tree. Then drawings of humans, animals and plants on the backboard were used in a discussion about them. Finally the last activity involved them separating pictures into living and non-living things.	Whole-group discussion with pictures
T14	Underwater straws	An activity with children doing an experiment with a drinking straw to design a 5 cm straw into an 'A' shape to be floated in the water by adding clips with weights.	Science experiment
T15	Water, sand and oil	An activity with children doing an experiment involving pouring water, sand and oil into a beaker to learn about the scientific concepts of sinking and floating.	Science experiment

Appendix K: Transcription Conventions

T   teacher

Ss   several students at once or the whole class

S   student (not identified)

S1   identified student

[beginning of simultaneous or interrupted speech

(…)   words undeciphered e.g. (Silence)

(xxx)   information about equipment, non-verbal aspects of communication and any
                other contextual information

Orange   words spoken empathetically

Modified from Edwards and Mercer (1987) and Mercer and Littleton (2007)

Appendix L: Glossary

Constructivism: a learning theory on how we learn that views "learning as the result of mental construction" (Pritchard, 2009, p. 17). A child learns best by the active construction of learning, which happens by adding and mapping new information to a child's current knowledge, understandings and skills (Whitebread, 2000; Pritchard, 2009). Constructivism can be divided into two schools of thought: cognitive and social.

> Cognitive constructivism: for Piaget, a child learns by an interaction with environments, and learning is a process of accommodating new information to existing knowledge and understanding (Pritchard, 2009; Halpenny and Pettersen, 2013).

> Social constructivism: Vygotsky believes that social interaction with more able persons is a key factor for a child to construct learning (Light and Littleton, 1999; Mercer and Littleton, 2007; Pritchard, 2009).

Knowledge: facts or information about situations which tend to describe what things are, and what they are composed of. These can be learned by memorization, but it is important as fundamental to a further development of understanding.

Learning: based on social constructivism, learning is "the way people learn to make sense of the world, become able to solve problems and … take on new perspectives" (Mercer and Littleton, 2007, p. 3). An understanding of the world results from the construction of mental models in which the teacher's role is important in terms of promoting children's learning through interaction.

Questioning: At its simplest level, questioning is the teaching strategy often used for eliciting responses (Myhill, 2006). Questioning is considered to be a fundamental tool in education since questions foster thinking processes from which linguistic and cognitive responses are required (Tharp and Gallimore, 1988). Questions are commonly categorised into open and closed questions.

> Open questions: open questions are used to stimulate a child's thinking and have more than one possible answer.

> Closed questions: in contrast to open questions, closed questions elicit factual information which have pre-determined answers.

> Forced alternative questions: questions with relatively few choices for pupils to choose from.

> Focused questions: an approach of asking questions in terms of purposes to the best benefits of learning in specific teaching situations (Newton, 2013).

Questioning strategies: Traditionally "move types" refers to a repository of strategies that can be used by teachers in the feedback move associated with IRF or IRE exchange (Dillon, 1988; Wood, 1992). In the context of this study, questioning strategies refer to "move types" that help scaffold learning, and that leads to classroom interaction.

Scaffolding: The concept of scaffolding is very persuasive in psychology and education as this concept represents the active and supportive role of a teacher in a child's learning (Mercer, 1995). Scaffolding can be defined as follows.

> [Scaffolding] refers to the steps taken *to reduce the degrees of freedom* in carrying out some task so that the child can concentrate on the difficult skills she is in the process of acquiring (Bruner, 1978 cited in Mercer, 1995, p. 73, original emphasis).

Scaffolding promotes learning through dialogue. That helps a child to solve a task or to achieve an understanding that the child could not achieve on its own. In order to successfully introduce scaffolding, assistance or support provided by the teacher or more able peer needs to be tailored to the child's competency in the task (Mercer, 1995). The process of scaffolding is temporary and not permanent in that it involves handing over more and more responsibility to the child so that he/she can carry out the task independently (Maybin *et al.*, 1992; Myhill *et al.*, 2006). In this study, questioning is one means of scaffolding that teachers can use it to permit scaffolding a child to learn science in which "discussions can check on understanding, bring it all together and extend it" (Newton, 2012, p. 47)

Thinking skills or processes: The process of thinking and the development of thought processes is considered as the aim and goals of education. Bloom's (1956) taxonomy or the revised version in Anderson (2001) provides behavioural descriptive classifications of cognition that a child needs to practice, in order to develop thought processes from lower (simple) to higher thinking (complex) (Morgan and Saxton, 2006).

> Higher level thinking: higher levels of thinking involving analysis, evaluation and synthesis or creativity. They are closely related to learning for understanding.

Lower level thinking: lower levels of thinking involving factual recall and comprehension, application and explanation. They are closely related to learning in terms of the memorization of facts.

Understanding: "It requires the connecting of facts, the relating of newly acquired information to what is already known, the weaving of bits of knowledge into an integrated and cohesive whole" (Nickerson, 1985, p. 234). Importantly, understanding relates information in terms of thought, ideas and information to present mental models of the world. According to Newton (2000) there are four types of understanding:

Conceptual understanding: an understanding of scientific concepts such as air and pressure; the fundamental meaning and the relation to other concepts.

Causal understanding: an understanding of causes and effects with regard to how things change.

Procedural understanding: an understanding of ways of doing things and reasons for what they do. This usually includes practical work.

Situational (or descriptive) understanding: an understanding of characteristics and components of situations or scientific phenomena.