

## CHAPTER I

### INTRODUCTION

#### Significance of the Study

Following on from changes increased globalization, the crucial role of science in the development of a competitive and knowledge-based society has been highlighted. In order to share the benefits of a knowledge-based society and to compete with other countries to provide its people with a high quality of life and society, the Thailand government has recognized the need to develop its human resources (ONEC, 1999). The updated version of *the National Education Act (ONEC, 2002)* legislates the goal that Thai students will become people who have developed an equilibrium in their physical and mental health, and their intellect and knowledge, and who have morality and integrity. Students will be knowledgeable about religion, art, national culture, sports and local wisdom. Both Thai wisdom and universal knowledge are promoted. Students should be able to live in harmony with other people in society and have the capability of competing with others at an international level. From the National Education Act, the Ministry of Education of Thailand has legislated *the Basic Education Curriculum (Ministry of Education, 2002)* which focuses on developing students as quality citizens, preparing them for living, working and studying at higher levels and fostering in them a desire for life-long learning. This curriculum has educational content and standards that indicate the level of achievement expected from students from Grade 1 to Grade 12. In the curriculum there are eight subject areas, each with their own content and standards. These areas are hygiene and physical education; visual arts; social studies, religion and culture; Thai language; mathematics, occupational development and technology, international languages, and science. Scientific literacy for all, which relates to develop an understanding of science and encouraging all Thai people to be aware of and understand science and its relations to everyday life, is an important part of *the Constitution of the Kingdom of Thailand (The Council of State of Thailand, 1997)*.

### **Thai Educational Reform in Science Education**

Within the science subject area, *the National Science Content Standard (IPST, 2002)* emphasises that all students are expected to be scientifically literate, that is to have the knowledge, skills and attitude of scientists and to have knowledge about managing natural resources in a sustainable way. Students should be aware of the relationship between science, technology and society and be able to apply scientific and technological knowledge to their everyday life. The purposes of *the National Science Content Standards of Thailand* correspond with science content standards of other countries; for example, *the National Science Education Standards of the United States (National Research Council, 1996)* and *Science in New Zealand Curriculum (Ministry of Education, 1993)*. All these documents also identify that teaching and learning science is an active process that involves both mental and physical aspects; argue that science provides a basis for understanding the world, and acknowledge that science is a universal discipline that can contribute to different cultures. The suggestion is that science education should be available to all students and encourage all students to develop scientific understandings, skills, and attitudes.

The Thai education reform identifies the teacher as a key person in the design and implementation of the new curricula. Teachers are expected to plan both content and methods for students; provide an encouraging atmosphere and environment for learning; provide learning goals based on the needs of students and the community, and suggest ways to search for appropriate knowledge suitable for each individual student. Expert teachers or educators from universities, and also parents and the community, have the potential to help teachers to develop their teaching based on *the Basic Education Curriculum (Ministry of Education, 2002)*. In times of change, IPST and Minister of Education also have a role to train and introduce the new curriculum to science teachers in school.

Prior to the educational reform in 1999, primary education in Thailand was compulsory for six years. Students aged seven had to attend primary school. According to the *Thai National Education Act (Ministry of Education, 1978 and amendments 1990)*, the curriculum provided basic general knowledge and skills in

arithmetic and basic reading, writing skills for everyday life; promoted understanding of the world surrounding the students, and required them to be good members of society. There were five subject areas: basic skills (Thai language and mathematics); life experiences (social studies and science); character development (moral education, physical education, music and performance arts and art); work-oriented experience (practical skills and experiences for vocational skills), and special experience (special interest, most schools choose English as a special experience subject). Science was integrated as a life experience subject with the aim to encourage students to analyse and find ways to solve social and daily-life problems by using science process skills. As from *the National Education Act (ONEC, 1999)*, education has been extended to twelve years and science is presented as a specified subject at primary level. The students are encouraged to learn and fostered to think, acquire and construct knowledge by themselves. They are expected to be able to have knowledge, thinking skills, science process skills and a scientific mind based on eight science content standards.

Both *the National Education Act (ONEC, 1999)* and *the National Science Content Standard (IPST, 2002)* emphasize that an important goal for science education is to encourage students to develop their own scientific conceptions for understanding and explaining natural phenomena. Scientific conceptions should be meaningful to students and be applied to their everyday life (ONEC, 1999; ONEC, 2000; IPST, 2002). The specific goals of science education for Thailand are to have all science educators, teachers, parents, schools and communities provide science education for Thai students so they can reach the desired knowledge, skills and attitude. It is for these reasons that the Institute for the Promotion of Teaching Science and Technology (IPST, 2002) has as a focus the development of science education in Thailand. This study is derived from this focus with the aim of generating science education research in the area of the teaching and learning matter and its properties for primary students in Thailand.

### **A Focus on Teaching and Learning about Matter and Its Properties**

An understanding of matter and its properties is considered a necessity for studies in health science, geography, physics, zoology, botany, environmental science, and home economics (Brown et. al., 2000). This understanding is also related to everyday life. For example, everyone drinks water (liquid), wears shoes (solid) and uses O<sub>2</sub> for respiration (gas). In *the National Science Content Standards of Thailand (IPST, 2002)*, concepts to do with matter and its properties appear in the third content standard and Thai students at all levels are expected to learn about matter. At the elementary level, students are expected to learn concepts the properties of materials used in toys and everyday objects; the properties of matter (solid, liquid and gas); the change in state of matter; separation of matter; solution processes, and chemical change as a basis for learning sophisticated concepts in higher level . Later, they should understand the relationship between properties of matter, the structure of matter and inter-particle force, physical change, solution processes and chemical change.

Research studies in student alternative conceptions have probed students' understanding of the concept of matter and its properties for over 30 years. These research studies have shown that students hold many alternative conceptions about matter and its properties. For example, some students think water moves to the sky or into space after evaporation or boiling (Cosgrove and Osborne, 1981; Tytler, 1989; Bar and Galili, 1994; Johnson, 1998a) while others think the liquid particles change into a gas when a liquid evaporates (Lee et al., 1993). Some students think that no new substance is formed in chemical reactions (Schollum, 1981; Meheut, 1985; Pireto et al., 1992; Rahayu and Tytler, 1999); others think that the solute disappears during dissolving (Cosgrove and Osborne, 1981; Prieto et al., 1989; Longden et al., 1991; Selley, 2000; Valanides, 2000). Most students do not accept that mass and energy do not change after physical and chemical changes (Cosgrove and Osborne, 1981; Osborne and Cosgrove, 1983; Sere, 1986; Andersson, 1990; Stavy, 1990a; Stavy, 1990b; Pireto, 1992; Barker, 1999).

In Thailand, only three researchers have investigated student conceptions of matter and its properties. Savanakunanon (1993) studied the development of Grade one, three and seven students' ideas about matter. Chantanapitan (1997) studied Grade eleven student conceptions of the nature of molecules in different phases of water, and Sanguansin (2004) studied student's conception about state and changes in the states of substances at the upper primary level. All found that Thai students had some alternative conceptions about matter, especially abstract concepts. For example, most students could not separate gases from liquids because they could not explain the different physical properties of gases and liquids (Savanakunanon, 1993); many students could not explain the changes processes related to gases such as evaporation and condensation, and most students considered that the size of the molecules in each phase of matter was different (Chantanapitan, 1997). The results of TIMSS in 1995 supported that Thai students had difficulties in learning science. In TIMSS, Thai primary students' scores were ranged in 19th and 22nd in Grade 7 and Grade 8 in science. These findings show the same trends as those described by researchers from western countries.

### **A Conceptual Change Approach for Teacher**

Conceptual change is concept used in the science education community to explain the process of how student conceptions might change to more scientific conceptions (Wandersee et al., 1994; Duit and Treagust, 2003). Conceptual change is not only thought to occur in students' head but also in their relationship with the world (Duit, 1997). A conceptual change perspective realizes the requirement of *the National Education Act (2002)* and *the National Science Content Standards (IPST, 2002)*. It supports the importance of the development of student learning, the interaction between teacher-students and student-student. The encouraging of students' change in their concepts was related to the objective of student-centred approach which emphasized in *the National Education Act (ONEC, 1999)* and *the National Science Content Standards (IPST, 2002)*. Conceptual change perspective also highlight teachers' development in term of their abilities, interest and attitude toward teaching and learning, skills in teaching, and using research to develop the teaching and learning process.

In this view, effective teaching involves teaching for conceptual change as a way of facilitating students' understanding and acceptance of scientific conceptions. The teaching approaches developed for promoting conceptual change are many and varied and have been shown to be successful in many fields of science education. For example, Harrison and Treagust (2000) used analogies to teach the concept of atoms and molecules at high school level. Beeth (1998) focused on students' metacognition to promote the development of student's understanding of the concept of force and motion at a primary level. Vosniadou (1994) used modelling to teach the concepts to do with the motion of the sun and the moon to primary level students. These are just some of the strategies that have been used to promote conceptual change in science. There have, however, been few research studies on teaching for conceptual change about matter and its properties and few Thai studies are located. Some examples are the work of Nieswandt (2001) who constructed a teaching unit based on a conceptual change perspective to promote understanding of the changes of matter, and Solomonidou and Stavridou (2000) who studied ways to encourage students' conceptual change about chemical change. This study seeks to expand and extend research in the area with particular attention to the Thai context.

The purpose of this study was to help grade 6 students to understand matter and to develop their scientific conceptions of it and to prepare the teachers for using a conceptual change approach to enhance students' learning about matter. Concepts of matter are examined and developed based on *the National Science Education Standard of Thailand (IPST, 2002)*. The strategies which the researcher used to help the students were incorporated in an instructional unit based on conceptual change. The instructional unit included activities, lessons and tasks that aimed to encourage students to understand matter and its properties and to use a scientific way to explain phenomena. In the research, the teacher was regarded as a key person. Many researchers have shown that the teacher plays an important role in students' learning processes (Beeth, 1998; Akerson et al., 2000). In particular, teachers' understanding of scientific concepts, and their perceptions about teaching and learning have been found to affect teaching behaviour. However, few research studies have focused on

the teacher and teaching for students' conceptual change about matter and its properties. In Thailand, only one research study was found. Mungsing (1993) studied the effectiveness of teaching strategies for conceptual change and this was for genetics in high school students. There was no research study to do with teaching for conceptual change about matter and its properties at the primary level.

### **Purposes of the Study**

1. To explore Grade 6 (aged 11-12) students' conceptions about matter and its properties and teacher perceptions of their own understanding of matter and its properties and associated teaching strategies along with the challenges faced by students when learning about matter and its properties.
2. To study how can develop a conceptual change approach-based instructional unit and prepare teachers to teach it.
3. To design and implement a conceptual change approach based instructional unit on matter and its properties concepts and to examine the impact of the unit on teaching and learning.

### **Research Questions**

This study aims to find out what difficulties there are in teaching and learning matter and its properties in Thailand and to use this finding to design and study how an instructional unit based on the notion of conceptual change can help students develop their existing conceptions towards scientific conceptions of matter and its properties. Three research questions related to these aims provided a framework for the study. These questions were:

1. What is the existing situation of teaching and learning about matter and its properties for Grade 6 teachers and students in Thailand?
2. How can a conceptual change approach-based instructional unit be developed and teachers be prepared to teach it?

3. What is the impact of the implementation of a conceptual change approach-based instructional unit on teaching and learning about matter and its properties?

As the study was based on an interpretivist perspective, a concept survey, classroom observations, interviews and students' work were used to investigate student conceptions of matter and its properties and teachers' perceptions of teaching and learning about matter and its properties. A conceptual change approach based instructional unit was developed based on previous research and on data from the students and teachers. The impact of the unit was evaluated using a concept survey, classroom observations, interviews and students' work.

### **Anticipated Outcomes**

1. The science teachers will realize the importance of examining the students' existing conceptions and the used of strategies to promote students' scientific conceptions and use a conceptual change approach-based instructional as a guiding to develop instructional units on matter and its properties.

2. The finding will provide information for professional developers, science educator about teacher understandings of matter and its properties and enhance understandings of teaching strategies that promote student learning, especially student learning about matter and its properties.

3. The finding will provide a way for policy makers to support the use of use a conceptual change based instructional approach as a tool to promote teaching and learning science in Thai classrooms.

## **Delimitation of the Study**

### **1. Subjects**

The subjects in this study include teachers students from different schools are explained based on each research question namely.

**1.1 Research Question 1** In Phase I of a study, a sample of 157 Grade 6 students from six primary schools (one class from each school), in the rural area of Saraburi province took a matter and its properties concept survey after studying the topic of matter and its properties in the 2<sup>nd</sup> semester of the 2003 academic year. Six teachers, who had experience in teaching the topic of the matter and its properties were interviewed individually about their perceptions of their understanding in scientific conceptions, effective teaching strategies and student learning. These six teachers came from the six different schools where the students took the concept survey.

**1.2 Research Question 2** In Phase II of a study, the three teachers from the six schools in Phase I volunteered to participate in the study enrolled in a series of teacher conference for developing the instructional unit and prepare them for using this unit..

**1.3 Research Question 3** In Phase II, three teachers who volunteered to implement the instructional unit on matter and its properties, implemented the instructional unit in the 2<sup>nd</sup> semester of the academic year 2004. The researcher observed the teaching of the unit.

### **2. Content**

The content of a conceptual change approach-based instructional unit about matter and its properties is based on the 3<sup>rd</sup> content standard in *The National Science Content Standards (IPST, 2002)*. The unit comprises concepts about properties of

matter, change in state of matter, solution processes, chemical change, separation of mixtures, and matter in everyday life.

### **Operational Definition of Terms**

#### **1. Student Conception**

This refers to understandings about matter and its properties which can be obtained from the student's explanations in the classroom or from discussion and student responses to a concept survey. Students' explanations which are consistent with current scientific community's views will be described as scientific conceptions. Student explanations that are inconsistent with current scientific concepts are referred to as alternative conceptions.

#### **2. Teacher Perception**

This refers to teacher thinking about understandings of matter and its properties, teaching strategies and students' learning about matter and its properties. For the purpose of this study, teacher perception obtained from individual interviews.

#### **3. Conceptual Change**

This is a process in which students accept the value of scientific conceptions rather than their existing conceptions and apply the new concepts to appropriate contexts.

#### **4. Conceptual Change Approach**

Conceptual change based on constructivism in the view of encouraging the students to accept and use scientific ideas. In this approach, students need opportunities to express their existing conceptions and to be encouraged to develop their understanding of scientific conceptions. Students need opportunity to express

and consider their prior knowledge. And then, students need to be confronted with the phenomena which challenge their prior conceptions and introduced to activities which encourage them to use scientific conceptions to explain phenomena. Finally, students need to compare their prior conceptions with scientific conceptions as a way of explaining the same activities and to then apply scientific conceptions to a new situation.

## **5. Matter and Its Properties**

This encompasses the characteristics of matter in the states of solid, liquid and gas, the change in state of matter, solution processes, separation of mixture and chemical reaction. This content is based on *the National Science Content Standards, Thailand (IPST, 2002)*.

### **The Structure of the Thesis**

This chapter explains the significance, purposes and research questions of this study which was to develop teaching and learning about matter and its properties in Thailand through the development of a conceptual change-based instructional unit based on the National Science Content Standard and a survey of the existing situation. The details of this work will be presented in the following chapters.

Chapter two sets out a literature review of theories of learning; theories of conceptual change; student conceptions of matter and its properties; approaches to teaching for conceptual change; and teacher perceptions. This review argues for the advantages of a conceptual change approach in teaching about the matter and its properties, and also the important role of the teacher in promoting student learning.

Chapter three presents the research methodology and methods used in this study. The study used an interpretivist perspective approach. The methods used for generating data from multiple perspectives included interviews, surveys, classroom observation and student work samples. Issues to do with the trustworthiness of data generation and analysis and the ethical conduct of the study are addressed. Chapter

four includes the results from surveys of the existing situation of teaching and learning about matter and its properties in Thailand. This data constitutes Phase I of this study and addresses research question 1.

The findings from Phase II in which the teaching unit was developed and implemented are explained in Chapters five and six. These chapters answer research questions 2 and 3 respectively. As suggested by Duit et al. (1997), “the educational reconstruction model” is an effective model for developing an instructional unit. This model is included in Chapter five for development of a conceptual change-based instructional unit about matter and its properties. Chapter six details and discusses case studies from three different schools. The findings are presented in terms of teacher changes, student changes, and teaching and learning in each case study. The final topic in Chapter six is a cross case analysis among these three case studies.

Chapter seven summarizes and discusses the findings of the study and sets out its recommendations and implications for further research.