

CHAPTER III

METHODOLOGY

Introduction

This chapter sets out the research methodology for the study. Research methodologies are determined by the purposes of the study and shape the research design. The research questions for this study focus on understanding and describing teacher and student actions and meanings in the classroom where an instructional unit developed to promote student learning of the matter and its properties is being implemented. This requires an investigation of interactions between teachers and students and their meanings in a natural setting (Creswell, 1998). The first section outlines perspectives for educational research and details the characteristics of interpretive research and the various methods that were used for collecting data. The next section, the research design for this study, provides the research design used in this study. It describes the contexts and the two phases of the study. The data analysis, discussion of validity and reliability issues, ethical considerations and the summary of the main points of the chapter are presented in turn.

Perspectives for Educational Research

An interpretive methodology was selected to be used in this study because the interpretive paradigm involves studying things in their natural settings and interpreting phenomena from the view of the participants in a particular social world (Bryman, 2001). From this perspective, the interactions among participants in a social world are considered to show the participants' intentions and meanings (Walsh, Tobin and Graue, 1993). People are considered to interact with each other to construct meanings and actions which are influenced by situations and contexts (Denzin and Lincoln, 1994). They interpret the world within their social framework by socially constructing and sharing meaning. People are thought to construct a meaning of the world over time as they negotiate with others, so the construction of

meaning is regarded as a continuous process (Walsh, Tobin and Graue, 1993; Cohen, Manion and Morrison, 2000). The interpretive paradigm contrasts with the positivist paradigm which utilizes the methods of the natural sciences and focuses on controlling variables, testing hypotheses and generalizing the results from the research (Bryman, 2001).

Interpretive research is carried out in a natural setting by the researchers who participate in that context to explore what is happening in a particular instance (Lincoln and Guba, 1985; Creswell, 1998). This means that interpretive researchers do not work from outside but are involved as participants in the social world they are investigating (Erickson, 1985; Denzin and Lincoln, 1994; Miles and Huberman, 1994). Their roles are very important in interpretive research because they are directly involved in the data generation as they attempt to understand the meanings that people construct in everyday situated actions (Miles and Huberman, 1994; Bryman, 2001). The researchers search for information about the events and on the social world of the research participants and interpret this not only from their own point of view but also from the point of view of the participants being studied (Bryman, 2001; Lewis-Beck et. al, 2004).

Interpretive research is conducted in natural settings in which researchers use mostly qualitative methods to generate data. Interviews and observations are the most common methods used (Walsh, Tobin and Graue, 1993). Data generation and data analysis are ongoing so that the research process is flexible and responsive (Guba and Lincoln, 1989). The study may change in response to the researchers' and participants' perceptions and understandings of events (Erickson, 1985). The main considerations in planning and conducting interpretive research are multiple perspectives, multiple data generation methods, ethics and ways of ensuring trustworthy data generation and analysis.

The Multiple Perspectives and Data Generation Methods

Due to the interpretive research, it was important to include multiple perspectives and multiple data generation methods in investigating Thai teacher and student views. The next sections set out the reasons for this and the methods used.

1. Multiple Perspectives

People are viewed as intentional participants and all their perspectives are of interest (Erickson, 1985). Interpretive study focuses on making senses of the events and the social world through the eyes of the people being studied to interpret that world from the perspective of the participants (Bryman, 2001). In this study the perspectives of teachers and students were sought.

The research's aim was the development of student conceptions of matter and its properties. An instructional unit is employed as an intervention. Students' concept surveys, classroom observations, teacher and student interviews and the collection of students' work during the unit contributed to get multiple perspectives from multiples sources ,and not only from the researcher.

An important point of the pilot study was to get a preliminary insight into the ways in which students made sense of the concepts (Duit, 1997). The pilot study in this study comprised the empirical investigation that underpinned the development of the teaching unit. In order to find out the current situations of teaching and learning the concept of matter and its properties and to investigate teaching and learning science in Thai primary schools, the interviews with Grade 6 science teachers were carried out. The other preliminary study was a survey of student conceptions of matter and its properties. The Grade 6 students were asked to response to the questions to do with the concepts. Both studies exposed the difficulties of teaching and learning and what the student conceptions of the matter and its properties were. The results developed researcher's understanding in Thai science primary situation and how Thai

students explained the matter and its properties. This section explained the methods for gathering data in the pilot study.

2. Multiple Data Generation Methods

2.1 Interviews An interview is a conversation with a purpose which emphasizes an interchange of views between two or more people in a social situation (Maykut and Morehouse, 1994; Cohen, Manion and Morrison, 2000; Wellington, 2000). The purpose of an interview is to gather information, which can not be observed, on individual thought, opinion, beliefs, feelings, perceptions, views and perspectives (Patton, 1990; Best and Kahn, 1998; Cohen, Manion and Morrison, 2000; Wellington, 2000). In the process of the interview, the interviewer must keep in mind what information he or she needs. The interviewer need to develop a rapport with interviewee and should have background knowledge about the topic of interview (Wellington, 2000).

Interviews have the advantage that the interviewer can probe and elicit interviewee's answers during the process of the interview (Cohen, Manion and Morrison, 2000; Wellington, 2000). Other advantages are that the people are usually more willing to talk than write and the truthfulness, sincerity and insight of the interviewee can be evaluated by the interviewer (Best and Kahn, 1998). On the other hand, the main disadvantage of interviews comes from the bias, perception and interpretation of interviewer because the interviewer will define the situation in a unique way (Cohen, Manion and Morrison, 2000; Wellington, 2000). Another disadvantage of the interview comes from interviewee. Some interviewees provide information based on what they think the interviewer wants to hear (Best and Kahn, 1998).

The type of interview selected depends on the purpose of the research. Wellington (2000) categorized three types of interviewing based on the degree of the interviewer's interaction with the interviewee. A structured interview is the least flexible type of interview. Here the researcher follows a pre-determined outline and

the order of the questions is set. An unstructured interview or non-standardized interview is very flexible because there is no set list of questions. It is an informal conversation. The interviewer guides the conversation and tries to listen to and understand the interviewee's answers (Maykut and Morehouse, 1994). The interviewer is free to modify the sequencing of the questions, change the wording, explain them or add to them (Cohen, Manion and Morrison, 2000). The direction of interview is unpredictable so the data from this technique may be difficult to analyse. The last technique is the semi-structured interview. It is more flexible than a structured interview and more under the control by interviewer than the unstructured interview. The interviewer already has the topic to be considered or a number of issues for the interviewee to elaborate on their ideas but the main questions do not follow exactly from a list they are used as a guideline or checklist. Questions that are not on the list may be asked as the interviewer picks up interesting points raised by interviewee (Denscombe, 1998; Bryman, 2001).

Groups and individuals can be interviewed. A group interview can be very difficult to manage. The group opinion may be dominated by one person with other group members not expressing their real opinions. On the contrary, an individual interview involves a meeting between one researcher and one informant. It is the most common form of interview (Denscombe, 1998). One advantage is that it is easy to arrange. Other advantages are there is only one source of information and it is easier for researcher to grasp one person's ideas.

The common method for collecting data from interviews is audio taped recording. This is convenient, inexpensive and the interviewer can gather all the words and the tone of voice and of the interviewee (Best and Kahn, 1998; Bryman, 2001). One thing that the interviewer needs to realize is that they cannot tape-record the interview without permission from interviewee (Wellington, 2000). The interviewer can also take notes of the conversation. Both the techniques were used in this study. The researcher had note taking during interviewing all teachers to make sure that there was other evidences for interviewer and interviewee's conversation.

The data from audio-taped interviews has to be transcribed which is a very time consuming process although it is very useful to have written evidence of the interviewee's and interviewer's words (Bryman, 2001). This process is discussed in more detail in the section interview in this study. This study used semi-structured interviews because the researcher had chances to probe and elicit information from interviewee based on the flexible questions.

2.2 Survey For the purpose of collecting data from a large number of respondents, particularly without the presence of the researcher, this strategy is appropriate strategy (Wilson and McLean, 1994 in Cohen, Manion and Morrison, 2000). There are three types of survey: structured, semistructured and unstructured survey. Structured survey includes closed questions such as multiple choice questions and is appropriate for a large group of respondents. They are easy to analyze in a statistical way. Unstructured survey often includes completely open questions. They are appropriate to obtain more detailed data from small groups of individuals who responses freely in their own ways. Semistructured survey is similar to an unstructured but there are series of open questions with probes (Cohen, Manion and Morrison, 2000: 246-248).

There are many types of questions that can be included in a survey including multiple choice questions, dichotomous questions, rating scales and open-ended questions (Cohen, Manion and Morrison, 2000: 248-249). The key advantages of multiple choice questions are that they are more objective and less open to researcher bias in the interpretation of answers than open-ended questions, they are appropriate for larger groups of respondents and are quick to code and analyse (Barker, 2000; Cohen, Manion and Morrison, 2000: 251-252). However, multiple choice questions have the disadvantage that it is impossible to guarantee that every respondent understands the multiple-choices items in the same way and it is very hard to construct quality questions which represent all concepts and measure all the points the researcher would like to measure. Open-ended questions can solve some of the problems of multiple choice questions. The researcher can get information about respondents' thinking because they answer with their own words and are not limited

by the options in the item. A disadvantage of open-ended questions is that they require more effort from the respondents as they have to write a longer answer. The problem of low response rate is usually found. In this study, multiple choice and open-ended questions were the type of questions used in a survey with students to elicit their ideas about the matter and its properties.

2.3 Classroom Observations Classroom observation is a powerful method to gain insight into what is happening the classroom. The researcher can act as a complete participant, a participant observer, an observer as participant or a complete participant. The complete participant is the observer who observes in her own class or in another class and no one knows her purpose of observation. The participant observer is the observer who participates in the class as one of the participants but she is not the teacher or a student in the class. The observer as participant is the observer who participates sometimes in the class. She does not establish an in-depth relationship with the participants in the class. The complete observer is someone who does not participate in the class but just observes what happens.

Although a participant observer becomes reasonably closely involved with the participants (Ball, 1985; Cohen, Manion and Morrison, 2000), the presence of adult stranger in school can be difficult to accept by other participants. She or he may disrupt the naturalness of the situation (Denscombe, 1998). The acceptance of other participants for the observer is important rather than whether or not an observer is noticeable (Ball, 1985). The observer tries to observe the members of the social setting that she participates (Bryman, 2001). The advantages of participant observations are the observer can discriminate what is going on in real situations and has a chance to build relationship with full participants (Cohen, Manion and Morrison, 2000). In this study, the researcher worked in each of three classrooms where the unit was implemented as a participant observer. Each class was observed for the whole unit.

Video-taping, audio-taping and field notes are the techniques which are usually used in participant observations. Video-taping is useful because it can record both visual and verbal data but it is not possible to get the whole picture of the class. It is often obtrusive and inconvenient. Audio-taping to record the participants' discussions and tone of voices is more convenient than video-taping. Field notes are convenient and allow the researcher to move around although they do not capture all that is said and done. Field notes were used in this study because of their flexibility and their unobtrusiveness.

2.4 Case Studies of The Implementation of an Instructional Unit A case study is a method for studying individuals or small groups in real-life situations. A case study provides an in-depth account of events, relationships, experiences or processes in a particular phenomenon (Denscombe, 1998). It is an appropriate strategy when how or why questions are asked and when the researcher has little control on the situation. It is used when the focus is on a real life context. It allows a rich, thick description of the phenomenon under study, which includes an in-depth description of the events or entities being investigated (Sharan, 1998). Typically, researchers collect data using many methods such as observations, interviews, and the collection of documents. They try to give an intensive, holistic account of the event or situation and emphasize the details of relationships and processes in the natural setting (Cohen and Manion, 1994; Sharan, 1998).

Ethics

Ethics is an important consideration and cannot be ignored in any educational research (Bryman, 2001). This issue considers the trust and rapport established between the researcher and participants. Many ethical principles are related to educational research, of these harm to participants, the need for informed consent; confidentiality (Cohen, Manion and Morrison, 2000).

The potential for harm caused by researchers to the participants in a study needs to be considered by all researchers. Bryman (2001) explains that there are

many facets of harm: physical harm, harm to participants' development; loss of self-esteem; stress; and inducing subjects to perform reprehensible acts. Researchers working with teachers and students need to be aware of the impact of their presence in the classroom. The consensus is that researchers should gain participants informed consent prior to beginning any study. Participants should have opportunity to agree or refuse their participation in the study on the basis full information about the nature and implications of their participation (Bryman, 2000). They must be told about the nature and purpose of the research, exactly what will expect of them, any possible risks of the research and that they can withdraw for the research. They need to know and agree with the data which is collected and how it will be used in the research. Confidentiality and privacy are also important. This principle includes the need to keep data confidential and to make sure that all data from the participants remains confidential between the participants and the researcher and is not repeated to anyone else without consent. It also means that care needs to be taken in reporting on the results of a study, particularly when participants are likely to be known to each other.

Ensuring Trustworthiness of Data Generation and Analysis

The criteria for assessing the quality of research for the quantitative research, which are reliability and validity is not appropriate to use in qualitative research and interpretive research because differences of the grounding of these ideas. Interpretive researcher study in particular social context which she participates, showing the evidences of interpretation are important rather than the adequacy of measure (Bryman, 2001). Lincoln and Guba (1985) and Guba and Lincoln (1989) propose the alternative criteria for qualitative research, which they call trustworthiness. There are four criteria of trustworthiness; credibility, transferability, dependability and confirmability (Guba and Lincoln, 1989). Many different methods are used to enhance each criteria of trustworthiness.

Triangulation and respondent validation or member validation are the techniques for enhancing credibility. In triangulation, multiple methods, or multiple sources of data are used to collect data from different point of views or different

events. Member validation can be done by going to check with participants to inform both the data and interpretation. The credibility of research ensures that the research is accepted by others and confirms the correct understanding of the social world (Bryman, 2001).

Producing thick description, which is an extensive set of details concerning methodology and context provided in a research report, that is rich account of the details of the culture is enhancing transferability. It is the ability to apply the results of research in one context to another similar context. Transferability of a study invites readers to make connections between elements of the study and their own experiences because the small number of students in the study limits generalizability. Instead, generalizability depends on the degree to which the reader can relate to what is described, remove it from context, and interpret it in terms of his or her own life experience (Stake and Easley, 1987). The uses of thick descriptions help the reader of the study to decide whether findings can be transferred or applied to other context. The researcher needs to collect sufficient details of data in context and reports them with sufficient detail and precision to the reader (Guba and Lincoln, 1989; Bryman, 2001).

Dependability and confirmability are the final two criterion proposed by Guba and Lincoln (1989). A dependability audit involves ensuring a complete record is made of all phases in the research process. In other words a dependability audit relates to the technique of documenting the logic of process and method decisions used in the research so that they are trackable (Guba and Lincoln, 1989). Confirmability, the last of Guba and Lincoln's criterion, ensures the findings are the product of the study and not the bias of the researcher. It means that all data should be confirmable by the researcher. Confirmability is enhanced by making explicit to the reader that the data in the study can be tracked to a source and are rooted in real contexts and participants. Establishing confirmability is one of the objectives of an audit. Neither of these criteria is much used in practice because of their complexity (Bryman, 2001).

The Research Design for This Study

In this section the research design for this study is presented. The first section shows the summary of data collection and timeline for this study. The multiple perspectives from the participants, the data generation methods, and the data analysis strategies will be introduced. The triangulation methods for ensuring the trustworthiness of data generation and analysis are included in the last section.

1. Overview of Data Collection and Time Line

There are two phases in this study. The first phase of the study (June 2003-March 2004), comprised the empirical investigation of the Thai student and teacher views and conceptions. Six Grade 6 primary teachers from six different schools in Saraburi province, Thailand were interviewed to survey their perceptions about teaching and learning science. Fifty students' responses from same schools as six teachers were surveyed and analysed to find out their conceptions about matter and its properties. A literature review of matter and its properties was conducted. A conceptual change approach-based instructional unit was designed drawing on the data from the exploration of teachers and students and the insights gained from the literature review (Chapter 5).

In phase II (January 2004 to March 2005), the conceptual change approach-based instructional unit was implemented and evaluated. Three of the six teachers interviewed in phase I agreed to implement the unit. They participated in teacher conference sessions prior to teaching the unit. The teaching and learning processes of these teachers were observed while they taught the unit. The teachers were interviewed after lessons and at the end of the unit.

Table 3.1 summarizes the research phases, data collection and timeline. The teachers, students, interviews, survey and participant observations are described in detail in the next sections.

Table 3.1 The Research Phases

Phase	Data Collection
Phase I: Exploring of situation of teaching and learning about matter in Thailand (the 2003 academic year)	<ul style="list-style-type: none"> – Semi-structured interviewing the six teachers about their perceptions related to their understanding on science concept, teaching, students' learning. – Surveying the fifty students from six schools about students' conceptions related to matter and its properties.
Phase II: Designing, implementing and evaluating the conceptual change approach-based instructional unit about matter (the 2004 academic year)	<ol style="list-style-type: none"> 1. Designing of the unit. 2. Piloting the conceptual change approach-based instructional unit by the researcher. 3. Setting the teachers' conferences for working with teacher to develop the instructional unit and to track the effectiveness of the instructional unit through out the unit. 4. Implementing the instructional unit <ol style="list-style-type: none"> a. Diagnosing Students' understanding by using pre and post survey b. Unstructured interviewing the students to clarify their responses from pre and post survey at the end of the survey. c. Observing classrooms in three classrooms. d. Unstructured interviewing about student understandings about matter and its properties with 3-4 students in each of the 3 classes through out the unit. e. Unstructured interviewing about teaching and learning matter using the conceptual change approach-based instructional unit with 3 teachers throughout unit.

2. Multiple Perspectives

Teacher, student and researcher perspectives were important in this study where the goal was to design and implement a unit to enhance student understanding of matter and its properties. As previous discussed, the use of participant triangulation was also used to enhance the credibility of the research.

2.1 The Teachers Six teachers from different schools (A,B,C,D,E and F) in Saraburi province, Thailand involved in this study. Three of them, B (Ms Chujai), E and F (Ms Pailin) were volunteered to implement a conceptual change approach-based instructional unit. However, E denied to participate in this study later. Mr. Mana was a teacher who involved in this study instead. His background would present soon.

From Table 3.2, All teachers had experiences in primary class more than ten years. Three of them had taught science in Grade 6 more than twenty years. One teacher had taught science in Grade 6 only one year. Table 2 show backgrounds of these teachers.

Table 3.2 Teachers' Backgrounds

Teacher	Age (yrs.)	Education degrees	Teaching experience in primary level (yrs.)	Science teaching experience in grade 6 (yrs.)
A	47	major-Thai dancing, minor-art	26	20
B (Ms Chujai)	40	Thai language	11	1
C	47	agriculture	23	23

Table 3.2 (Cont'd)

Teacher	Age (yrs.)	Education degrees	Teaching experience in primary level (yrs.)	Science teaching experience in primary level (yrs.)
D	45	general science	18	6
E	45	educational administration	19	19
F	54	elementary education	31	23

(Ms Pailin)

These six experienced teachers had never got any experiences in any research projects. Most of them realized that they had low confidence in science teaching because they thought they had low content knowledge and science process skills. Students' interest, students' skills, curriculum and science equipment available were the factors which some teachers were aware of when they selected teaching strategies. Most teachers had the same opinion that practical works and learning from real things were good for teaching the hardest concepts and the concept of matter and its properties because they could motivate students to learn, develop students' science process skills and science content knowledge and relate to everyday life. Most teachers also said that outside help was useful so they asked other teachers or experts to teach their students or brought their students to the learning resources such as science exhibition.

The three teachers who volunteered to implement a conceptual change approach-based instructional unit are showed.

2.1.1 Ms Chujai Ms Chujai was forty years old teacher from School 1, a small primary school in rural area of Saraburi. Her formal qualification was Thai language. She was a teacher in primary level for 11 years but she has just got experiences in teaching science for 1 year. She had little experiences in teaching grade six and science because she taught in lower primary level for ten

years. She felt reluctant at first when she was asked to be involved in the research. However, she volunteered to participate in this study because she said she had some difficulties in teaching science and she knew a bit about science that made her have less confidence in teaching science. So, she would like to develop herself.

2.1.2 Ms Pailin Ms Pailin was a fifty four years old teacher
in

School 3. Her school was the biggest school in town. She got a Bachelor degree in primary education and had experiences in primary teaching for 31 years. She had taught science for 23 years and got the best science teacher award of Saraburi in 2002. Although her school still used an old curriculum which integrated science with social studies and health education, she had taught science as a separate subject. She had tried to encourage students to have more practical work but she said she had less confidence when teaching students to do experiments and using science equipment. She wanted to be involved in the research because she had had little knowledge about science and teaching science because she did not have a qualification in science. She would like to know more about how to teach primary science.

2.1.3 Mr. Mana Mr. Mana was a thirty one years old teacher who got a bachelor degree in Education (general science). He had experiences in teaching science in college for eight years. After that he had experiences in teaching science in grade 7 to grade 9 for eleven semesters. Mr. Mana was a new teacher for school JF at the time in implementing the instructional unit. He participated with grade 6 students for science subject, computer subject and Boy Scout. Because of Mr. Mana was a new teacher in school JF, he was assigned for many jobs in which other teachers did not want to participate, for example to be responsible for grade 4, to enroll in seminar or teacher training provided by the government. These made him have no enough time to prepare himself for teaching and sometime he had to postpone his class. Mr. Mana thought that science was a study about natural phenomena. He explained that science help people to live with an environment. He believed that students learn by exploring and constructing knowledge by themselves. He thought science knowledge was the fact but the ways to get knowledge were different.

2.2 The Students Fifty grade 6 students from six primary schools in Saraburi province, Thailand were involved in this study. All of them took the concept survey about matter and its properties in March 2004. Eighty-one students from three classes in three schools were selected participating science classes where a conceptual change approach-based instructional unit being implemented in November 2004. These were the students of Ms Chujai, Ms Pailin and Mr. Mana. Students' concept surveys, classroom observations, teacher and student interviews and students' works were used for gathering data.

2.3 The Researcher The researcher involved in all processes of data collection, generation and analysis. Matter is related to every life; every one touches it, eats it, and uses it. Her interests in the concept of matter come from her experience as a student teacher and her literature review. She found that there were two sets of concepts of matter, scientific matter and everyday matter. There are numerous studies of alternative conceptions of matter from many countries, mostly from Western countries. She needs to know more about Thai students' alternative conceptions especially for young students. The students whom she works with live in a rural area, they have many experiences of the physical world; they play in mud, they burn dry leaves, they see dew and fog in the morning, and they filter coconut milk. Do their experiences relate to the science content in curriculum? If the answer is yes, why do they still have alternative conceptions about these ideas? Why can they not explain these ideas in a scientific way? To answer these questions the researcher will present them with a way to explain what is happening in their lives in relation to the concept of matter, by showing them a scientific conception and asking them to make the decision, is it concurrent with their conception? Which one do they prefer and why? Developing the teaching unit which based on conceptual change was the strategy that she chose to answer these questions. The instructional unit was including activities, lessons and tasks that encouraged the students to understand matter and to use a scientific way to appropriately explain phenomena.

3. Multiple Data Generation Methods

Multiple data were gathered through teacher and student interviews, students' concept surveys, classroom observations, and students' works.

3.1 Interviews in This Study Interviews in this study occurred with six teachers as individuals. There were two sets of interviews with teachers (see Table 3.1). The first set of interviews was took place in Phase I (June 2003). The teachers were interviewed about their perceptions concerning science, science concepts, teaching strategies and student learning. The informal interviews were managed to encourage the teacher to feel comfortable while they were asked to speak and describe about their ideas about teaching and learning science. The main questions were prepared for these semi-structured interviews as in Table 3.3:

Table 3.3 Teacher Interview Questions

Topics	Questions
1. Teacher perception about their understanding about science	<ul style="list-style-type: none"> - What is science? How can we get scientific knowledge? - What is the nature of science? - Is science in elementary level important? How?
2. Teacher perception about their understanding about science concept	<ul style="list-style-type: none"> - From your direct experience, which is the most difficult concept to teach? Why? - Do you have any difficulties to teach the concept of matter?
3. Teacher perception about their teaching strategies	<ul style="list-style-type: none"> - How did you teach the most difficult concept? Why do you use these strategies? - How do you teach the concept of matter? Why do you use these strategies? - Do you use the same strategy to teach in different concepts? - How can you help your students understand the concept of matter?
4. Teacher perception about students' learning	<ul style="list-style-type: none"> - Which concept is the hardest for students to understand? - Do the students have problem about the concept of matter? How? What is the cause of the problem?
5. Science concepts in elementary level	<ul style="list-style-type: none"> - What science content do elementary students learn? - What science content do elementary students learn in the topic of matter?

All the interviews were audio taped and transcribed verbatim by the researcher. All teachers looked no anxiety after stop the audio taping process. Each teacher was interviewed for approximately 30 minutes during lunchtime or after school.

The second set of interviews was conducted at the end of phase 2 (November 2004) after teachers had implemented a conceptual change approach-based instructional unit. They were asked to express their ideas about teaching, learning and assessment during this unit. This information was used as one of reflections of the unit.

3.2 Survey in This Study In this study, a survey consisted of 15 items which covered the concepts of matter and its properties in grade 6 (11-12 years old). There were seven topics: properties of solids, liquids and gases; matter and nonmatter; particulate nature of matter; change in state of matter; solution processes; chemical change and separating of mixtures. The first two topics were surveyed as the basic concepts for other five concepts. The three types of question were used in this survey; multiple-choice questions, multiple-choice with free response questions and open-ended questions. In the open-ended questions, the student was asked to draw pictures and/or describe their ideas.

Different types of questions in survey were chosen rely on the purpose of each item in the survey. Because matter was very complicated concept, some issues were hardly to be judged that it was scientific conceptions or alternative conceptions. For example, “water evaporation means it disappears or it boils”, “a new substance occurs in the process of dissolving”, “dissolving is chemical change”. These ideas were not congruent with the ideas in chemistry textbooks but these were not partly wrong. Each student had their own meaning about “disappearance”, “boiling”, “a new substance” and “dissolving”. Free response was required in this survey for students to explain about detail of these kinds of concepts.

Most of the questions in this survey were derived from the questions that were used by other researchers. For example, an idea from LIPS Working Paper 37 (University of Waikato) about the form of rust before iron reacts with water and oxygen was adapted to the question 14 in the survey (Schollum, 1982). According to literature review of numerous studies about student conceptions about matter from various countries especially from western countries, the reason for developing the questions was based on other research because those research studies showed the pattern of student conceptions about matter. It was very interesting that how Thai student conceptions match with student conceptions from other countries. Using the similar questions allowed for more direct comparison and gives some ideas about how best to do with other questions which developed by own researcher. The used questions gave a sense of having been piloted by other researchers. The measurement qualities of questions could be shown from their reliability and validity testing (Bryman, 2001).

The issue of validity and reliability of survey is important as the evidence to show whether the survey is measured what it is supposed to measure or whether the survey has the consistency of results when it is implemented more than once. The most obvious type of validity is content validity, which shows the adequacy of measuring what the questions are supposed to measure and those questions are representative samples of the behaviour domain under investigation (Burns, 2000). In this study, the experts who were familiar with the area of this study gave some feedbacks which were ensured the corresponding of questions with the objectives of curriculum and the appropriateness with respondents. They were two scientists from Faculty of Science, Kasetsart University and three science educators from IPST and Ministry of Education

The survey was pilot in February, 2004, to identify the appropriateness of language, the suitability questions and options and the suitability of the time. This pilot study was carried out at two primary schools in Saraburi province, Thailand. Twenty four students were surveyed. They were small group of students who were comparable to the sample in the real study (Bryman, 2001). This survey was

administered for 45 minutes. Following the pilot study, the survey was re-organized in term of unclear and confusion language, unclear picture and administered time from 45 minutes to 50 minutes. The distribution of the survey was conducted in March, 2004. There were 157 students from six primary schools in Saraburi province, Thailand. This survey was administered for 50 minutes.

3.3 Classroom Observations in This Study During the classroom observation, field notes were recorded by the researcher and classroom activities were videotaped or audio-taped.

3.4 Students' Works in This Study The student work results during the unit such as students' worksheet, students' journal and students' experiment report were photocopied.

3.5 Case Studies in This Study

There were three case studies in this research consisted of three Grade 6 class from different schools. The researcher participated on their real life context for collecting a thick description of the situations and relationship between the participants in natural setting. Many methods above such as classroom observations and interview were used.

Ethics in This Study

Ethical considerations about potential harm to participants, the need for informed consent and confidentiality were responsive in this study. Consent forms were given to the principals of the schools and individual teachers to ask for their permission to do research in their schools and in their classes. The purposes of the study, all data generation methods and the expected use of the data were explained to the teachers at the beginning of the study. The researcher asked the teachers in each class to introduce what she would do with the students. All data from observations in

the class and student works were kept confidential by the researcher. Pseudonyms for school names, teachers and students were used to preserve anonymity and their privacy was protected. The researcher was most careful to reduce potential harm and maintain confidentiality when referring to the participants in the publication of data.

The researcher also asked permission from teachers and students to use the students' work in this study. The results of their work were photocopied or photographed and the originals returned to the students.

Ensuring Trustworthiness of Data Generation and Analysis in This Study

The criteria of trustworthiness proposed by Lincoln and Guba (1985) and Guba and Lincoln (1989) were used in this study. The process of triangulation was employed to enhance credibility through the collection of different ideas about the teaching and learning of matter and its properties and the effectiveness of the intervention. Multiple methods of data collection were also used. These methods included teacher and student interviews, a student conceptions survey, classroom observations and students' work. This allowed for the thick descriptions required for transferability and for cross matching of the findings from different classrooms.

During the intervention, the researcher had discussed with the teachers about the activities, their teaching, student learning and assessment. She also had discussed with some students about their understanding of matter and its properties based on their actions and interactions during lessons and their answers to the worksheets. The teachers were also interviewed at the end of the intervention to elicit their views about the overall usefulness of the intervention and their ideas about student learning. This data was used to inform the researcher's interpretations about the teaching and learning about matter and its properties that took place in the classroom and the effectiveness of the intervention. The compilation of case studies provided a means to ensure the transferability of the study. It provided details of teaching and learning matter and its properties in each classroom.

Respondent validation or member validation of the researcher's initial interpretations of classroom events was also used to enhance credibility of the analysis of the intervention. This member validation occurred with the teachers who implemented the intervention.

Data Analysis

The analysis of data in this study came from the purposes of this study to describe how students understood matter and its properties and how a conceptual change approach-based instructional unit encourage teaching and learning about matter. The triangulation of multiple data generation methods from multiple perspectives of participants was used. To analyse data from multiple data generation methods are presented following,

1. Classroom Observation Data

The data from field notes recorded by which was videotaped or audio-taped was transcribed. The relationships between the participants in the natural setting were established. The data from each of class were triangulated with other data collecting methods.

2. Teacher Interviews

All interviews data which was tape-recorded was transcribed verbatim by the researcher except one teacher who did not allow audio-taping. The researcher took notes during interview with her. Pseudonyms were used for all six teachers who participated in this study.

3. Student Interviews

The student interviews aimed to probe each student understanding about the lesson and pre and post survey. The students were selected for the interview by the

researcher. The researcher selected the students by their responses to the class activities and concept survey. Each interview was tape record and fully transcribed.

4. Survey Data Analysis

All student responses from the survey were categorized and analysed based on the categorization of concepts of Andersson(1990), Tytler and Peterson (2000) and Tytler (2003) and modified to meet the objectives of this research. In this research modification (M) category is separated into two categories, modification 1 (M 1) and modification 2 (M 2) for presenting levels for different ideas of modification. For M1, the students only describe the change in state but for M2, the students explain more about the effect of heat to the change in state.

The scientific conception in each concept had different category. For example, scientific conception for the change in state of matter is a category Modification 2 (M 2) which refers to the effect of heat to change of state of matter.

5. Student Works Data

The student work results during the unit were photocopied and used to triangulate information from the students' concept survey and student interviews.

Summary

An interpretive methodology was used in this study because the interpretive paradigm fits with the research questions which involve studying student conception development and teacher teaching in a natural setting and interpreting these phenomena from multiple perspectives. The timelines in this chapter show how and when the teachers and students participated in each phase of the study. This study was conducted from a conceptual change perspective and multiple data generation methods were used. To interpret the data, qualitative data analysis methods including triangulation were applied. The criteria developed by Lincoln and Guba (1985) were

used to ensure the trustworthiness of the data generation and analysis in this study. Ethical considerations were also addressed in the chapter.

The next chapter (Chapter 4) presents the results from Phase I of this study which relate to the existing situation of teaching and learning about matter in Thailand. The results from Phase II are presented in Chapter 5 and 6.