The development of teacher knowledge in preservice science teachers in Thailand

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The Development of Teacher Knowledge in Preservice Science Teachers in Thailand

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Thesis Certification

CERTIFICATION

I, Kanyarat Sonsupap, declare that this thesis, submitted in partial fulfillment of the requirements for the award of Doctor of Philosophy degree, in the Faculty of Education, University of Wollongong, Australia, is wholly my own work unless otherwise referenced or acknowledge. The document has not been submitted for a qualification at any other academic institution.

Kanyarat Sonsupap
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ABSTRACT

The education of preservice teachers is critical to the quality of teaching in schools (Parkinson, 2009). The 1999 National Education Act from Thailand recommends that teachers become facilitators of learning and use different 'sources of knowledge' to improve the quality of education (Section 24, p.11). Although there have been many research studies on teacher knowledge, most of them have been conducted in Western settings or conducted with Western teachers.

The purpose of the research is to study the development of teacher knowledge acquired by preservice science teachers during the fourth year of a teacher education degree and to ascertain the influences on this development. The specific research question is:

> What forms of teacher knowledge do student teachers develop during the fourth year of their university course and what influences this development?

A multiple case study design was employed to address this question. In order to gain the required in-depth data, a range of qualitative methods was used. These included semi-structured interviews, concept maps, lesson observations and documents. Data were collected from a group of four Thai university fourth-year science student teachers over a period of 12 months, Somchai, Natee, Manee, and Suda. The data were analyzed by using Shulman's (1987) seven forms of teacher knowledge as an analytical framework.

The results of the study found that the preservice teachers developed different categories of teacher knowledge and to different extents. For content knowledge, all four preservice teachers initially shared similar views developed from their university subjects and teaching experiences. They believed that the university science subjects provided them with the knowledge essential for teaching. However, each case had a different degree of development.

For the category of general pedagogical knowledge, the practicum was the major influence in the preservice teachers' change. Although all four preservice teachers showed some change in their beliefs about general pedagogical content knowledge,

they used only a lecture style approach in their practice teaching. Curriculum knowledge was developed in the preservice teachers through their teaching experiences and mentors' advice.

Somchai and Suda changed their views of learners and their characteristics from thinking like a student gained from their own school experiences to thinking like a teacher. Natee maintained his belief about the students. He felt confidence that he could understand children's natures. Manee showed her concern about her students during her practicum. For knowledge of learners and their characteristics, the student teachers' prior experiences as a student and their teaching experiences helped shape their views.

Data about the category of knowledge of educational contexts varied between the four student teachers. None of the preservice teacher showed development of pedagogical content knowledge, most likely because this type of knowledge requires the development of teacher knowledge about teaching specific content from teaching experiences, which is usually absent in preservice teachers.

The main finding of the study is that the practicum played an important role in terms of developing teacher knowledge (Hoban, 2005). Furthermore, an individual's prior experience as a school student was a strong influence on the way each one thought about teaching and learning. An implication is that it is important for teacher education programs to let preservice teachers reflect upon and understand the importance of their prior experiences as students in school. It is recommended that the period of practicum should be longer under close monitoring by experienced mentors and university supervisors, and the education program should enable them to explore their "apprenticeship of observation" (Lortie, 1975).

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Chapter One

Introduction

Background of the Study

In recent decades there has been growing concern internationally with the contribution of education, particularly mathematics and science education, to national economic competitiveness in Thailand. As a consequence, the 1997 Constitution and the 1999 Education Act of Thailand provide a policy for using educational reforms with the aim of developing Thailand into a knowledge-based society, which is a pre-requisite for becoming a knowledge-based economy. The intention of these reforms was to provide the Thai people with equal access to life-long education and training, enabling them to acquire knowledge and capital to generate income and to eventually pull the country out of its existing economic and social crisis (Office of the National Education Commission, 2006). As part of developing a more productive workforce and competitive economy, Thailand has identified the need to improve the quality of mathematics and science education. However, according to the Asian Development Bank's (ADB) Key Indicators (KI) (2003), a large proportion of Thai students were functioning at or below the basic level of mathematics and science ability. In particular, they lack scientific thinking process skills and fail to develop analytical and critical thinking ability (ADB, 2003). This situation indicates problems with mathematics and science education that demands urgent attention.

One way to improve science achievement for school children is through better science education for trainee teachers. Teachers play a significant role in the provision of quality education as outlined in Thailand's 1999 National Education Act. This act states that:

> In organizing the learning process, educational institutions and agencies concerned shall: (5) enable instructors to create the ambience, environment, instructional media, and facilities for learners to learn and be all-around persons, able to benefit from research as part of the learning process. In so

> doing, both learners and teachers may learn together from different types of teaching-learning media and other sources of knowledge. (Section 24, p.11)

The Act, therefore, intends that teachers become facilitators of learning and use different sources of knowledge. According to professional Education standards, those who enter the teaching profession should meet the specified standards of professional knowledge and experience. This knowledge includes: language and technology for teachers, curriculum development, learning management, psychology for teachers, educational measurement and evaluation, classroom management, educational research, educational innovation and information technology, and self-actualization (Professional Standards Bureau Secretariat Office of the Teachers' Council of Thailand, 2005).

In order to accomplish the goal of better science education in schools and universities, the development of high quality teachers of science and technology begins in their teacher education program. Teachers need to be able to create a learning environment that enables students to learn and acquire knowledge for themselves. For this to occur, it is essential that teachers be true professionals and develop a range of forms of teacher knowledge.

Rajabhat University

There are two types of institutions that prepare science teachers in Thailand: the university Faculties of Education and the Rajabhat University. The Rajabhat University is a group of public universities comprised of 41 universities around Thailand that were formerly known as Teachers Colleges (Posrie, 2000). In 1992, His Majesty the King conferred the title "Rajabhat Institute" to all Teachers Colleges and the Rajabhat Institute Act was declared in the same year. Therefore, the name "Teachers College" was changed to "Rajabhat Institute" and all institutes were under the Office of the Rajabhat Council, Ministry of Education. According to this act, Rajabhat Institutes could offer wider ranges of courses such as Education, Liberal Arts, and Sciences. However, this act still stated that Rajabhat Institutes were responsible for teacher preparation. On 14 June 2004, all Rajabhat Institutes were upgraded by His Majesty the King. According to the Rajabhat University Act B.E. 2547 (2004), all Rajabhat Institutes were promoted to the status of Rajabhat

Universities and subjected to the National Tertiary Education Commission, the Ministry of Education.

Science Education Program in Thailand

A four year science teacher curricula have been used in Thailand up until the 2004 academic year. However, Rochanasmita (2006) stated that there were many problems in four-year preparation programs, For example there were problems concerning teachers' limited understanding of science content, problems in writing lesson plans and teaching science by emphasizing science process skills. These problems, combined with poor performance in international assessments mentioned earlier, resulted in the beginning of education reform through the National Act of 1999. A new teacher education curriculum was developed by the Ministry of Education and has been in use since 2004 to train a new generation of teachers. This has included changing the four-year program to a five-year program. This five-year B.Ed was proposed by the Rajabhat Institute (Pillay, 2002). The five-year science education curriculum includes four years for science, teaching methods, and general and free selection courses, and one additional year for teaching practice. This would increase the total credit to not less than 163 credit hours. However, this five-year teacher education program is a very new program, and only one cohort graduated from this program in 2009.

There are many questions regarding the effectiveness of the new program. Although the new curriculum is believed to help improve teacher quality, some senior representatives of the Ministry of Education and the ONEC criticized this new program in that it might not be the right answer for the desired education reform (Pillay, 2002). They suggested that the new preservice teacher education curriculum did not address concerns about the new teaching and learning issues in a knowledge-based society, such as a comprehensive understanding of knowledge for the information age, attributes of knowledge-based workers, and new learning models and technology-based learning. Moreover, experts pointed out that this new program did not focus on developing the teachers' abilities to choose teaching strategies to maximize student learning outcomes. Therefore, there needs to be more research to ascertain what types of teacher knowledge are being developed by the preservice teachers in science education.

The Study

Purpose of the Study and Research Question

The purpose of the research was to study the development of teacher knowledge by science student teachers during the fourth year of a five-year teacher education degree. The following research question was designed as a guide for this investigation:

> What forms of teacher knowledge do student teachers develop during the fourth year of their university course and what influences this development?

Research Setting

The study was set in the context of a five-year teacher education program. The participants of the study were a group of four undergraduate science education student teachers who were studying in the fourth year of their degree. Theses students were the first cohort studying the new five-year program and the fourth year is when practicum occurs for the first time. The participants did their school observations and practicum before entering an internship in their fifth year. None of these students had teaching experience before entering the program.

Four case studies were designed to focus on the development of teacher knowledge and its influences on each student teacher. The study was carried out in one academic year over two semesters in a university and at practicum sites. The data were gathered using various methods that included: (a) semi-structured interview, (b) concept maps, (c) lesson observations, (d) the researcher's own field notes, and (e) documentation.

Method of Analysis

In order to analyse the teacher knowledge that student teachers developed, the researcher used Shulman's (1987) seven categories of teacher knowledge as an analytical framework. The researcher employed these seven types of teacher knowledge for organizing data collected during the study to analyze whether the student teachers developed any form of teacher knowledge, and to investigate what influenced the development of each type of teacher knowledge.

Significance of the Study

The 1999 National Education Act requires that teachers need to develop "different sources of knowledge". However, according to the new teacher education degree, there is no evidence so far to indicate whether knowledge is developing and what type of knowledge. Since the participants in this study were the first cohort of the five-year program, research should be conducted in order to understand the development of their teacher knowledge and the factors that influence such change.

This study aims to gain insight into what forms of teacher knowledge student teachers possess and how they develop this knowledge in the fourth year of their teacher education program. The results of the study will be applicable to educators who are interested in how preservice teachers develop different forms of knowledge. A better understanding of how these forms of knowledge develop and are used can be applied to enhance preservice teacher education and inservice teacher professional development in Thailand and elsewhere. Moreover, a review of the literature has indicated that, to the best of our knowledge, Shulman's categories of teacher knowledge have rarely been used as an analytical framework in previous studies of preservice science teachers.

Definition of Terms

Teacher education program

Teacher education program refers to the policies and procedures designed to equip teachers with the knowledge, attitudes, behaviours and skills they require to perform their tasks effectively in the school and classroom.

The preservice teachers / student teachers

In the present study, preservice teachers or student teachers are those who enroll in the initial science teacher education program at the Rajabhat University in Thailand.

Practicum / student teaching

The practicum refers to practice teaching in an assigned classroom supervised by a mentor and supervisor. It is provided to preservice teachers when they finish their method courses to practise the theory they have studied (Rochanasmita, 2006).

Teacher knowledge

Teacher knowledge is a special kind of knowledge unique to teacher and "begins with a teacher's understanding of what is to be learned and how it is taught" (Shulman, 1987, p. 7). There are four sources of teacher knowledge: (1) scholarship in content disciplines; (2) the materials and settings of the institutionalized educational process; (3) research on social and cultural phenomena that affect what a teacher can do; and (4) the wisdom of practice (Shulman, 1987).

Teacher-centred approach

A teacher-centred approach is defined as a way of teaching that predominantly involves the one-way transmission of information from a knowledge expert (teacher) to a relatively passive recipient (learner). Content knowledge, standards and teaching method are determined by the teacher. The interaction between teacher and students is minimal, and the students' role is responding to teacher directed questions and organisation. Lectures and textbooks are used as the main instructional tools and assessment mainly involves recall of content knowledge (Simmons et al., 1999; Hara, 1995; Brown, 2003). There is very little responsibility left to the student for making decisions about learning.

Student-centred approach

A student-centred approach places the students in the centre of their learning process whereby the teacher acts as a facilitator. The student has the main responsibility for making major decisions about the content and method of learning. It focuses on students' individual needs, interests, abilities, and learning styles. The teaching objectives are the development of learners' own capacity and intelligence. Students gain knowledge through their own actions including hands-on activities, group work, project work, and laboratory investigations as facilitated by the teacher. (Simmons et al., 1999; Hara, 1995; Brown, 2003).

Organization of Chapters

Chapter One: Introduction

Chapter One presents an overview of the context of the study, including background, research question, significance of the study, methodology and definition of terms.

Chapter Two: Literature Review

Chapter Two contains a literature review and theoretical framework. This chapter focuses on concepts of teacher knowledge and the categories of teacher knowledge.

Chapter Three: Methodology

Chapter Three presents the research method used in this study, including descriptions of the participants. It outlines the procedure for collecting and analyzing data regarding teacher knowledge using Shulman's (1987) forms of teacher knowledge. The ethical issues are also addressed in this chapter.

Chapter Four: The Case of Somchai

This chapter begins with a context of the new teacher education program in Thailand. These four chapters present the data as case studies, each chapter representing one preservice teacher participating in the study. The data given in these chapters were collected from semi-structured interviews, classroom observations and concept maps.

Chapter Five: The Case of Natee;
Chapter Six: The Case of Manee
Chapter Seven: The Case of Suda

Chapter Eight: Discussion and Conclusions

Chapter Eight provides an overview of the research findings across the four case studies. This is followed by a discussion to address the purpose of the study leading to conclusions that are related to the research literature. The thesis concludes with a discussion of implications for practice from the study and suggestions for further research.

Chapter Two

Review of Literature

Overview

This chapter provides a review of literature related to the research problem of the thesis and a discussion of the theoretical framework of this study. The study focused on what forms of teacher knowledge are possessed and developed by a group of four science student teachers during the fourth year of their university course and what influenced this development. The first section discusses the definitions of teacher knowledge from different perspectives. It then identifies Shulman's (1987) seven forms of teacher knowledge which formed the analytical framework for this study. This section also discusses different categories of teacher knowledge used by other researchers and how knowledge is developed by students in preservice and inservice programs. The next section presents the literature on teacher knowledge along with various research studies.

What is Teacher Knowledge?

The nature of teacher knowledge is unique. It is a special kind of knowledge teachers own that is characteristically different from scientific, technological, or other kinds of knowledge (Bishop & Denley, 2007). From Clandinin and Connelly's (1995) perspective, teacher knowledge is a "body of convictions and meanings, conscious or unconscious, that have arisen from experience (intimate, social, and traditional) and that are expressed in a person's practice" (p. 7) and "that has arisen from circumstances, practices, and undergoings that themselves had affective content for the person in question" (p.7). This view is similar to that of Tsui (2003), who suggested that teacher knowledge is usually embedded in teaching practice, oriented to a particular situation in which it arises and is often not clearly articulated.

Elbaz's (1983) work is one of the earliest systematic studies of teacher knowledge (Tsui, 2003). Studies on teacher knowledge prior to Elbaz viewed knowledge as cognitive knowledge, but Elbaz's study showed that the type of knowledge called 'practical knowledge' can be understood by examining teachers' everyday teaching routines and what they think about their practices, and by listening to teachers speak

about their teaching (Beattie, 1995; Tsui 2003). Elbaz suggested that practical knowledge is knowledge that emerges from teaching experience and the teacher is the one who holds and uses this knowledge to guide their practice. Elbaz summarized the concept of practical knowledge as follows:

> In carrying out this work, the teacher exhibits wide-ranging knowledge which grows as experience increases. This knowledge encompasses firsthand experience of students' learning styles, interests, needs, strengths and difficulties, and a repertoire of instructional techniques and classroom management skills. The teacher knows the social structure of the school and what it requires, of a teacher and student, for survival and for success; she knows the community of which the school is a part, and has a sense of what it will and will not accept. This experiential knowledge is informed by the teacher's theoretical knowledge of subject matter, and of areas such as child development, learning and social theory. All of these kinds of knowledge, as integrated by the individual teacher in terms of personal values and beliefs and as oriented to her practical situation, will be referred to here as 'practical knowledge' (p. 5).

Connelly and Clandinin (1995) referred to teacher knowledge as 'personal practical knowledge'. They believed that teacher knowledge is developed from experience and embedded in teachers' teaching practices, and therefore that teacher knowledge can be understood through teachers' narratives. Connelly and Clandinin (1995) argued,

> Our best understanding of teacher knowledge is a narrative one. In this view of teachers' knowledge, teachers know their lives in terms of stories. They live stories, tell stories of those lives, retell stories with changed possibilities, and relive the changed stories. In this narrative view of teachers' knowledge, we mean more than teachers telling stories of specific children and events. We mean that their way of being in the classroom is storied: as teachers they are characters in their own stories of teaching, which they author (p.12).

Tsui (2003) summarized the characteristics of teacher knowledge as follows:

> First, teacher knowledge as manifested in teachers' classroom practices is often an integrated whole that cannot be separated into distinct knowledge domains. Second, teachers' personal conceptions of teaching and learning play

> a very important part in their management of teaching and learning. These personal conceptions are influenced by their personal life experiences, their learning experiences, their teaching experiences, their academic background, as well as the opportunities for professional development, including professional courses. Third, teachers' pedagogical content knowledge, which is embodied in the act of teaching, can be perceived as mainly two intertwined dimensions, the management of learning and the enactment of the curriculum in the classroom. Fourth, there is a dialectical relation between teachers' knowledge and their world of practice. As teachers respond to their contexts of work and reflect on their practices, they come to a new understanding of teaching and learning. The knowledge that they develop in this process constitutes part of the contexts in which they operate and part of their world of practice (pp. 66-67).

The person who wrote the seminal article to identify different forms of teacher knowledge was Lee Shulman.

Shulman's Forms of Teacher Knowledge

Shulman's theory of teacher knowledge has had a major impact on the research of teacher knowledge. Shulman (1986a) highlighted the neglect of subject matter in effective teaching research. He pointed out that:

> In their necessary simplification of the complexities of classroom teaching, investigators ignored one central aspect of classroom life: the content of instruction, the subject matter. This omission characterized most other research paradigms in the study of teaching as well. Occasionally subject matter entered into the research as a context variable, a content characteristic for subdividing data sets by content categories. But no-one focused on the subject matter itself. No one asked how subject matter was transformed from the knowledge of the teacher into the content of instruction. Nor did they ask how particular formulations of that content related to what students came to know or misconstrue. (p.11)

Shulman and his colleagues referred to the absence of subject matter in the various research paradigms as the 'missing paradigm'. To address questions relating to the 'missing paradigm' of teacher knowledge, Shulman and his colleagues at Stanford University launched a research program called 'Knowledge Growth in Teaching' (Grossman, 1990) to answer the following questions: What are the sources of teacher knowledge? What does the teacher know and when did he/she come to know it? How is new knowledge acquired, old knowledge retrieved, and both combined to form a new knowledge base?

Teacher knowledge is characterized by concreteness and richness in contextual and personal experience (Hiebert, Gillimore, & Stigler, 2002). Shulman (1987) highlighted the importance of teacher knowledge in the fact that "teaching necessarily begins with a teacher's understanding of what is to be learned and how it is to be taught" (p.7). He identified four major sources for teacher knowledge: (1) scholarship in content disciplines; (2) the materials and settings of the institutionalised educational process; (3) research on social and cultural phenomena that affect what a teacher can do; and (4) the wisdom of practice. According to Barnett and Hodson (2001), each teacher relies on a store of collective teacher knowledge. Teachers can develop this knowledge by talking to each other and reflecting on classroom experiences. Wellington (2000) suggested that "teachers have a set of knowledge which they bring to the classroom and a set of knowledge which is developed and learned from their classroom experience" (p. 27).

The theoretical framework that influences the conceptualisation of this study is Shulman's (1986[b], 1987) theory of forms of teacher knowledge. He listed categories of knowledge that contributed to successful teaching. Burgess (2006) stated that Shulman's forms of teacher knowledge "relates to the structures of how the teacher knowledge is organised, linked, and represented in the teacher's mind" (p. 2). Initially, Shulman (1986b) suggested three categories knowledge in teaching: (1) subject matter knowledge; (2) pedagogical content knowledge; and (3) curricular knowledge. Then in a following paper, Shulman (1987) reclassified teacher knowledge into seven types:

- content knowledge, which includes three subsets of content knowledge: substantive knowledge; syntactic structures; and beliefs about content matter;

- general pedagogical knowledge; broad principles and strategies of classroom management; and organization that appear to transcend subject matter;
- curriculum knowledge: knowledge of materials for particular instruction;
- pedagogical content knowledge (PCK): knowledge of how to teach specific content effectively;
- knowledge of learners and their characteristics;
- knowledge of educational contexts: knowledge of the working of the group or classroom; the character of communities and cultures and government agendas; and
- knowledge of educational ends, purposes, and values, and their philosophical and historical grounds.

Based on Shulman's categories of teacher knowledge, other researchers have refined and developed their own models of the teacher knowledge base. For example, Turner-Bisset (1999) developed a model of twelve types of knowledge bases for teaching from Shulman's work. Sanders, Borko, and Lockard (1993) selected three categories from Shulman's (1986a, 1986b, 1987) seven forms of teacher knowledge as their framework which were content knowledge, pedagogical knowledge, and pedagogical content knowledge. Exley (2005) grouped Shulman's categories of knowledge into three professional knowledge base themes: (1) content knowledge; (2) teaching process knowledge, which includes general pedagogical knowledge, curriculum knowledge, pedagogical content knowledge, and knowledge of educational ends, purposes and value; and (3) teachers' knowledge of the students, which contains knowledge of learners and their characteristics and knowledge of educational context. Wellington (2000) argued that teacher knowledge comprised two sets of knowledge, namely subject knowledge (SK) and pedagogical knowledge (PK). These two types of knowledge increase as teachers gain more teaching experience. Subject knowledge is developed through classroom experience, and pedagogical knowledge develops through observing other teachers' teachings, modelling, mentoring, studying, and reflecting on one's own practice. Fennema and Franke (1992) proposed a model for research on teacher knowledge in mathematics teaching. This model contains four components: (1) content of mathematics, which includes knowledge of concepts, procedure and problem-solving processes; (2) pedagogical knowledge, which includes

knowledge of teaching procedures; (3) knowledge of learners' cognitions, which includes knowledge of how students think and learn; and (4) context-specific knowledge.

Studies Focusing on Teacher Knowledge

There have been many studies using different categories of teacher knowledge (Elbaz, 1983; Leinhardt & Greeno, 1986; Grossman, 1990; Reynolds, 1995; Adams & Krockover, 1997; Gustafson, Guilbert, & MacDonald, 2002; Santucci & DeFranco, 2004; Justi & Van Driel, 2005; Banks, Leach, & Moon, 1999; Bishop & Denley, 2007; Collinson, 1996; and Gess-Newsome, 1999). For example, Elbaz (1983) chose five categories of teacher knowledge based on her understanding of teachers' practical knowledge. This includes knowledge of self, the milieu of teaching, subject matter, curriculum development, and instruction. Grossman (1990) summarized four general forms of teacher knowledge: subject matter knowledge, general pedagogical knowledge, pedagogical content knowledge, and knowledge of context. In a subsequent study, Adams and Krockover (1997) combined Elbaz's (1983) and Grossman's (1990) works to construct a model for investigating teacher knowledge. Their categories were:

- pedagogical content knowledge (includes knowledge of curricula, students' understanding of subject matter, instructional strategies);
- subject matter knowledge (consists of syntactic structure, content, and substantive structure);
- knowledge of the milieu (i.e. class room, school, community, district);
- general pedagogical knowledge (learners and learning, classroom management, curriculum and instruction); and
- knowledge of self (contains beliefs and values).

Bishop and Denley (2007) explored teacher knowledge in highly-accomplished science teachers by using Shulman's categories of teacher knowledge. However, they saw PCK as a 'meta knowledge' – a knowledge that emerges from a blending of an individual teacher's knowledge – rather than one category of teacher knowledge. Banks, Leach and Moon (1999) stated that teachers' professional knowledge is the active interaction of four elements: subject knowledge (which comprises subject

content knowledge, school knowledge i.e. the way subject knowledge is transformed for schools, pedagogic knowledge, and the personal construct of the teacher which is a combination of past knowledge, experiences as a learner, a personal view of what constitute 'good' teaching, and belief in the purposes of the subject. Merseth (1991 cited in Cunningham, 2007) outlined four general types of teacher knowledge and expertise: (1) knowledge and the application of technical skills; (2) knowledge and the application of theories, principles and concepts; (3) the ability to analyse a situation critically and generate multiple interpretations of it; and (4) the ability to formulate deliberate action plans that result from critical analysis. The first two types of knowledge are knowledge that we expect from beginning teachers, and these types of knowledge are easy to assess, but the last two types of knowledge are complex and difficult to gain. Collinson (1996) developed three categories of teacher knowledge called a 'triad of knowledge': (1) professional knowledge, which includes subject knowledge, curricular knowledge, and pedagogical knowledge; (2) interpersonal knowledge, which includes human relationships with students, educational community, and local community; and (3) intrapersonal knowledge, which includes ethics, dispositions, and reflections. Collinson claimed that this triad of knowledge is "necessary for becoming an exemplary teacher" (p.7). Gess-Newsome (1999) proposed five categories of teachers' knowledge of and beliefs about subject matter: conceptual knowledge; subject matter structure; nature of the discipline; content-specific teaching orientations; and contextual influences. Gess-Newsome also compared two models of teacher knowledge: integrative and transformative models. In the integrative model, subject matter, pedagogical, and context knowledge are developed independently and integrate in teaching. On the other hand the transformative model is comprised of subject matter and pedagogical knowledge, which are transformed into pedagogical content knowledge.

Among his seven forms of teacher knowledge, Shulman (1987) claimed that pedagogical content knowledge (PCK) was, "of special interest because it identifies the distinctive bodies of knowledge for teaching" (p. 8). He believed that neither strong content nor strong pedagogical knowledge alone is adequate to increase student achievement; rather, it is the teacher's ability to transform his or her knowledge of the subject matter and pedagogical knowledge that is crucial to student achievement. For Shulman, the key to understanding the knowledge base of teaching was a particular

type of knowledge that was a blend of content and pedagogy that he called pedagogical content knowledge which "lies at the intersection of content and pedagogy, in the capacity of a teacher to transform the content knowledge he or she possesses into forms that are pedagogically powerful and yet adaptive to the variations in ability and background presented by the students" (Shulman, 1987, p. 15). Furthermore, PCK is the kind of knowledge that can be used to distinguish the understanding of the content specialist from that of the pedagogue. The key concepts in PCK are knowledge of representations of subject matter and understanding of specific learning difficulties and student conceptions. He defined pedagogical content knowledge as, "that special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of professional understanding" (p. 8). PCK is a very complex concept because it is independently developed from each person's experience and blends teaching approach with content knowledge. An, Kulm and Wu (2004) point out that different educational beliefs give rise to different ways of presenting PCK. Importantly, PCK is an essential key to outlining teachers' beliefs and determining how effective their teaching is.

Since Shulman (1987) introduced the idea of PCK, it has been further developed, especially in the field of science education (Grossman, 1990; Cochran, DeRuiter, & King, 1993; Fernandez-Balboa, & Stiehl, 1995; Van Driel, Verloop, & De Vos, 1998; Gess-Newsome, 1999; Magnusson, Krajcik, & Borko; 1999; Mishra & Koehler; 2006). Other scholars have extended this idea by including some categories of PCK. For example, Grossman (1990) described PCK as consisting of knowledge of strategies and representations for teaching particular topics and knowledge of students' understanding, conceptions, and misconceptions of these topics. Cochran, DeRuiter, and King (1993), renamed PCK as pedagogical content knowing (PCKg), meaning a teacher's combined understanding of four components: pedagogy, subject matter content, student characteristics, and the environmental context of learning. By building on Shulman's PCK, Mishra and Koehler (2006) proposed a conceptual framework for educational technology called Technological Pedagogical Content Knowledge (TPCK) containing content knowledge (CK), pedagogical knowledge (PK), PCK, and technology knowledge (TK). Magnusson, Krajcik and Borko (1999) pointed out that PCK includes the teacher's orientation to teaching the subject, knowledge of subject curricula, knowledge of assessment, knowledge of student subject area understanding and knowledge of instructional strategies.

Pedagogical Reasoning

Shulman (1987) contented that the different forms of teacher knowledge support pedagogical reasoning. He constructed a model of pedagogical reasoning from his three years research on several teachers (Figure 2.1). It contains a cycle of activities necessary for good teaching. It can be described as the process of how teachers used their teacher knowledge to make decisions about what to teach and how to teach it (Bishop & Denley, 2007). Shulman (1987) explained:

> This image of teaching involves the exchange of ideas. The idea is grasped, probed, and comprehended by a teacher, who then must turn it about in his or her mind, seeing many sides of it. Then the idea is shaped or tailored until it can in turn be grasped by students. This grasping, however, is not a passive act. Just as the teacher's comprehension requires a vigorous interaction with the ideas, so students will be expected to encounter ideas actively as well (p.13).

The model of pedagogical reasoning includes six types: comprehension, transformation, instruction, evaluation, reflection, and new comprehension.

Comprehension

It is necessary for teachers to understand purposes, content, and ideas within and outside the discipline. Teachers need to understand what they teach in several ways, so they can find alternative explanations in case students find one teaching approach difficult. They should comprehend how an idea relates to each other within and outside the subject area. Understanding of purposes is also important. According to Shulman (1987), "we engage in teaching to achieve educational purposes, to accomplish ends having to do with student literacy, student freedom to use and enjoy, student responsibility to care and care for, to believe and respect, to inquire and discover, to develop understandings, skills, and values needed to function in a free and just society" (p. 14).

Transformation

Transformation is a process of transforming the comprehended content into teaching approach and this distinguishes a teacher from non-teaching peers. It is a highly complex process that combines of four sub-stages (Bishop & Denley, 2007). According to Shulman (1987), the four sub-stages are:

1. *preparation*: critical interpretation and analysis of texts, structuring and segmenting, development of a curricular repertoire, and clarification of purposes
2. *representation*: use of a representational repertoire which includes analogies, metaphors, examples, demonstrations, explanations, and so forth
3. *selection*: choice from among an instructional repertoire which includes modes of teaching, organizing, managing, and arranging
4. *adaptation and tailoring* to student characteristics: consideration of conceptions, preconceptions, misconceptions, and difficulties, langue, culture, and motivations, social class, gender, age, ability, aptitude, interests, self concepts, and attention (p. 15).

The combination of these sub-stages product a lesson plan or teaching strategies used in presenting the particular content.

Instruction

Instruction comprising the variety of teaching acts includes many of the most crucial aspects of pedagogy: classroom management, presentation of the lesson, assignment and checking, interaction with students using question and investigation, answers and reactions, discussion, and praise and criticism.

Evaluation

The evaluation process involves checking for understanding and misunderstanding during interactive teaching as well as testing and evaluating students' understanding at the end of lessons or units. This process includes the evaluation of teaching performance, the lesson, and teaching materials and adjusting for experiences.

Reflection

Reflection is the process that allows teachers learn from experiences. The process includes reviewing, reconstructing, reenacting and critically analyzing one's own teaching performance, and used as evidence for changing to become a better teacher.

The reflective practice can be done alone or in a group setting in order to understand one's own teaching behaviour and help the individual and colleagues improve as teachers.

New comprehension

The teacher achieves new comprehension of the educational purposes, the subjects taught, the students, and the processes of pedagogy through acts of teaching that are "reasoned" and "reasonable". However, the new comprehension cannot spontaneously occur, even through evaluation and reflection, and needs specific strategies for documentation, analysis, and discussion.

Figure 2.1 represents a model of the interrelationships between different forms of pedagogical reasoning that is underpinned by teacher knowledge.

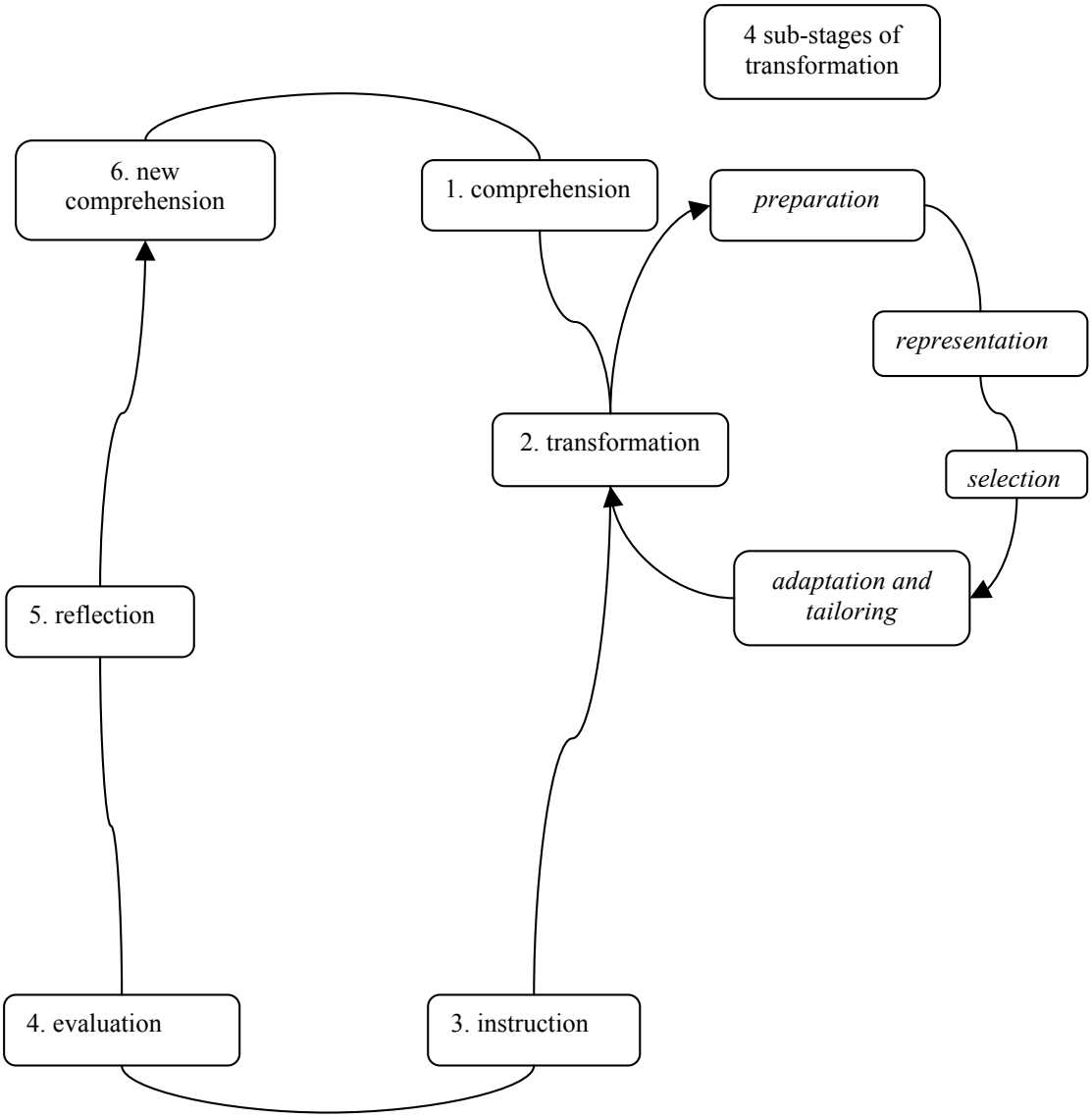

Figure 2.1 Shulman's model of pedagogical reasoning (adapted from Bishop and Denley (2007))

Studies on the Development of Teacher Knowledge

Shulman (1987) claimed that the forms of teacher knowledge are interrelated. He argued that to teach effectively, each category of teacher knowledge cannot be treated separately; all of them have to bind together. However, teachers and preservice teachers are at different stages of development in their careers and may develop

different forms of teacher knowledge at different times in their profession. There have been research studies of teacher knowledge for experienced teachers, beginning teachers and preservice teachers.

Studies of teacher knowledge in inservice teachers

Being an experienced teacher does not simply mean the one who has taught for a long time. Many teachers have taught for years and not become experienced. In order to be expert in teaching, it requires more than just years of teaching. Experienced teachers possess the ability to use different resources in order to reach their education goal and be reflective about their experiences. Furthermore, they are comfortable to develop new and useful tools as needed. For example, Hughes (2005) pointed out that experienced teachers could apply their newly-learned technology in their teaching, even though they had limited technology experience. There have been several studies on the teacher knowledge of experienced teachers. The following studies (Exley, 2005; Sander, Borko, & Lockard, 1993; Mulholland & Wallace, 2005) employed case studies as their research approach and one study (Van Driel, Verloop, & De Vos, 1998) adopted a grounded theory approach. The studies used interviews and observations to gather the data to ascertain teacher knowledge.

Hativa, Barak, and Simhi (2001) used a qualitative method to study teacher beliefs and knowledge in effective teaching and strategies of four exemplary teachers, two from the department of literature and two from the department of psychology, in a university in Israel. In order to triangulate the findings, the researchers used the following data sources: teachers' interviews, students' interviews, videotaped classes, and effective-teaching questionnaires to examine four dimensions of effective teaching, i.e. clarity, organization of the lesson, providing motivation for learning, and a positive classroom climate. The results suggested that it was not necessary to excel in all four dimensions of effective teaching to be an effective teacher but it was sufficient to stand out in some of these dimensions and do well in the others. However, all four instructors showed high performances in clarity and positive classroom environments.

In Exley's (2005) thesis, two case studies of Western teachers employed by Australian educational institutions to work in Central Java, Indonesia, were carried

out in order to gain a better understanding of the teacher knowledge of Western teachers working in offshore education. One of the major findings was that the participants used all types of teacher knowledge and these knowledge bases were interrelated. The author concluded that teachers must have all types of knowledge in their framework to teach successfully.

Sander, Borko, and Lockard (1993) examined the similarities and differences in the planning, teaching, and reflecting of three experienced high school science teachers while teaching a class using content that was both familiar and unfamiliar to the teacher. The study focused on the teachers' content knowledge, pedagogical knowledge, and PCK. The finding showed that in an unfamiliar area, the teachers seemed to act like novice teachers, however, they were able to use their pedagogical knowledge to inform their teaching. Their knowledge of pedagogy and PCK appeared to help them get through any content they were teaching.

Van Driel, Verloop, and De Vos (1998) studied 12 experienced chemistry teachers who joined the work shop about chemical equilibrium. Data were audio recorded of workshop session, student's assignments from the experimental courses, and additional sources related to the workshop. They found that teaching experiences and adequate subject-matter knowledge were main influences in the development of PCK.

Beginning teachers are often stuck between the two worlds of being a university student and being a teacher, and this may lead to some confusion in their identities. Adams and Krockover (1997) studied the following questions: (1) what are the major tenets that science education faculties expect beginning science teachers to have as a result of their programme experiences; (2) what is the knowledge base for teaching that those beginning science teachers have developed; and (3) what correlation exists between the secondary science programme and its implementation by beginning science teachers? The study consisted of interviewing and observing beginning science teachers and science education faculty members as well as analysing documentation. The result indicated that faculties expected beginning science teachers to construct general pedagogical knowledge, pedagogical content knowledge, and student-centred learning.

Beginning teachers encounter many problems during the initial years of teaching due to the limitations of their teacher knowledge. However, if they are provided with support, they can continue to develop their teacher knowledge successfully. There are two studies that support this proposition (Gustafson, Guilbert, & MacDonald, 2002; Justi & Van Driel, 2005). These studies used interviews, questionnaires, and reflective journals as data sources. Data were analyzed and compiled for predetermined categories of teacher knowledge. Gustafson, Guilbert, and MacDonald (2002) studied the development of teacher knowledge of 13 beginning Canadian elementary teachers who were mentored by experienced teachers for a short time. Results indicated that even this limited supporting experience could help the growth of a beginning teacher's general pedagogical knowledge; curriculum knowledge, PCK, knowledge of learners, and content knowledge respectively. Justi and van Driel (2005) studied five beginning science teachers in a post-graduate teacher education programme in The Netherlands who were participating in a special course on using models and modelling in teaching Chemistry. This study investigated the development of teacher knowledge on this topic, and showed that this programme promoted the building of teacher knowledge, especially pedagogical content knowledge.

Long-term studies of development of teacher knowledge

A long-term study lets the researcher investigate the same factors for a long period of time. Regarding the studies of teacher knowledge, the researchers are able to track the development of knowledge in same people for a long time. This will give rich insights to the participants in the study. Mulholland and Wallace (2005) traced the development of one elementary science teacher's knowledge over a 10-year period. They portrayed this teacher's knowledge at three critical points in her career: as a student teacher, beginning teacher, and established teacher. They analysed and represented the development of knowledge in the form of a knowledge tree. The tree illustrated that science knowledge was a major branch at the beginning but was later overshadowed by the general teaching and interactive knowledge branches. However, the researchers pointed out that those developments of all three types of knowledge together over time promoted the growth of science PCK. In summary, the previous articles on science teachers show that the teachers' knowledge combined with their teaching experience played an important role in their teaching capability.

Davis and Smithey (2009) tracked the development of seven beginning elementary science teachers over ten years to explore how they learn about teaching science. Three goals were using as a framework: learning about inquiry oriented science teaching, using science curriculum material effectively, and anticipating and work with students' ideas in instruction. They used interviews, the use of online curriculum by the participants, and participants' reflective journals as their data sources. The results indicated that the reflective journal help the participants accomplished the three importance goals important for their teaching.

Watzke (2007) studied the change in PCK of beginning foreign language teachers over the first two years of their teaching. The participants were nine secondary teachers of French, German, and Spanish. The researcher employed reflective journal entries, classroom observations, and focus group interviews as data gathering methods. Four categories i.e. prior knowledge that frame instructional decisions, attitudes toward teacher control in the classroom, instructional goals for daily lesson, a considerations for responding to student affect were used as a framework for identifying change in PCK. The finding indicated change in all four categories. The beginning teachers initially used their own experiences as a learner to make decisions in their practices then shifted to their experiences as a teacher as they gained classroom experiences. They became less control over students. Their instructional goals changed from knowledge about language to students' task performance and communication and they developed the view of the student as a language learner not just a learner.

Studies of teacher knowledge using preservice teachers

There have been several research studies on the teacher knowledge of preservice teachers (Wickramasinghe, 2004; Southerland & Guess-Newsome, 1999; Ho & Toh, 2000; Eick & Dias, 2005; Steven & Wenner, 1996; Fives &Buehl , 2008; Corrigan, 2007; Sperandeo-Mineo, Fazio & Tarantino, 2006; Ineke, Ton , Laurinda & Ingvar, 1999; Tsui & Treagust, 2002; De Jong, 2003). There are first two studies (Wickramasinghe, 2004; Southerland & Guess-Newsome, 1999) that focused on the growth of teacher knowledge in preservice teachers. The first study examined the changes in teacher knowledge during the practicum period. The second one focused on the views and beliefs of preservice teachers about teacher knowledge.

Wickramasinghe (2004) conducted a study to investigate the change of Sri Lankan preservice teachers' knowledge over the practice teaching period by using interviews and concept maps. The study showed that the preservice teachers developed their teacher knowledge during their practicum. They were able to transform theoretical knowledge into practical teaching by using multiple strategies. In addition, they had broader views of effective teaching after the practicum. These changes were due to their teaching experiences, their college workshops and their own reflections.

Southerland and Gess-Newsome (1999) explored 22 preservice teachers' views of knowledge and learners as they tried to understand science teaching in inclusive classrooms. The data sources came from participants' written assignments, reflective journals, class discussions, and interviews. The researchers identified three images of teaching and learning from preservice teachers' points of view: (1) knowledge is universally accepted and unchanging; (2) learners have fixed abilities; and (3) learners, despite their diversity, are to be helped to achieve a standard norm. this finding indicated their positivist views of knowledge, earning, and teaching science.

Preservice teachers' limited teacher knowledge give rise to many problems in their practice teaching. Ho and Toh (2000) explored how the teacher knowledge and beliefs of Singaporean preservice teachers impacted on their classroom practices. Two interviews were conducted with each of four preservice teachers in pre- and post-practicum stages. The research found that the preservice teachers had limited teacher knowledge, especially general pedagogical content knowledge. Thus, they tended to teach from texts, use lecture style teaching, not use wait-time when questioning, and could not choose suitable teaching strategies to meet students' needs in mixed ability classrooms. A similar finding was reported in Eick and Dias (2005). The researchers traced the development of elements of American method students' practical knowledge while co-teaching using structured inquiry during field placements. The participants were interviewed and observed. At the beginning, student teachers relied heavily on formal knowledge about teaching from university course work and their experiences as school students. Only later did they begin to integrate these experiences with knowledge they had learned during their practice teaching. Steven and Wenner (1996) investigated teacher knowledge and beliefs regarding science and

mathematics in American elementary preservice teachers. Sixty-seven undergraduate students enrolled in an upper level course focusing on methods for teaching elementary science and mathematics were asked to answer questions designed to survey students' content knowledge and belief in science and mathematics. The result showed that preservice elementary teachers had a relatively low level of science and mathematics content knowledge. However, these preservice teachers had a high level of confidence in teaching.

A large scale study was conducted by Fives and Buehl (2008) who investigated teacher knowledge in 53 preservice and 57 practising teachers in the United States. The participants were asked to answer an open-ended teaching belief questionnaire (OTBQ) and data were analysed using constant comparative method to develop a framework representative of the maximum number of themes that emerged. The conceptualisation of teacher knowledge that came out could be organized into five themes: (1) pedagogical knowledge, including knowledge about facilitating student meaning-making, assessing learning, motivating students and maximizing learning for diverse classrooms; (2) knowledge of children, including knowledge of learners, of learning in general, and of the specific students; (3) content knowledge, including knowledge about the specific content taught, PCK, and curriculum knowledge; (4) management and organizational knowledge; and (5) knowledge of self and others.

Corrigan (2007) used a framework drawn from Shulman's (1987) seven teacher knowledge domains as a diagnostic and development tool to assist the learning of 20 preservice chemistry teachers enrolled in the chemistry education course at Monash University, Australia. The student teachers were asked to do self-reporting by using learning logs, chemistry teaching portfolios, assignments, practical performances, and to self-evaluate to identify what teacher knowledge they developed after taking the course. The data were mapped against Shulman's (1987) forms of teacher knowledge. The result showed that, after this coursework, preservice teachers significantly developed some categories of teacher knowledge, especially pedagogical knowledge and content knowledge.

Many studies have pointed to the difficulties student teachers have in transferring the knowledge of science content acquired while studied in the initial teacher education

institutes to the school classroom. There are a number of studies that address the question of how to research the development of preservice science teachers' PCK. Often the studies focus on how preservice teachers understand and teach complex topics, such as thermal processes (Sperandeo-Mineo, Fazio & Tarantino, 2006; Ineke, Ton , Laurinda & Ingvar, 1999), genetics (Tsui & Treagust, 2002), and molecules and atoms (De Jong, 2003). These topics comprise abstract concepts that are considered difficult to understand.

Employing the case study as a research tool, Tsui and Treagust (2002) observed one preservice biology teacher in order to explore her development of teacher knowledge while teaching genetics with *BioLogica*, an interactive multimedia program. The results indicated that the participant did not have strong content knowledge, or a rich repertoire for teaching genetics. However, she tried to expand her content knowledge and used the computer software to improve her teaching, so that she could develop her PCK. In addition, the researchers pointed out that university programs do not adequately prepare preservice teachers to meet the diverse demands and challenges of teaching in classrooms.

Studies of teacher knowledge in preservice teachers in Thailand

Singmuang (2002) studied the influences of Thai preservice middle school mathematics teachers' subject matter knowledge and knowledge of students' conceptions of division of rational numbers when they did their practicum. Four preservice teachers with the following characteristics were selected: high knowledge of subject matter and low knowledge of students' conceptions, high knowledge of subject matter and low knowledge of students' conceptions, low knowledge of subject matter and high knowledge of students' conceptions, and low knowledge of subject matter and low knowledge of students' conceptions. Each participant was observed for three weeks during their practice teaching of division of decimals, representing fractions as decimals, and division of fractions. The researcher conducted formal interviews with each of the four preservice teachers before and after teaching each unit and informal interviews before and after each lesson. Teaching materials used in the class were collected. Interviews were also conducted with mentors and supervisors. The results showed that all preservice teachers planned lessons and taught by following an algorithmically-based national curriculum. The preservice teachers with

high subject matter knowledge used various examples and could create new examples when students asked questions. On the other hand the preservice teachers with low subject matter knowledge made hardly any new examples while on their practicum. The preservice teachers with high knowledge of students' conceptions used their knowledge of student's conceptions during their lessons more often than the preservice teachers with lower knowledge of student's conceptions. However, by the finish of the lessons, all preservice teachers had gained subject matter knowledge and knowledge of students' conceptions of division of rational numbers.

Finally, although there are many studies in teacher knowledge referring to Shulman's theory of teacher knowledge (for example, Grossman, 1990; Cochran, DeRuiter, & King, 1993; Fernandez-Balboa, & Stiehl, 1995; Van Driel, Verloop, & De Vos, 1998; Gess-Newsome, 1999; Magnusson, Krajcik, & Borko; 1999; Mishra & Koehler; 2006), to the best of our knowledge very few have used all of Shulman's forms of teacher knowledge as an analytical framework. Moreover, although the patterns of teacher knowledge have been researched for some time, almost all research studies have been conducted in Western settings or have been focused on Western teachers. There is no known literature on the development of teacher knowledge for preservice science teachers in Thailand especially those that incorporate all Shulman's categories as a theoretical framework. Thus, it is possible that the development of teacher knowledge in Thai preservice science teachers may differ from Western teachers due to the differences in beliefs and cultures. It is this possibility that the present study seeks to consider.

Summary of the Chapter

This chapter has examined the literature on teacher knowledge to give a theoretical understanding of the concept of teacher knowledge. This chapter also discussed Shulman (1987)'s seven forms of teacher knowledge which was used as an analytical framework in the present study. Moreover, Shulman's theory of teacher knowledge has a major influence on the research of teacher knowledge. There are many researchers who developed their own model of teacher knowledge based on Shulman's categories of teacher knowledge but few studies have so far employed Shulman's seven forms of teacher knowledge as an analytical framework. In addition, almost all research studies on teacher knowledge were conducted in western setting. This present study intends to contribute to the gap and give more complete picture to the research of teacher knowledge in a Thai context. The next chapter explains the methodology to address the research question.

Chapter Three

Methodology

Introduction

The study is located in the context of a five year teacher education degree and in particular the fourth year of a Thai teacher education program which qualifies students for teaching science in primary and secondary education. The student teachers who are the subjects of the study did not have teaching experience before entering this program. This chapter presents details about how this study was designed and implemented. The chapter illustrates the research, research setting, the participants and data-gathering methods used in this study. The data analysis procedures, verification, limitations, and ethical consideration are also discussed. The pilot study which trialed the methodology of the research is included.

The Use of Qualitative Research

The basic qualitative study in education typically draws from concepts, models, and theories in educational psychology, cognitive psychology, and sociology (Merriam, 1998). As defined by Mertens (2005), 'qualitative research is a situated activity that locates the observer in the world. It consists of interpretive, material practices that make the world visible. These practices transform the world. They turn the world into a series of representations, including field notes, interviews, conversations, photographs, recordings, and memos to the self' (p. 229). Qualitative research uses multiple methods, involving an interpretive, naturalistic approach to its subject matter (Denzin & Lincoln, 1994 cited in Thomas, 2003) to make sense of personal stories and the ways in which they interact (Glesne & Peshkin, 1992 cited in Thomas, 2003). Merriam (1998) identified several characteristics of qualitative research: it seeks to understand the meanings people have constructed, its primary instrument for data collection and analysis is the researcher, it usually involves fieldwork, it primarily employs an inductive research strategy, and finally, the product of this study is richly descriptive.

In relation to this study, a qualitative approach was used in order to monitor the development of teacher knowledge in preservice teachers. Teacher knowledge has a

complex character that needs descriptive and in-depth information to explain the phenomenon. The research was conducted by using a range of data gathering methods: interviews, observations, concept maps and documentation. Every preservice teacher was interviewed individually about his or her practical experiences and reflection concerning teaching and learning experience. Interviews were conducted in a semi-structured way. In the same period, the preservice teachers were requested to draw concept maps relating to science teaching. In addition, the lesson observations were carried out in each preservice teacher's practicum sites. Documents pertaining to the courses and the lessons were collected and analysed.

Research Design

This study employed a multiple case study research design to examine student teachers' development of teacher knowledge. As stated by Gall, Borg and Gall (1996), case study research refers to 'the in depth study of a phenomenon in its natural context and from the perspective of the participants involved in the phenomenon' (p. 545). A case study design therefore was chosen because teacher knowledge is very complex and needs in-depth information for its understanding. Further, a multiple-case design was used in order to strengthen the result by replicating the pattern-matching, thus increasing confidence in the robustness of the theory generated (Tellis, 1997). Multiple-case studies follow a replication rather than sampling logic (Tellis, 1997). Yin (1994 cited in Tellis, 1997) points out that generalization of results, from single or multiple-case studies is made to theory and not to populations. Therefore, each individual case study consists of a 'whole' study, in which facts are gathered from various sources and conclusions drawn on those facts (Tellis, 1997).

According to Yin (2003), the benefits of the case study evidence can be maximized and can help to deal with the problems of establishing their construct validity and reliability by using three principles

1. *Use multiple sources of evidence.* The use of multiple sources is the major strength of the case study approach. Multiple sources allow a process of data triangulation. With this process, the problem of construct validity might be erased because the multiple sources of evidence essentially provide multiple measures of the same phenomenon.

2. *Case a case study database*. The research should have a good system for organizing and documenting the data collected for case study.
3. *Maintain a chain of evidence*. This principle increases the reliability of the information in a case study. It lets an external observer (the reader of a research report) to follow the chain of evidence both from initial research question to conclusions or from conclusions back to initial research question. Therefore, this principle is based on a concept similar to that used in forensic investigation.

Setting

According to the definition of the case study, namely in studying the phenomenon in a natural setting, this study was conducted with a teacher education program in the Rajabhat University in the Northeast of Thailand and in science classrooms in primary and secondary schools serving as placement sites for the preservice teachers during their student teaching field experience.

Gaining Access to Participants

Prior to the study, permission from the dean of Education was obtained to conduct the research using student teachers from the faculty of Education (see Appendix 5E for Letter of Permission). The student teachers' supervisors were also provided a full description of the study and its purpose by the researcher and were asked for permission to meet the student teachers. In order to gain access to practicum site, approval from a school principal was obtained. Each participant's mentor was informed of the detail of the study and asked for permission to do classroom observations as well.

Selection of Participants

Creswell (1994) suggests that the idea of qualitative research is to purposefully select informants that will best answer the research question, hence it is not necessary to select a sample randomly. In this study, the participants were a group of four undergraduate science education students who were studying in the fourth year of their five-year science teacher education program. Science student teachers were chosen because science is the area that the researcher is familiar with and is the area

of the researcher's own teaching background. None of these student teachers had any prior teaching experience in school classrooms. Thus, the researcher expected that teacher knowledge would develop in some way during the program. Each participant was unique and could be expected to develop their teacher knowledge in a different way. However, Bassey (1990 cited in Burton & Barlett, 2005) suggests that although each case might be unique, there might be similarities and the findings from one study might be useful when seeking to understand others.

The reason for using these particular four student teachers was based on the suggestion of the university supervisor. The supervisor recommended that these four student teachers were high-achieving students who held scholarships and they were more likely to talk openly compared with their classmates. This is consistent with the notion in qualitative research to have participants who can articulate their experiences to better understand any changes in teacher knowledge cause by teacher education program (Yin, 2003).

The Researcher's Role

The role of the researcher in relation to a case study design is complex. Mertens (2005) suggests that the researcher is the instrument for collecting data in a qualitative research; he or she decides which questions to ask and in what order, what to observe and what to write down. It means that the researcher carries out data collection and becomes personally involved in the phenomenon being studied (Gall, Borg & Gall, 1996). Qualitative research relies on the reflection of researchers on their own values, assumptions, beliefs, and bias and this reflection is monitored through the progression of the study in order to determine their impact on the study's data and interpretations (Mertens, 2005). However, Locke *et al.* (1987 cited in Creswell, 1994) argue that the researcher's contribution to the research setting can be useful and positive rather than disadvantageous.

Data Gathering Methods

A case study must involve the collection of extensive data to produce an understanding of the entity being studied (Burns, 1994). Many authors who discuss case study research design address the importance of using several methods (Yin,

2003; Gall, Borg & Gall, 1996; Merriam, 1998; Burton & Barlett, 2005). Multiple sources allow for triangulation through converging lines of enquiry and improving the trustworthiness of the data and findings. This corroboration makes a case study report more convincing (Burns, 1994). As Patton (1990 cited in Merriam, 1998) argues:

> Multiple sources of information are sought and used because no single source of information can be trusted to provide a comprehensive perspective … By using a combination of observations, interviewing, and document analysis, the fieldworker is able to use different data sources to validate and cross-check findings. (p. 137)

As a result, data for this study came from a range of data-gathering methods in order to enhance trustworthiness.

Interviews

The interview in this study consisted of oral questions by the interviewer and oral responses by the research participants (Gall, Borg & Gall, 1996). Fraenkel and Wallen (2006) state that "the purpose of interviewing people is to find out what is on their mind - what they think and how they feel about something" (p. 455). There are advantages with interviews. First, they are adaptable, i.e. the interviewers can follow up a respondent's answers to obtain more information and clarify vague statements. Second, they can create trust and understanding with participants, thus, making it possible to obtain information that the person might not reveal by any other data collection method (Gall, Borg & Gall, 1996). As a result, an interview is an appropriate method for gathering data in this research, as it provides detailed in-depth information that is necessary to explore the factors that influence the development of teacher knowledge.

There are three possible approaches to conducting interviews: the informal conversational interview; the semi-structured interview guide approach; and the standardized open-ended interview (Coll & Chapman, 2000). This study used a semi-structured interview approach. This type of interview is more structured in nature than the informal conversational interview and involves outlining a set of issues that are to be explored before interviewing begins, in order to ensure all relevant topics are covered (Coll & Chapman, 2000). Yin (2003) recommends that case study interviews

should have an open-ended nature that allows the interviewer to ask key respondents about the facts of a matter as well as their opinions about events. The semi-structured interview is a combination of more-or-less structured questions (Merriam, 1998). Thus, specific information desired from all participants is collected by using the highly structured part of the interview, and the less structured part is applied to investigate the opinion of the respondent. This type of interview suits the present study because it gives the respondents the chance to express their own views and perceptions in their own words. In turn, this can explain how each student teacher builds up and uses their teacher knowledge, because each individual develops teacher knowledge independently and in a unique way. Moreover, the interview guide allows the data gathering to be more systematic and facilitates analysis. The questions were developed around the pre-exiting categories in the teacher-knowledge frameworks, concept maps, lesson observations, and documentation.

In this study, the participants were individually interviewed three times: August 2007, November 2007, and February 2008. Interview questions included questions about the concept maps. The interviews were audio recorded, transcribed and translated into English before being analyzed. The analysis of the transcripts focused on the identification of regularities or patterns in the reports made by participants, with the use of an *a priori* established system of categories. See Appendix 1A for interview questions.

Concept Maps

Concept maps were developed by Novak and his research groups at Purdue University and Cornell University in the 1970's to help facilitate evaluation of students' conceptual knowledge and its change (Novak, 1985). Concept maps are a way to organize and present knowledge graphically or pictorially (Novak & Gowin, 1993). Concept mapping involves identifying the main concept, finding related topics, and linking related ideas (Williams, 2004). According to Novak and Gowin (1993), a concept map represents meaningful relationships between concepts in the form of propositions. A concept can be defined as "a perceived regularity in events or subjects, or records of events of objects, designated by a label (Novak & Canas, 2006, p. 1)" and propositions are "statements about some object or event in the universe, either

naturally occurring or constructed … propositions contain two or more concepts connected using linking words or phases to form a meaningful statement" (Novak & Canas, 2006, p. 1). Wickramasinghe (2004) employed concept maps in the study of Sri Lankan preservice teachers' knowledge and recommended that concept maps could be used as a tool for analysis and reflection within and after the student teachers' practicum.

Concept maps are hierarchically displayed with the broadest and most general concepts at the top of the map and the more specific, less general concepts positioned below respectively (Novak & Canas, 2006). According to All and Havens (1997), this arrangement represents the structure of knowledge in a form that is psychologically compatible with the way humans construct meaning.

Concept maps are appropriate for the present study because they represent an individual's personal interpretation of ideas and its attached meaning (All & Havens, 1997). The diagram of the relationships each participant makes allows the researcher to see the connections clearer. Elbaz (1983) suggests that teacher knowledge would be organized in a hierarchical manner. In addition, Williams (2004) states "the choice of concept mapping as an assessment strategy in the case study was logical because the student was going to build on existing knowledge" (p. 35). Moreover, many researchers (Wallace & Mintzes, 1990; Markham, Mintaz & Jones, 1994; Wickramasinghe, 2004) have demonstrated that a concept map is a valid and powerful tool for exploring conceptual change in experimental and classroom settings.

In August 2007, before the beginning of the study, the participants were given instruction from the researcher on how to draw concept maps, even though the preservice teachers were familiar with construction of concept maps, to ensure they had the same understanding about them. See Appendix 2 concept maps instructions.

In this study, the participants were asked to draw three concept maps for the topic "Science Teaching" at three different times i.e. during preservice teachers' classroom observation, before practice teaching, and after practice teaching. Every time, they draw new concept maps without reference to the previous one. The participants

constructed their maps using Thai language, and then the researcher translated them into English. See Appendix 2C for an example of concept map.

Shortly after drawing each concept map, the participants were asked questions relating to concept maps. The participant was shown his or her previous concept map in order to compare and discuss any changes between the most recent concept map and the previous one. These interviews were recorded and transcribed. Interviews were conducted in Thai then translated into English before analyzing them. See Appendix 2B for concept map questions.

Lesson Observations

Observation is another primary source of data in case study research design. According to Merriam (1998), observation can be distinguished from interviews in two ways: first, observations take place in the natural field setting instead of a location designated for the purpose of interviewing; and second, observation data represent a firsthand encounter with the phenomenon of interest rather than a secondhand account of the world obtained in an interview. The participant has to deal with what is happening in reality and observation makes it possible to find evidence of what knowledge he/she has and uses in the immediate act of teaching.

In the present case study research the researcher acted as participant observer in a participant observation study. Fraenkel and Wallen (2006) state that "researchers actually participate in the situation or setting they are observing" (p. 450). Merriam (1998) points out that an observer cannot help but affect and be affected by the setting, and this interaction may lead to a distortion of the situation as it exists under non-research conditions.

In this study, three classroom observations were conducted with each student teacher. The researcher used field notes as a method of recording the data collected during lesson observations in schools whilst the preservice teachers were on practicum. Field notes normally consist of two parts: (1) the descriptive part, which includes a description of the setting, the people and their reactions, interpersonal relationships, and accounts of events; and (2) the reflection part, which includes the observer's

personal feelings or impressions about the events, comments on the research method, decisions and problems, records of ethical issues, and speculation about data analysis (Ary *et al*, 2006). Data in the field notes were analyzed to provide an understanding of the research setting and the relationship in the setting. The data from observation could be categorized into the research setting and the behaviour of people within that setting. See Appendix 3B for an example of field note.

Documentation

A variety of documents is likely to be used by a case study researcher. Such materials can provide an insight into life in educational institutions and can enhance or be enhanced by data gathered via various other research methods (Burton & Barlett, 2005). The advantages of documents are: (1) they enable a researcher to obtain the language and wording of informants; (2) they can be accessed at a time convenient to the researcher; (3) they represent data that are thoughtful in that informants have given attention to compiling them; and (4) they are written artifacts, which therefore saves a researcher the time and expense of transcribing (Creswell, 1994). In addition, Burton and Barlett (2005) give the benefits of documentation in relational to educational research as follows: (1) it helps provide official versions of how different education institutions, curricula and assessment operate at a particular time; (2) it demonstrates changes over time; (3) it often generates further questioning by the researcher; (4) it is a useful stimulant for further discussion by those involved; and (5) it provides a record of data that may have been forgotten or not known by research participants. Yin (2003) claims that for a case study, the most important use of documents is to support evidence from other sources. The same author also suggests that documents play an explicit role in any data collection in doing case study research. Therefore, it is necessary to make systematic searches for relevant documents in every data collection plan. One helpful way to deal with these case study documents is to have an annotated bibliography. An annotation would facilitate storage and retrieval so that later investigators can inspect or share documents.

In this study, documents were collected relating to the teaching (e.g. lesson plans, handouts, and course syllabuses) and used in generating questions asked during interviews with the participants. According to Burton and Barlett (2005),

documentation may offer a stimulus for interview or observation or it may give useful contextual or explanatory data for something a researcher has found through other data collection methods. Therefore, documents were analyzed to find evidence for corroborating and enhancing data from other sources. See Appendix 4 for lesson plans, handouts, and worksheets.

In summary, the research design for this study is represented in Figure 3.1 and the timeframe in Table 3.1.

Limitations

There were only 4 preservice teachers in the present study. The number of participants not meant be representative of the population in general. However, due to the nature of case study employed in this study which relies on descriptive information for each participant, it was reasonable to use small number of participant because it was possible to closely investigate each participant to gain in-depth information about the development of teacher knowledge.

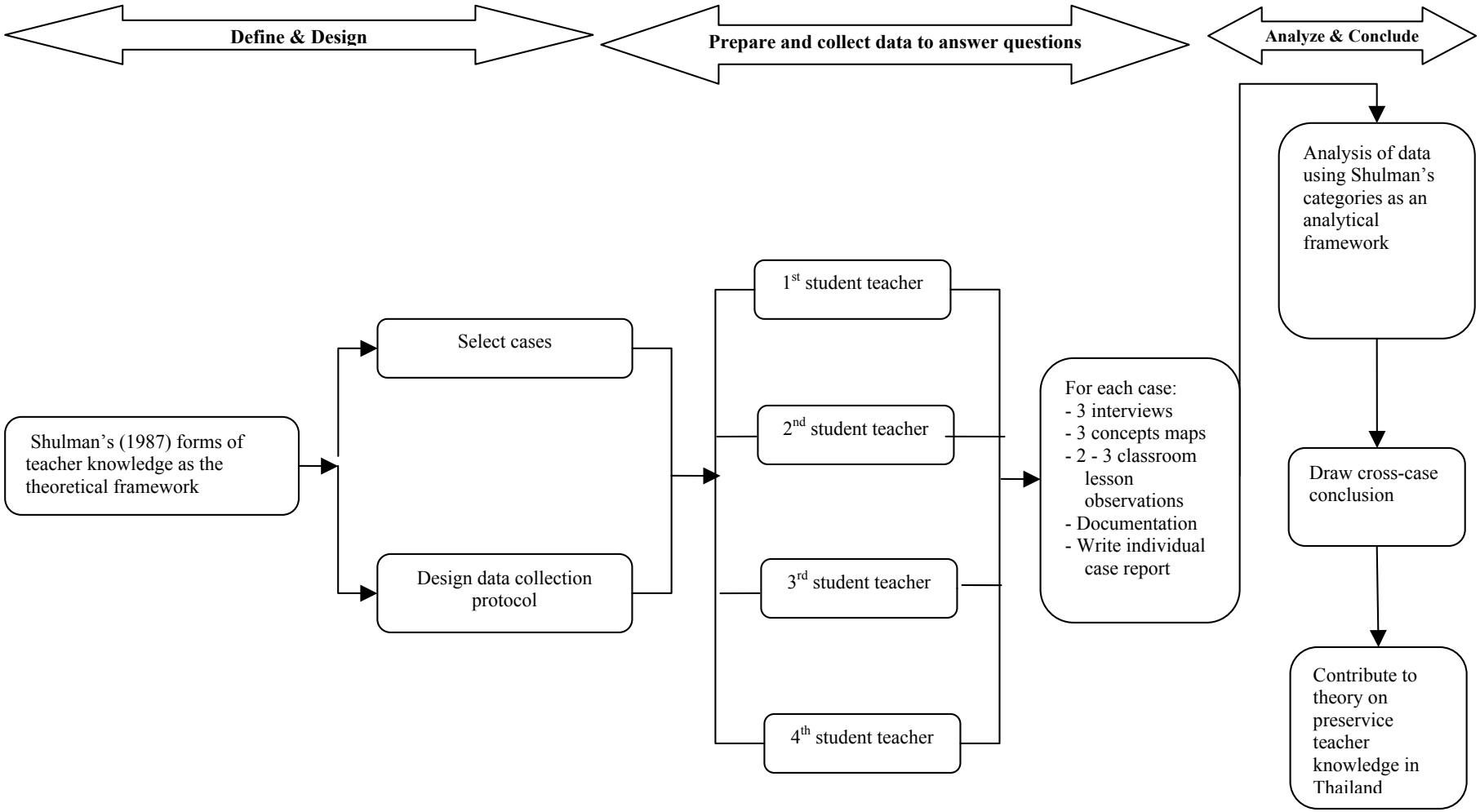

Figure 3.1 Summary of Research Design (Adapted from Yin (2003))

Table 3.1 Timeframe for data collection

1st Semester	**August**				**September**				**October**			
	Week 1	2	3	4	1	2	3	4	1	2	3	4
Concept Maps	- selection of participants - introduction to concept maps		1st Concept Map									
Interviews			1st Interview									
Documents		Collection of documents (program and subject information)							Analyze			

2nd Semester	**November**				**December**				**January**				**February**				**March**			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Concept Maps	2nd Concept Map														3rd Concept Map					
Interviews	2nd interview														3rd Interview					
Observations													1st, 2nd, & 3rd Lesson Observations on practicum							
Documents	Collection of documents related to practicum																			

Data Analysis

According to Merriam (1998), case study is an intensive, holistic description and analysis of a single, bounded unit. Tellis (1997) states that the analysis of case study evidence is the least developed and hence the most difficult aspect of doing a case study. Moreover, regardless of the large amount of information, case study data have usually been derived from a wide range of data sources such as interviews, field observations, and documents, which may present disparate, incompatible or contradictory information. Thus, a case study researcher has to pay attention to data management in order to make sense out of the data. From available types of case study analytical techniques, this study employed a cross-case analysis as the analytical practice. This technique was applied specifically to the analysis of multiple cases (Yin, 2003). The cross-case analysis consisted of two stages of analysis: the within-case analysis and the cross-case analysis (Merriam, 1998). For the within-case analysis, each case was first treated as a single bounded unit. The data of the single qualitative cases were analyzed by using content analysis and the construction of categories. When the data analysis of individual cases was completed, the next step began. Cross-case analysis was conducted to "build a general explanation that fit each of the individual cases, even though the cases will vary in their details" (Yin, 1994 cited in Merriam, 1998, p. 195). The researcher tries to see "processes and outcomes that occur across many cases, to understand how they are qualified by local conditions, and thus develop more sophisticated descriptions and more powerful explanations" (Miles & Huberman, 1994 cited in Merriam, 1998, p. 195). Nevertheless, no matter what analytic strategy or techniques have been chosen, Yin (2003) directs researchers to make every effort to produce an analysis of the highest quality. In order to achieve this, Yin presents four principles that the researcher should pay attention to: firstly, show that the analysis relies on all the relevant evidence; secondly, include all major rival interpretations in the analysis; thirdly, concentrate on the most significant aspect of the case study; and fourthly, use the researcher's prior, expert knowledge to further the analysis.

In this case study analysis, all interviews were audio-recorded in Thai and transcribed verbatim including the concept maps into English. After that, the interview data were confirmed or disconfirmed with the data from the other sources (i.e. data

triangulation). Finally, the results concerning individual preservice teachers were compared to identify common patterns in their development, and factors influencing these developments. Data collected from interviews, concept maps, lesson observations, and documentation were categorized into groups based on Shulman's (1987) seven categories of teaching knowledge as an analytical framework. Patterns of case reports were compared to draw cross-case comparisons.

The extent of change in teacher knowledge

In order to describe the extent of change in teacher knowledge, a classification system was used to categorize change as either major change, minor change, or no change. Major change was interpreted to mean a change in thinking leading to a new way of understanding the form of teacher knowledge. For example, some preservice teachers think like a student based on their own school experiences as a learner. A major change is when they begin to think like a teacher because they have to implement lessons and learn from experience as a teacher. Minor change was taken to be an extension of an existing way of thinking, not a new way of thinking. For example, some preservice teachers maintained their way of thinking about curriculum or perhaps extended it throughout their practicum. The third category was no change meaning it has been absent throughout or has been present but has not been expressed differently.

Verification

In ensuring the accuracy of the study, the following criteria were employed.

Credibility

Guba and Lincoln (1989 cited in Mertens, 2005) refer to credibility as the criterion in qualitative research that parallels internal validity in postpositivist research. It concerns the truthfulness of the inquiry's findings. It involves how well the researcher has established confidence in the findings based on the research design, participants, and context (Ary *et al*, 2006). Thus, the research has to represent the realities of the research participants as accurately as possible. Several research strategies can be used to enhance credibility. The present study used these strategies as describe below:

1. Triangulation of data. “Triangulation is the process of using multiple methods, data collection strategies, and data sources to obtain a more complete picture of what is being studies and to cross-check information” (Gay, Mills, & Airasian, 2006, p.405). For this study, data were collected through multiple sources i.e. interviews, concept maps, observations and documentation in order to find support for conclusions.
2. Long term and repeated observations at the research sites. In the present study, the study was conducted over a period of one academic year and regular and repeat observations were made in research settings and were continued until the completion of the field experience.
3. Control of bias. Bias was controlled by using reflectivity, which is the use of self-reflection to recognize one’s own bias and to actively seek it out (Ary *et al*, 2006).

Transferability

Transferability is the qualitative parallel to external validity in post positivist research (Guba & Lincoln, 1989 cited in Mertens, 2005). According to Ary *et al* (2006), transferability refers to the degree to which the finding of a qualitative study can be applied or generalized to other contexts or to other groups. Therefore, it is the researcher’s responsibility to provide sufficiently rich, detailed, thick descriptions of the context to enable the reader to make the comparison and judgments about similarity and hence transferability (Mertens, 2005; Ary *et al*, 2006).

In the present study, a multiple case design was used to support external validity. Yin (1994 cited in Mertens, 2005) suggests that the use of multiple cases can strengthen the external validity of the results and the relationship between the case study, and extant theories can lead to decisions about generalization from case study research. Moreover, the cross-case analysis was used to find similarities between cases. Ary *et al* (2006) recommend cross-case comparison as a strategy to enhance transferability. If findings are similar; this would increase the possibility of relating findings to other settings or contexts.

Dependability

Guba and Lincoln (1989 cited in Metens, 2005) identify dependability as the qualitative parallel to reliability. Reliability means consistency over time in the postpositivist paradigm. Unlike quantitative research, qualitative research expects variability because the context of studies changes. Thus, consistency is looked at as the extent to which variation can be tracked or explained (Ary *et al*, 2006). In case studies, Yin (2003 cited in Mertens, 2005) describes this process as maintaining a case study protocol that details each step in the research process. In this study, the research used the same methods of data gathering in every cases in order to ensure the stability of data collection as recommended by Gray, Mills, and Airasian (2006).

Confirmability

Confirmability in qualitative research is similar to objectivity in quantitative research (Ary *et al*, 2006). Confirmability means that data and their interpretation are not figments of the researcher's imagination (Mertens, 2005). Hence, qualitative data should be tracked to its source, and the logic that is used to interpret the data should be made explicit (Mertens, 2005). Ary *et al* (2006) proposes a confirmability audit to provide the trail to original sources. Yin (1994 cited in Mertens, 2005) refers to this strategy as providing a chain of evidence in the case study.

Ethical Considerations

Ethical approval was obtained from the University of Wollongong Human Research Ethics Committee before conducting the study. At the beginning of the study all participants were informed about the purpose and detail of the study, verbally as well as in writing (see Appendix 5A for Information sheet). In this way the participants understood the nature of the research and its possible impact on them. A written consent form was given to all participants and the participants were requested to complete a consent form, which indicated their acceptance to take part in the study (see Appendix 5C for Participant Consent Form). Pseudonyms were used for individuals and places to protect identities, therefore privacy and confidentiality were maintained at all times. Participants had the right to withdraw from the study at any stage. They were assured that their withdrawal would not affect any relationship between them and lecturers, the teacher education program or the university. Data

would be kept in a safe place for five years before being destroyed in order to ensure that they will not fall into the hands of a third person. See Appendix 5 for information sheets and consent forms.

Pilot Study

A pilot study is a small scale preliminary study conducted prior to a main study to explore the methodology to improve the quality of method design (Gray, Mills, & Airasian, 2006). According to the present study, a pilot was carried out to check the data gathering methods and identify if there was any problem or issue with the study that needed to be solved before conducting the actual research in Thailand. In this pilot study, the participant, Yoko, was a Master of Education student majoring in Teaching of English to Speakers of Other Languages (TESOL), at the University of Wollongong in 2007. She was an experienced English teacher in Japan.

Pilot study: the Case of Yoko

Yoko's background to teaching

Yoko is a master of Education student majoring in Teaching of English to Speakers of Other Languages (TESOL), at the University of Wollongong. She taught English at high schools in Japan for 12 years before coming to Australia to continue her studies. She studied English Literature as her major in her bachelor degree before beginning a teacher training course.

When she was a junior high school student she had a 'great' English teacher who not only taught English but also told her about cultures and societies in different countries. Yoko said that at that time she thought if she could speak English, she could meet people from all over the world. Therefore she chose a career that allowed her to continue to study English. It is clear that this teacher inspired Yoko to choose to be an English teacher and influenced the way she thought about teaching English. She said:

> In English class, I want to teach them not only English, but also … oh … have a look in the world we have a lot of countries … I wanna show them.

Another motivation was a letter from her favorite actor, Tom Cruise, which she received when she wrote to him. She said that she always told her students about this

story to give them motivation. She claimed that it is important to find some kinds of motivation in order to study English well.

For Yoko, English is a universal language because it enables people from different parts of the world to understand each other. It is a universal tool for communication. If someone knows English they can communicate with other people in many different places in the world.

Even though she was an English teacher, Yoko said she still had problems with listening compared with other skills such as reading, writing, and speaking. The reasons were more than catching up with the conversation. She also needed to have a basic knowledge of culture and society across many topics to understand the conversation.

Yoko's teacher knowledge

Yoko taught two English subjects, English Conversation and General English, to Grade 10 students. There were two 50-minute lessons per week for English Conversation class and three lessons per week for the General English course. There were 40 students in her class, which, although it is an average class size in Japan, Yoko thought was quite a big class.

She said that her students' ability was at an average level. In Yoko's opinion, these students had difficulties with listening and speaking, especially in English communication, because they did not have many chances to communicate in English in Japan. Furthermore, the students paid more attention to reading and writing than to listening and speaking in order to prepare for the university entrance examination, which was written.

Yoko further mentioned that at the beginning her students were enthusiastic to study English. They wanted to use English very well. However, when they began to study using textbooks that focused on grammar, they became bored and gradually did not want to learn. It seems that her students lost motivation easily. In her second interview, Yoko said:

> … if they are very advanced students, I think they can do everything … but my students are very average; so, sometimes they need help … I mean … if they have a very difficult activity they will lose motivation … oh we can't … So, that means they don't like to do that.

Therefore, she had to find strategies to encourage her students. She mentioned:

> … it's very hard to keep their motivation … so sometimes I gave them sweets … like a treat …

Yoko considered motivation an important factor for learning English. She wanted to allow her students to do anything they wanted in order to give them motivation; however it was quite difficult because she had to follow the curriculum. Yoko noted that she would do this kind of teaching in an extracurricular subject when she returns to Japan. She said:

> I think if I can give them their favorite things about English maybe English study … not only … you know … we don't have order … first, blah, blah, blah second blah, blah, blah … no, no … just what kind of thing do you like … maybe movie, music or chatting something like that …

In the first interview, Yoko gave her opinion about what makes effective teaching for her. According to Yoko's explanation, teachers should change their role from being the dominant character in the classroom to being 'a facilitator' instead. Yoko's idea of teaching is to make it very simple, and give students basic knowledge instead of answers. Her main goal was to make students think, practise and find the answers themselves. It appears that she wanted her students to change from being passive learners to being active learners. Yoko said:

> … how can I make them use English, speak English, like English … so … like a PE education, in PE class at first you have to learn about the rule like the soccer rule … and after that you'll start to play the game … like that …

Yoko wanted her students to be the main characters in her class. The teacher's role is primarily that of a facilitator, supporter, and observer to give students support and help. She stated:

> Now my decision is to teach English simply by making them work very hard … a low-profile English teacher is the best … teacher is director … students are actors or actresses … why do teachers speak so much … so that means when students think at the moment … facilitator means the teacher should observe the students … the teacher should give them support and help … like a supporter … this is my ideal teaching style …

Also in the second interview, Yoko mentioned about the change in the teacher's role from leader to helper. She said:

> So, when students start to play … to do activity … um … we join them and sometimes a student will have a problem doing an activity; at that moment just give them advice … and also sometimes we join the activity like a student … because sometimes they are very quiet, so we have to encourage them.

In the second interview, Yoko explained more about effective teaching. She gave more detail about the similarities between the physical education teaching method and her English teaching method. She wanted to teach the rules of English and after that let her students practise. However what really happens in Japan is that teachers explain everything, leaving the students with no chances to practise even in English classes. She commented:

> PE education … okay, we learn the rule to play soccer. After that, of course students play soccer … soccer game … the same thing after learning about grammatical thing and structure, expression, phrases and after that basically that's all in Japan, but after that, using, speaking in the classroom, so that is my best way of teaching English.

Yoko told about how she prepared lessons for a speaking class. At the beginning of the class, she told the students about the vocabulary to be used in that lesson, then she explained about that day's activity, before letting them do the activity. When the students were doing the activity, she and another native-speaking teacher joined in the activity and gave students advice. This was the normal procedure for her conversation class. The activities Yoko used in her class included individual work, pair work, group work, presentations, discussion, debate, and games based on the topic.

Yoko said that she had different expectations for different teaching subjects depending on the subject's objectives. For example, in conversation class she wanted her students to understand vocabularies and expression, and speak English. But she did not mind the level of grammatical accuracy. On the other hand, when she taught the general English course she expected that her students would use grammar correctly. Each subject concentrated on a different point. Therefore, her teaching style varied depending on the subject. It appears that she knew the nature of each subject very well. In addition, she applied the subject matter to meet students' abilities. She said:

> If I teach English like a grammatical thing at that moment I ask them please concentrate on the accuracy, but this is just … um … you know … speak … speak but no worry just encourage them … so, no worry even though you can't speak very precisely, accurately but … um … we don't worry.

Yoko was not satisfied with the English textbooks used in her school. She said that English textbooks in Japan always focused on grammar even when they were English conversation textbooks. Moreover, the contents have been the same since she was a high school student, with the only change being from printing in black and white to colour. In her opinion, using only these textbooks was not enough and quite boring for students, and she needed to add supplements when she taught her students. Yoko commented in her second interview:

> … we have a textbook … a course book … we have to use it … but we only use a course book that is not good because it's not enough and also sometimes it's boring. So, I choose something special related to the course book … and also another thing is the course book has some kind of problem as well … so we're kind of struggling …

Yoko was also concerned about using other teaching materials in her English class. She said it was difficult to use her own teaching materials because she had to follow the curriculum and use textbooks approved by the Ministry of Education. Another reason was that many teachers taught the same subject and she could not teach differently from other teachers.

The summary of Yoko's teacher knowledge can be shown in the form of the concept map in Figure 3.2. This map has 22 concepts, 20 relationships, nine cross-links and six hierarchies. There are four organizational concepts. The first organizational concept, 'knowledge of learners' sits above the concept of 'average level students' who need to have 'motivation' in order to study English well. The concept 'motivation' links to the concept 'students think'. Yoko gives the second organizational concept, 'general pedagogical knowledge' as a main concern. And under this 'general pedagogical knowledge' is the concept 'teacher as a facilitator' who becomes 'observer', 'helper', 'supporter', and teaches 'simply'. The concept 'simply' teaching means the teacher focuses on only 'one point' and makes 'students think' rather than telling them every thing that leads to effective learning. The 'content knowledge' cluster shows the 'subject matter' that needs to be applied to meet 'students' ability' to make 'effective teaching'. This 'effective teaching' leads to 'effective learning'. The fourth organizational concept is 'curriculum knowledge'. Beneath this concept are 'text books' which focus heavily on 'grammar', and this is 'boring' and 'not enough'; therefore Yoko has to add 'supplements' to make her 'students think'.

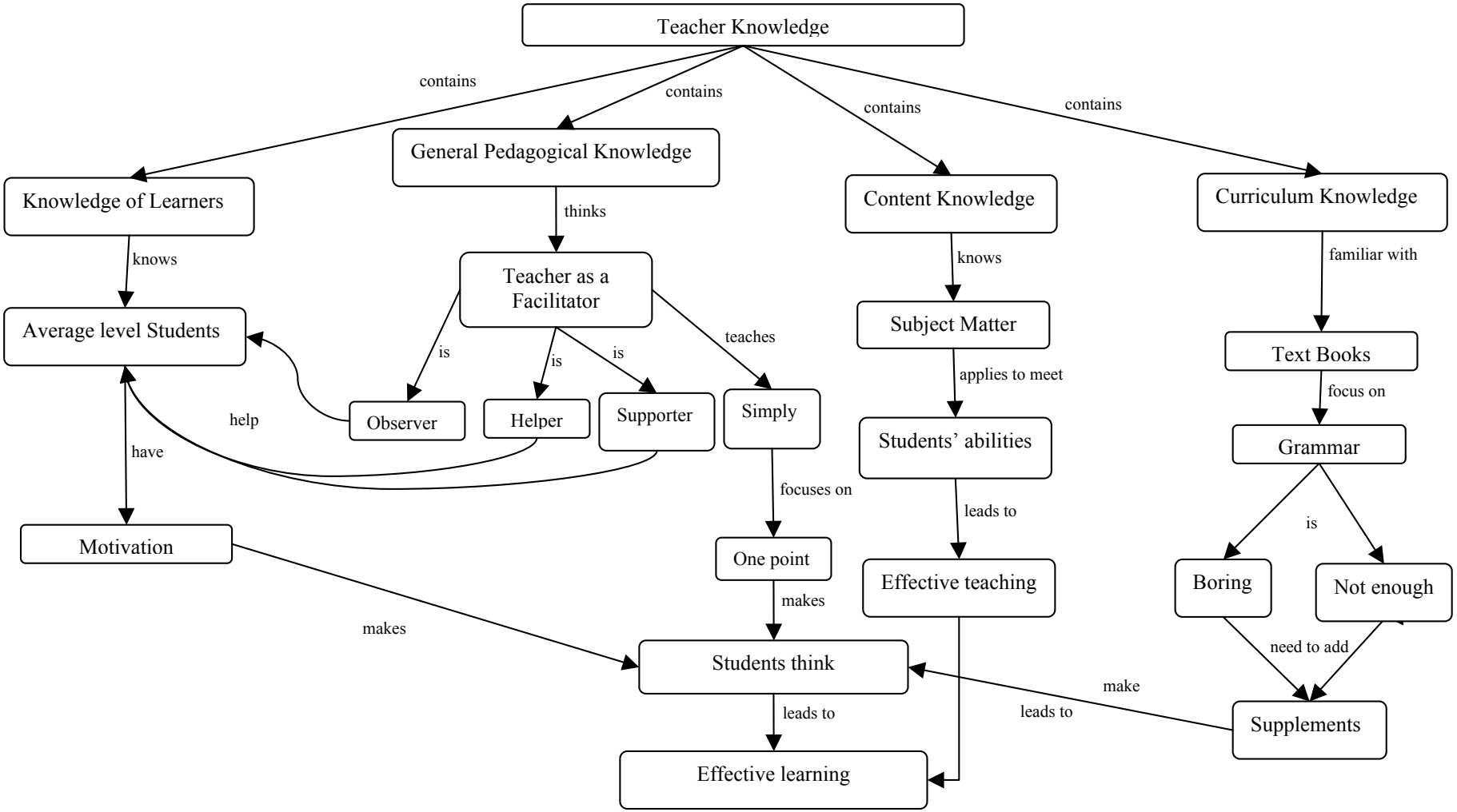

Figure 3.2. Concept map of Yoko's Teacher Knowledge

Summary of Yoko's case

In conclusion, it appears that Yoko believed students should be motivated in order to study English well. Therefore she tried to find many strategies that would motivate students. Yoko focused on the teacher as an important factor in effective teaching. She commented that teachers should change their role from being the leader in a class to being a facilitator, an observer, a supporter, and a helper instead. Students, not the teacher, should play the main role in the class. In addition, she noted that each subject had a different objective; hence, she expected students' achievements to be different for each subject. Yoko also modified the subject matter to meet her students' abilities. According to Yoko, she claimed that English textbooks in Japan mainly focused on grammar which made students feel bored and the contents were not supportive enough. She needed to find extra supplements to give her students motivation and encouragement to think. As a result of the pilot study, it was evident that a combination of interview supplement by concept map was a reasonable way to ascertain a participant's teacher knowledge

Summary of the Chapter

This chapter presented the detail of the research methodology used in the present study. The setting, selection of participants, method of data gathering, procedures, and data analysis were described. Ethical considerations were presented to ensure participants' privacy. A pilot study was conducted with a participant in Australia prior to the main research in Thailand. The pilot study was used to check the feasibility and the methodology in order to improve the effectiveness of the study. The next four chapters provide case studies of the four teachers in Thailand.

Chapter Four

The Case of Somchai

Overview

The chapter begins with overview of science education and its curriculum in Thailand to provide a context for the research. The second part presents the case study that investigates the research question about Somchai's teacher knowledge as it developed during his teacher education course and the influences on this development. It is presented in four sections. The first section shows Somchai's initial view on teaching. The second section represents his data on the forms of his teacher knowledge as it developed at different times during the study. As with each of the case studies, the theory applied to analyse Somchai's teacher knowledge is Shulman's (1987) framework of seven types of teacher knowledge. The third section explores the changes in Somchai's view of teaching toward the end of the study. The final section summarizes what type of teacher knowledge Somchai possessed and examines influences on why it changed during his teacher education course.

The Context of Science Teacher Education in Thailand

Teacher education in Thailand has a long and involved history. After the establishment of compulsory primary education in 1921, the monks played an important role as teachers which helped alleviate the lack of trained teachers at that time (Blanchard, 1958). However, as the numbers of teachers increased, the monks were eventually replaced. The first teacher training school for elementary school teachers was founded in 1892 (Assumption University, n.d.). The government set up several kinds of teacher training schools to meet an urgent demand for more teachers. The teacher training schools were under the Teacher Training Department of the Ministry of Education. The schools offered an education program leading to a lower Certificate of Education (Rajabhat Mahasarakham University, n.d.). Then teacher training schools were changed to Teachers Colleges, under the Teacher Training division of the Teacher Training Department, offering education programs leading to both a Lower Certificate of Education and a Higher Certificate of Education (Suan Dusit Rajabhat University, n.d.). Due to the declaration of a Teacher College Act (Issue 1) in 1975, the teacher training curriculum was improved resulting in the

modification of a Teacher College in either administrative or academic structure. Initially the teacher Collage only offered Bachelor's degree in education then expanded to art and science degrees.

In order to improve the quality of education, a College of Education was established in Bangkok in 1953 to be a model to other training schools (Blanchard, 1958). In the mean time, the Thai government made a contract with Indiana University in an attempt to develop teacher education, so many American educators worked with the College of Education and other teaching institutes to assist the development of a new teacher training curriculum (Blanchard, 1958). The College of Education was then upgraded to Srinakharinwirot University in 1975.

Over time, teachers colleges located across the country gained high respectability in providing teacher training for elementary and secondary schools. The student teachers who entered teachers colleges at that time were high-achieving students. However, after teachers colleges were changed to Rajabaht Institutes and now Rajabaht Universities (specially designed for training teachers), faculties of education became 'second-class' faculties in terms of their profile. The graduates felt inferior to graduates from other programs and often developed negative attitudes towards their careers.

A New Degree Structure for Teacher Education

After the 1999 Education Acts was promulgated, Thailand entered a major change for educational reform. It was considered urgent to improve the quality of teacher education in order to improve the overall quality of students' education in schools. In order to accomplish the educational reform goal, teacher quality needed to be improved as rapidly as possible. The new five-year teacher preparation program was one of the attempts to increase the quality of science teachers. This new teacher preparation program has been used since the 2005 academic year and the first cohort graduated in 2009. Those who complete the program are issued with a teaching licence that is suppose to guarantee the quality of their teaching. Issuing a teaching licence to teachers endows them with knowledge and competence and with desirable behaviour and strict observance of the teachers' code of ethics is a measure for

development of the teaching profession in accord with Section 81 of the Constitution of the Kingdom of Thailand 1997 (Charupan & Leksuksri, 2000).

Structure of the new program

The preservice teacher education degree, that is the focus of this thesis, is this new five year education degree. Those who enroll in the program first must complete upper secondary education. Each student teacher studies both academic disciplines and teaching methods. Taking into account both types of studies, the graduate gains the qualification Bachelor of Education in Science (B.Ed.). The science teacher education curriculum requires preservice teachers to take not less than 208 total credit hours. The curriculum consists of four main types of core courses including general education courses, professional courses, specialize courses and general elective courses. The general education courses are in areas of language, social science, humanities, mathematic and science with total credit not less than 55 credit hours. The professional courses are in the areas of education and professional training with total credit not les than 60 credit hours. The specialized courses are in areas of science content education with total credit not less than 91 credit hours. The curriculum requires preservice teachers to study science content courses in broad range of areas such as in Biology, Chemistry, Physics and physical science. The professional education courses require at least 60 credit hours, the courses including curriculum and instruction, ethics and codes for teachers, basic concepts of education, principles of education measurement and evaluation, educational psychology, introduction to educational technology, method of teaching science, seminars in science teaching, and field experiences. The two or three credit hours general elective courses are chosen by the student based on one's own interests.

The program requires preservice teachers to take field experience courses of 25 credit hours including practicum 1, 2 and 3, and internship 1 and 2. The practicum 1 is field observations which include observation and limited participation within a classroom under the supervision of a classroom teacher. The preservice teachers are required to study learners, the school, community, and community in different aspects. The practicum 2 takes place in the second semester of the fourth year. The preservice teachers spend 60 hours in practice teaching in real classrooms under the supervision of a mentor and a supervisor. This course is provided for preservice teachers to

connect university coursework to classroom practice. In internship 1 and 2 during the fifth year, student teachers spend a whole academic year as preservice teachers in a practicum school under the supervision of a mentor. The overall course structure can be seen in Table 4.1.

Table 4.1 Course program

Subjects		Credit Points
Year 1- Session 1		
GEED101	Communication in Thai Language	5
GEED101	Communication in Thai Language	5
GEED102	Communication in English Language	6
GEED102	Communication in English Language	6
SCIE201	Nature of life	5
SCIE301	Chemistry	5
SCIE301	Chemistry	5
	Session Total	37
Year 1- Session 2		
GEED104	Thinking and Personal Growth	5
GEED104	Thinking and Personal Growth	5
GEED105	Human Beings and Society	5
SCIE202	Producers	5
SCIE401	Earth and Space	5
	Session Total	25
Year 2- Session 1		
EDUC101	Foundation in Education and Inclusive Education	5
EDUC103	Curriculum and Management of Learning	5
GEED103	Communication in …Language	4
GEED103	Communication in …Language	4
SCIE203	Consumers	5
	Session Total	23
Year 2- Session 2		
EDUC102	Nature of the Learners	5
EDUC102	Nature of the Learners	5
GEED106	Life Through Science and Technology	5
GEED106	Life Through Science and Technology	5
SCIE302	Organic Chemistry	5
SCIE403	Fundamental Physics	5
SCIE403	Fundamental Physics	5
	Session Total	35
Year 3- Session 1		
SCIE101	English for Academic Purposes for Science Teachers 1	3
SCIE102	English for Academic Purposes for Science Teachers 2	3

SCIE303	Inorganic Chemistry	5
SCIE402	Mathematics and Computer for Science Teachers	5
500	Elective Subject	2 or 3
	Session Total	18 or 19
Year 3- Session 2		
EDUC104	Learning Innovation	5
PROF101	Practicum 1	3
SCIE204	Micro organisms	5
SCIE404	Fundamental Physics 2	5
	Session Total	18
Year 4- Session 1		
EDUC106	Research for Learning Development	5
PROF102	Practicum 2	3
SCIE207	Biodiversity	5
SCIE304	Environmental Chemistry	5
	Session Total	18
Year 4- Session 2		
EDUC105	Teacher professional Development	5
PROF103	Practicum 3	3
SCIE208	Biotechnique	5
SCIE501	Research Methodology in Science	5
	Session Total	18
Year 5- Session 1		
PROF104	Internship 1	8
	Session Total	8
Year 5- Session 2		
PROF105	Internship 2	8
	Session Total	8

What is unknown, however, is whether this new course structure helps to prepare teachers for working in schools and whether it improves their teacher knowledge. The next section presents the first of four case studies. It provides evidence to describe Somchai's teacher knowledge as it developed during his teacher education courses and the influences on this change.

Somchai's Views on Teaching at the Beginning of the Study

Somchai was a 22-year-old student teacher majoring in science, in the fourth year of a five-year program. After he graduated from Grade 12 (Matthayom 6) in a nearby province's high school, he enrolled in an education degree at the Rajabhat University in the northeast of Thailand. His decision to become a teacher was influenced by his parents, who are teachers, and the winning of a scholarship for studying in this program.

At the beginning of the study Somchai portrayed himself as a science teacher who is a "normal teacher with a little bit more enthusiasm and ready to teach other people" (Int. 1, Aug 2007). He strongly believed that education subjects would be beneficial to him when he began teaching because they prepared him for teaching. He also claimed that his lecturers were significant role models for teaching: "If the lecturers don't do it [teaching] as an example, I can't do it at all …" (Int. 1, Aug 2007). During his school observations period, he was asked if he could explain the influences on his pedagogy, how much influence came from his university course and how much from classroom observations. In a form of pie-chart, Somchai stated that he estimated 4/5 of his teaching style would come from his experiences in university and 1/5 from lesson observations. For classroom observation, he said he might get some "tricks" from the teachers he observed. He believed that his main strength as a teacher was his subject matter knowledge and teaching technique, "The first thing is my subject matter knowledge … if you don't have any knowledge, you can't teach anyone else. The second is teaching technique … I think I have tricks" (Int. 1, Aug 2007). He was also concerned about subject knowledge as a priority for teaching. When asked what areas he would like to improve, he suggested his teaching technique and subject matter knowledge as areas that he wanted to improve most. He said, "[I want to improve] everything especially teaching technique and knowledge … I want to make them better …" (Int. 1, Aug 2007).

Somchai's Views on Teaching as Represented by the First Concept Map

In August 2007 at the same period of the interview, Somchai was asked to draw a concept map to explain his views about how he teaches science. Somchai's first concept map in Figure 4.1, focused on the content knowledge of science rather than teaching or learning strategies. He explained that the subjects taught in the high school science curriculum are composed of physics, chemistry, and biology. These subjects are core subjects for the Science and Mathematics program. Somchai also gave examples of topics in each subject. Even though he said that science subjects are equally important in every level, he considered science subjects in Matthayom 4-6 (Grades 10-12) as a basic level of knowledge for university standard. Therefore, he paid attention to these subjects. Somchai stated that:

> … I think students can use knowledge from Matthayom 4-6 (Grades 10-12) science subject for entrance exam and as a fundamental when they study at university level. I think students should have a deep understanding of these levels. So, I want to investigate these levels. (Int. 1, Aug 2007)

Somchai's first concept map indicated that his view of science teaching was mainly influenced by content knowledge with little impact from other forms of teacher knowledge, such as knowledge of learners and their characteristics, or curriculum knowledge.

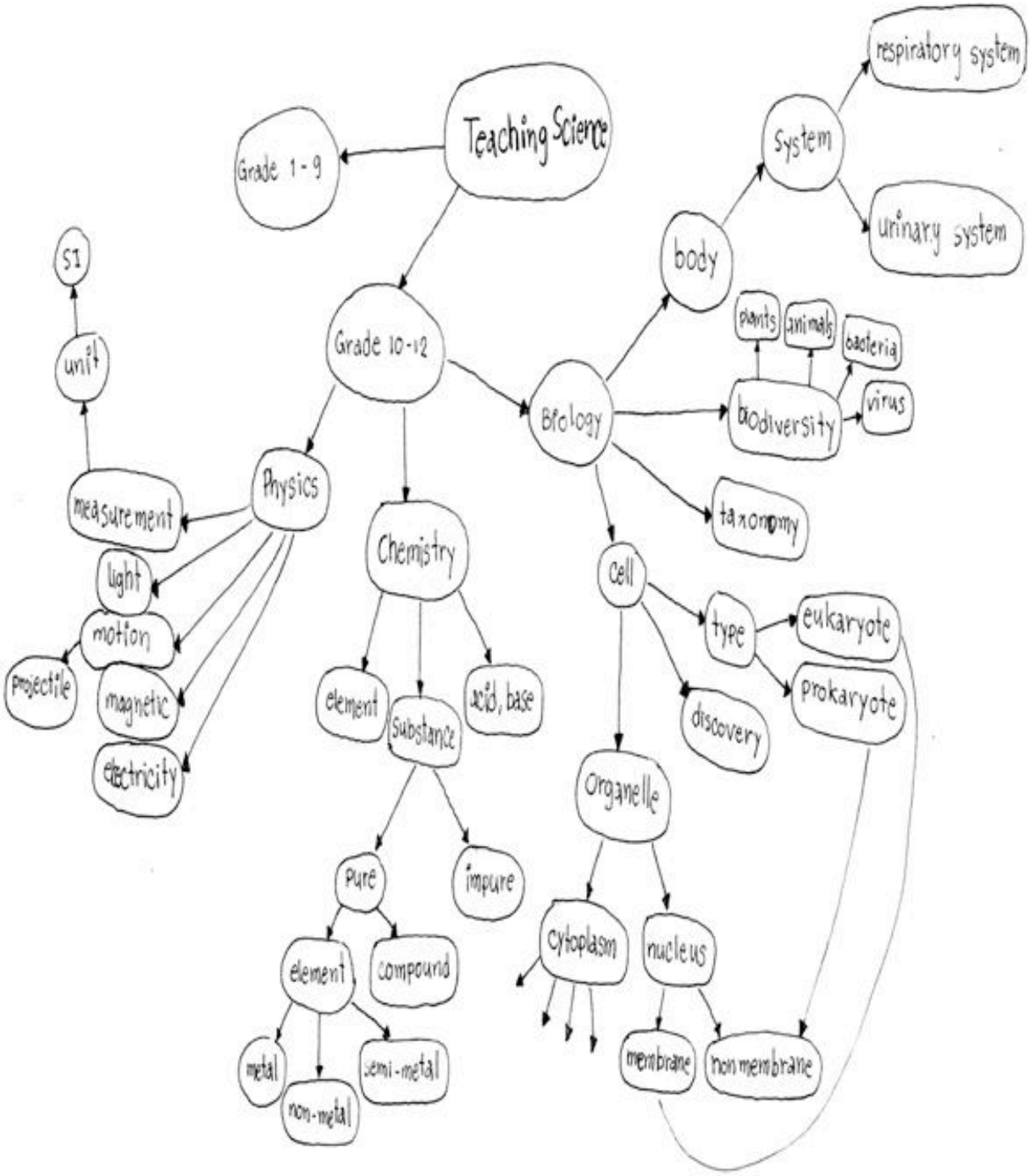

Figure 4.1. Somchai's first concept map

Analysis According to Categories of Teacher Knowledge

The theoretical framework that influenced the conceptualization of this study was Shulman's (1987) theory of seven types of teacher knowledge: (a) content knowledge; (b) general pedagogical knowledge; (c) curriculum knowledge; (d) pedagogical content knowledge; (e) knowledge of learners and their characteristics; (f) knowledge of educational contexts; and (g) knowledge of educational ends, purposes, and values, and their philosophical and historical grounds. Shulman's categories are used here to analyze Somchai's teacher knowledge from data collected from interviews, lesson observations, and concept maps at different times during the study. Changes in Somchai's teacher knowledge during the teacher education program were investigated.

(a) Somchai's content knowledge

In the first interview in August 2007 during his classroom observation, Somchai was asked to explain if the science studied courses in the university benefited him. He strongly believed that the science courses he learned from the university would be beneficial to him when he started his teaching career. At this stage, Somchai considered the university science subjects as fundamental knowledge. That is, his main categorization of teacher knowledge was as content knowledge.

In his second interview in November 2007, his beliefs were reaffirmed. Somchai stated that he could not teach without knowledge he had learned at the university. He added, "If I hadn't studied [in the university], I couldn't teach because I wouldn't have knowledge" (Int. 2, Nov. 2007). Somchai also noted that although he had forgotten what he had learned, with a little revision he could remember it again.

In his last interview in February 2008, Somchai still believed in the value of his content knowledge from the university science subjects. However, at this time, he viewed the university science subjects as important tools for explaining knowledge to students. Though the knowledge he had learned at university was deeper than knowledge he needed for teaching, it enabled him to easily understand the subject content and explain it to his students clearly. Somchai noted that school science subjects had a broad scope of knowledge. He also talked about the subject he taught. He taught physical science, but this subject did not have its own textbook. Hence, he

had to find its content from other resources such as the Internet and Grades 7-9 science textbooks, and then modify these to suit his lessons. He usually used the information from the Internet because it was convenient. He could download interesting pictures and diagrams for his handouts and worksheets. He also saved time in typing by cutting and pasting text from the Internet. However, Somchai emphasized that he must carefully choose the content from reliable sources.

Somchai was asked the same question on three occasions about the influence of science knowledge that was presented in university subjects. His responses are shown in Table 4.1 it shows that he believed his university subjects were important throughout his course.

Table 4.2 Data Related to Somchai's Content Knowledge

August 2007	November 2007	February 2008
Yes, a lot. Sciences in the university are fundamental for teaching students. *Confirmed by the first concept map (Figure 4.1)*	Yes, If I hadn't studied sciences from the university, I don't know how I could get the knowledge to teach students. At least, if I had already learned and if I had forgotten … with only a little revision, I could remember again. If I hadn't studied, I couldn't teach because I wouldn't have had the knowledge.	Yes, although what I learned from the university is deep, and what I explain to my students is not so deep but broader, it made me understand and I can easily explain to them. I can answer what students ask. Q: Where do you get the content? Somchai: The subject that I took responsibility was physical science … it doesn't have a textbook; therefore, I studied from the Internet and from other subjects that have content similar to my subject like Matthayom 1-3 (Grades 7-9) sciences to support. Then I rearranged it again into my own style and used this to teach my

		students. Q: What is the good point of the Internet? Somchai: Its convenience. I can download colorful and beautiful pictures and these make students interested. And it is also easy. I don't have to type it again … just copy and paste it. But you have to choose reliable websites. *Confirmed by classroom observations of Somchai's lessons and lesson plan, handout, and worksheet (Appendix4A,4B, and 4C)*

In summary, there was a minor change in Somchai's content knowledge. He thought that university science subjects were beneficial to him. The knowledge he had learned from the university gave him confidence to teach. It was clear from the interviews that Somchai believed content knowledge was the most important type for him which he gained from his science disciplines subjects at university. In addition, the subject Somchai taught when he practised teaching did not have its own textbook. So he found the content from other sources such as textbooks used by other classes and the Internet.

(b) Somchai's general pedagogical knowledge

Somchai's first interview took place in August 2007 during his classroom observation period. He was placed in one of the largest secondary schools in the province with his other classmates. In this period, he did not view himself as a teacher. He still did not have any idea about teaching beyond the transmission of content. He thought about teaching by following how he was taught when he was a high school student, indicating he believed that if his teachers could make him understand by using this method, his students should understand it too. He explained, "I think students will understand this because I have been taught like this and I understood, so the students should understand it too" (Int. 1, Aug 2007).

In the second interview, in November 2007, he provided details about his experience from classroom observations. His classroom observations also had an impact on how he thought about teaching. He prepared his lessons by following the lesson he had observed. At this time, he mentioned how he could assess his students by asking questions. Also, he pointed out the importance of experiments and practice for more understanding, claiming, "if we only give them lectures without doing the real experiment, they will not see what is really happening" (Int. 1, Aug 2007).

However, in his practicum at another secondary school where he had a chance to teach physical science in the Matthayom 4 (Grade 10) foreign language program, Somchai used only a lecture style in his class due to limited access to the laboratory and teaching materials. Although he wanted his students to conduct experiments, he said, "… I really wanted to use the computer laboratory to let my students use multimedia and the Internet but I didn't know how to ask for a permission …" (Int. 3, Feb 2007).

In addition, he was not satisfied with his general pedagogical knowledge; he wanted to improve his teaching method, as he mentioned: "… I want to have much better teaching techniques. I wish I could teach with more fun…" and "I wanted to teach each topic by using different strategies" (Int. 3, Feb 2008).

He was asked the same questions on three occasions, about how he planned to teach his science lessons. His responses are shown in Table 4.2 which suggests that he thought about teaching because his own school expectation which changed as a result of practicum in school.

Table 4.3 Data related to Somchai's general pedagogical knowledge

August 2007	November 2007	February 2008
Q: Suppose you have to teach science. How will you teach it? Somchai: First, introduce	Q: Can you give me an example of teaching a science lesson? Somchai: Acid and base	Q: How do you plan your lesson? Somchai: I do it this way when I'm practice-

the topic. Tell students roughly about the topic, tell them the whole picture before giving in-depth information. And depending on what teaching method we use … maybe use an experiment in order to help the students gain as much knowledge as they can. Q: Can you give me an example of teaching a science lesson? Somchai: Cell. I'll show them a picture of a cell and its organelles. I'll show students what each organelle looks like. This uses both memory and understanding … it cannot be learned without memorizing. Then I'll explain organelles' structure and functions. Then I'd draw a flow chart about a cell, which is composed of cytoplasm, protoplasm … and so on. This will give them a clear picture about cells. Q: Why do you plan the way you do? Somchai: If I use other methods … I still have no idea. For this technique, I used to study by this method. I think students will understand this because I studied like this and I understood, so the students should understand it too. If I teach other people with the method that I understand, they should	for Matthayom 2 (Grade 8); testing acidity by using litmus paper. First, I'd prepare some materials essential for the test and then tell students to bring acidic things from home. I'd let students test for acidity from either nature or chemistry, then I'd summarize to help them gain more understanding. I'd question them individually to stimulate their thinking and to check whether they understood or not. If they could answer that would mean they had understood. Q: Why do you plan the way you do? Somchai: If students have a chance to do an experiment, they'll understand. If we only give them lectures without the experiment, they will not see what is really happening. If they can see something like colour change … it will make them interested.	teaching … I always prepare lesson plans, content, handout, and worksheets before teaching because I worry I might not have anything to teach … then I add something later … Q: Are there any factors that affect your teaching? Somchai: Teaching materials, tools and classroom environment are very important for my teaching. Even though I prepare my lessons well, if I lack the teaching materials and tools that make the students see the real picture, they will not understand … even if they are clever or very well prepared. … I really wanted to use the computer laboratory to let my students use multimedia and the Internet but I didn't know how to ask permission … … I'd like to say there're two points. First, I wanted to teach each topic by using different strategies but my practicum site lacks many things, lack of laboratory equipments, and it doesn't have enough teaching materials. So, I had to teach by using worksheets. I used only one teaching method but I am not satisfied with this. Students didn't have a chance to do an experiment ….they learned it from hand outs.

understand.		Q: In what areas would you like to improve as a teacher? Somchai: I want to improve my teaching because I used only one method … used hand-outs and worksheets. I want to have much more teaching technique. I wish I could teach with more fun. *Confirmed by lesson observations of Somchai's lesson.*

In summary, Somchai developed a major change in his general pedagogical knowledge mainly because of the practicum. In the first interview Somchai still thought like he was a student because his ideas about teaching came from his experience of when he was a student at school. Then in his second interview, when he returned from his classroom observations, the way he planned his lesson followed the method he had seen at his practicum school. However, in his final interview after his practicum, he stated that he used only one teaching method, which was a conventional teacher-centred style and let the students answer questions on worksheets. He thought this was because his school lacked laboratory equipments and he could not access the computer laboratory. However, he still wanted to improve his teaching technique and try different teaching styles.

(c) Somchai's curriculum knowledge

It should be noted that in the first interview conducted in August 2007, Somchai did not mention anything about curriculum knowledge**.**

In Somchai's second and third concept maps, he mentioned studying the curriculum thoroughly before planning any lessons. Especially in his third concept map, he placed 'study curriculum' as the first concept, which shows that he had become more aware of this form of teacher knowledge. See Table 4.3 for his curriculum knowledge.

Table 4.4 Data related to Somchai's curriculum knowledge

August 2007	November 2007	February 2007
No discussion about curriculum knowledge	Somchai placed concept of 'study curricum' as the second concept. *Confirmed by the second concept map (Figure 4.2)*	Somchai placed the concept of 'study curriculum' as the first concept. *Confirmed by the third concept map (Figure 4.3)*

In summary, there was a major change in Somchai's curriculum knowledge. His concept maps indicated development of his understanding of curriculum which was absent at the beginning of the study.

(d) Somchai's pedagogical content knowledge (PCK)

There was no evidence that relates to Somchai's pedagogical content knowledge.

(e) Somchai's knowledge of learners and their characteristics

In August 2007, Somchai was asked to explain his views about what makes science difficult for students. He believed that the students' difficulties in learning science were related to two factors – examinations and memorizing. Furthermore, he thought that the two science subjects students disliked most were physics and biology, while chemistry was the favourite science subject. The reason students preferred chemistry to other science subjects was that in chemistry class students do experiments. To confirm this, he used his experience as an example. In addition, Somchai specifically gave as an example, "boys don't like reading", suggesting that his views were influenced from his experience as a student. Somchai said: "From my experience, I didn't like physics. Biology needs memorization and boys don't like reading. Children don't like memorization but they like experiments. Doing experiments in a laboratory … they like it very much" (Int. 1, Aug 2007).

When asked the question, 'what could make the study of science easier for students?' he again used his experience as a student to answer this question. Somchai criticized

the old style of teaching in which the teacher wrote down everything on the black board and students had to remember it all, making the student feel bored. Teachers should have teaching techniques that motivate students, he added.

In the second interview, after he finished his school observations in November 2007, his opinion about students' learning science had changed. Somchai explained that the main problem came from students themselves. He thought, "students nowadays are lazy" and "don't have a good basic knowledge"; therefore, when they continue their study to higher levels they cannot understand the content because they do not have sound fundamentals. This results in a bad impression of science subjects. However, he still believed that good teaching strategies and experiments can encourage students to learn science.

Three months later, in February 2008, his beliefs about what makes science difficult for students to learn were reinforced. He remained concerned that students' weak science fundamentals – that is, content knowledge – were a main factor in their being unsuccessful science learners. At this time, he also commented about his students at his practicum site. His students did not have much ambition in learning science. Only a minority were interested in science. However, he said he understood teenagers' behaviours and tried to decrease the age gap between him and his students as much as he could. He said "I tried to adapt myself to get along with them as much as I could. I tried not to have an age gap between me and them. I think it is okay at this level … at least they listened to me" (Int. 3, Feb 2008). He reaffirmed that teaching methods were important for making students interested in studying science. This time he specifically suggested the using of "computer simulation" as a way to motivate students. He pointed out that "students at this age like computer things" (Int. 3, Feb 2008).

He was asked the same question on three occasions about what makes science difficult for students and what could make it easier for them. His responses are shown in Table 4.4 which suggested that which suggest that he learned a great deal about students from his time in schools and blamed them for many problems.

Table 4.5 Data related to Somchai's knowledge of learners and their characteristics

August 2007	November 2007	February 2007
I think examinations … students don't like examinations … If talking about science subjects … I think they don't like physics and biology. But students like chemistry because it has experimentation. From my experience, I don't like physics. Biology need memorization and boys don't like reading. Children don't like memorization but they like experiments. Doing experiment in a laboratory … they like it very much. Begin with the teachers themselves … old style teachers just write on a black board and let students memorize … nothing more. So, students get bored. If teachers have strategies or do something interesting … students might like it.	I think students nowadays are lazy, don't have a good basic knowledge. Suppose they study in Matthayom 1 (Grade 7), and they are not interested in the subjects, when they proceed to a higher level where each subject is more difficult … but its content has a fundamental difference from the previous level, then the students do not understand the subject content and this makes them not like the subjects. We should make students think sciences are easy by using better teaching techniques. Maybe focus on experiments to let them see the real picture to make students curious about why it happens like this, then we explain. This might make students like sciences. And we must not concentrate on memorizing, rather concentrate on understanding.	It's difficult because students don't like reading and don't have good fundamentals, so when they reach advanced levels, they cannot understand. Then students think sciences are difficult even though they are very easy. The point is students don't have enough basic knowledge for higher levels and this makes them think sciences are difficult. I want the school to have enough teaching materials. I want to use computer simulation. Using computers for doing experiments … I mean do experiments online via the Internet. In this way it saves the cost of chemicals but has picture, light and sound. Students can see the real change … they will like it. Students at this age like computer things. Teachers also are important, but they must pay more attention to their students. Q: Could you tell me about students in your class? Somchai: They paid little attention to their study. Only a few people were really interested in their study. I understand the behavior of teenagers. I tried to adapt myself to get

		along with them as much as I could ... tried not to have an age gap between them and me. I think it is okay at this level … at lease they listened to me. *Confirmed by lesson observations of Somchai's lesson.*

In summary, there was a major change in Somchai's knowledge of learners and their characteristics. In the first interview, he used his experience as a learner in his own schooling as an example to explain science learning difficulties. He thought the obscurities came from the education system and teachers. However, after his experiences of classroom observation and the practicum, he suggested that the causes began with the students themselves. Somchai stated that his students were not interested in science; only a few were really interested in the study. Students did not pay attention to science and do not have adequate science fundamentals, so when they continued their study at higher levels, which had more complex content, they could not understand. However, Somchai attempted to adapt himself to get along with them. He tried to relate to his students, and by doing this, his students listened to him more attentively.

(f) Somchai's knowledge of educational contexts

There is no evidence that relates to Somchai's knowledge of educational contexts

(g) Somchai's knowledge of educational ends, purposes and values and their philosophical and historical grounds

There is no evidence that relates to Somchai's knowledge of educational ends, purposes and values and their philosophical and historical grounds.

Classroom observation of Somchai's lessons

Somchai did his practicum at a large-size high school in a northeastern province. The school had approximately 975 students in Matthayom 1 (Grade 7) through to Matthayom 6 (Grade 12). Somchai taught the Matthayom 4 (Grade 10) physical science class. The class periods lasted approximately one hour.

Somchai's classroom was on the second floor of the building. A television was placed above the blackboard on the front wall. There were two doorways and several windows in the room. The teacher's desk was in the left front corner of the classroom, beside the windows. The students' desks were organized in pairs facing the blackboard. There was enough space for the teacher to move around the room. Two bulletin boards in the front of the room had seasonal items that were decorated by students.

The researcher observed Somchai's class in February 2008 for three lessons on 'Light' (see Appendix 4A, 4B, and 4C for samples of Somchai's lesson plan, handout, and worksheet). The subject was taught three times a week, Monday, Tuesday, and Wednesday, but Somchai was responsible only for the Tuesday afternoon class. The lessons were timetabled for one hour, but due to this class starting after a lunch break, the students used about ten minutes at the beginning of the class to enter the room, take their seats, and prepare themselves.

When Somchai entered the classroom, a student who was the head of the class led the other students in greeting the teacher. At the beginning of the lesson, Somchai checked the roll by reading students' names aloud and students who heard their names would raise their hands in response. After Somchai had the students' attention, he told them what the topic of the day was and he informed students of the lesson's objectives. Normally, Somchai presented a new topic to the students by using a question-answer approach. The questions he asked were relevant to the topic, for example, 'Give me a name of an optical instrument'. Then he told the students to group together, in groups of four or five students. Somchai gave handouts and worksheets to all students and told them to study the handout and answer questions from the worksheet for 30 minutes. He let students work and discuss in their groups but they could ask him if they had any questions. While students worked, Somchai always walked around the room to monitor and assist them. When he was moving around, he often talked with his students in an informal way, rather like talking with a friend; sometimes he used a northeastern dialect instead of the standard Thai language generally used in school. Consequently, students talked with him in quite a relaxed manner. Sometimes students called out to ask him to explain the question. Somchai sometimes discussed with the students in their groups, and sometimes he discussed

the problem with the whole class and wrote on the blackboard. Once the students commented that Somchai talked too fast, and then he tried to talk more slowly. However, only some students paid attention to the group's work; other students, especially male students, talked to each other or did other activities.

After 30 minutes, Somchai asked for volunteer students to put the work on the blackboard. If students could not answer, he would solve the problem on the blackboard with the help from the class. Somchai sometimes asked questions from handouts and would give extra credit to anyone who could answer; many students tried to answer the questions but only a few students gave the right answers. Then Somchai revised and concluded the lesson. He told his students to retain their worksheets if they could not finish their tasks, and allowed them to send it in later, after class. At the end of the class, the head of the class led the students to bow to the teacher and say "Thank you, teacher". Somchai then allowed the students to leave the class.

From the beginning to the end of the practicum, Somchai's mentor observed his teaching only once. When he observed his class, he stood outside the classroom and monitored through the door. Somchai said that his mentor brought him to the classroom to introduce him to the students once and after that he was on his own. Somchai did not discuss any lessons with his mentor. However, Somchai mentioned that his mentor gave him textbooks, handbooks, curriculum materials and the course syllabus. His mentor also showed him examples of topics and gave him a consultation.

Somchai created one lesson plan per day. Due to the limitation of each lesson period being one hour, he could not carry out an experiment. Thus, he had to let his students study from handouts and worksheets. Another reason that he chose handouts and worksheets as his teaching materials was that if he used a lecture style of teaching, the students would not listen to him and became very noisy. By using handouts and worksheets, his students were more quiet and interested in the lesson.

In this lesson observation, Somchai showed content knowledge, general pedagogical knowledge and, most clearly, his knowledge of learners and their characteristics.

Somchai's Views of Teaching Toward the End of the Study

In the second interview, Somchai weighed his experiences from university and from classroom observations as equally important. He said, "study in the university lets us gain knowledge for teaching; lesson observation makes us learn from experience a real situation" (Int. 2, Nov 2007). However, in the last interview, at the time after his practicum, he claimed that 3/5 of the pie-chart of the impact on his teaching model came from practicum experience and 2/5 from his university course. He then said, "we gain knowledge in the university but for experience and teaching technique we have to find out for ourselves what technique we have and how we can transfer knowledge" (Int. 3, Feb 2008). It appeared that the changes and awareness in his pedagogy were stimulated by his experience of classroom observations and the practicum.

When Somchai was asked about experiences he gained from his practicum, he identified several things. He stated that the practicum made him realise that a practical lesson always proceeded differently from what he had planned. By working closely with students, he could appraise students' characteristics and their learning process. This also strengthened teacher-student relationships between himself and his students. Moreover, Somchai noted that the practicum made him develop a teacher's perspective. When he practised teaching, he could identify his weak points that he needed to improve and ideas for new teaching methods. At his practicum site, Somchai also had chances to practice other work besides teaching, such as administrative work. He viewed this as a good opportunity to gain experience of real teaching life.

Somchai did mention problems he faced in his practicum. First, the classroom environment did not promote an effective learning environment. Second, students often did not pay attention to the lesson. Third, there was a lack of laboratory equipment. Finally, the actual teaching sometimes did not follow the lesson plan.

Somchai's Belief about Pedagogy as Represented by Concept Maps

Somchai's second concept map was markedly different from his first attempt. The second concept map reflected the teaching method he had observed at school. He mentioned, "[This second concept map] is very different from the first [concept map]. In the first one I focused on content but this time I focused on teaching method." (Int. 2, Nov 2007).

The factors that influenced this change were his classroom observations. He had had a chance to observe teaching in a real classroom, and realised that he should concentrate more on how to help students understand rather than just focusing on the content alone. He also mentioned studying the curriculum before planning topics.

Somchai noted that the content of his first concept map was a part of the curriculum. He said, "contents in the first concept map are in the curriculum … we can put them together in the curriculum" (Int. 2, Nov 2007). He reflected that his first concept map was a "subset" of the second concept map.

The second concept map is arranged in linear form. Each concept links to another in the same direction. This concept map has only one cross-link, between 'student cannot answer' and 'explain additional theory'.

The second concept map illustrates his knowledge of content, general pedagogical knowledge, curriculum knowledge, and knowledge of learners and their characteristics.

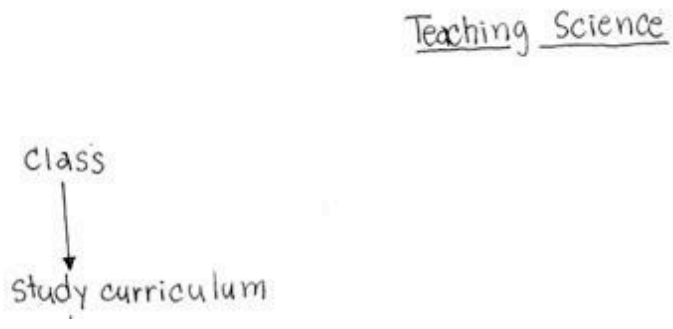

Figure 4. 2. Somchai's second concept map

The third concept map (Figure 4.3) characterizes Somchai's view on teaching science in a different way. He would study the objectives of the curriculum before preparing the lesson. He stated that he would study the content thoroughly prior to teaching. Somchai used worksheets as an evaluation tool. If students did not understand he would seek a new teaching technique for planning the lesson again. He noted that students' understanding was very important and it depended on the way he taught and how he helped them understand. He also suggested that the important concepts in the last concept map were the understanding of the curriculum and the experiment.

In this concept map, Somchai was concerned about his teaching method and how to use it, which differed from his previous concept map that focused on lesson plans. This change was induced by his practicum experience. He stated:

> … lesson plan is also important … but sometimes when we are in the real situation, we cannot follow our plan; so, I think teaching method is more important … we can adjust it to the situation which is either in the framework of the lesson plan or outside it … (Int. 3, Feb 2008).

Now he viewed the process of teaching science as a cycle. The cross-link between 'find new technique to explain' and 'lesson plan' indicates that he valued students' understanding as a priority, and if students could not understand he would make a new lesson plan and find a new teaching technique.

The third concept map demonstrates Somchai's content knowledge, general pedagogical knowledge, curriculum knowledge, and knowledge of learners and their characteristics.

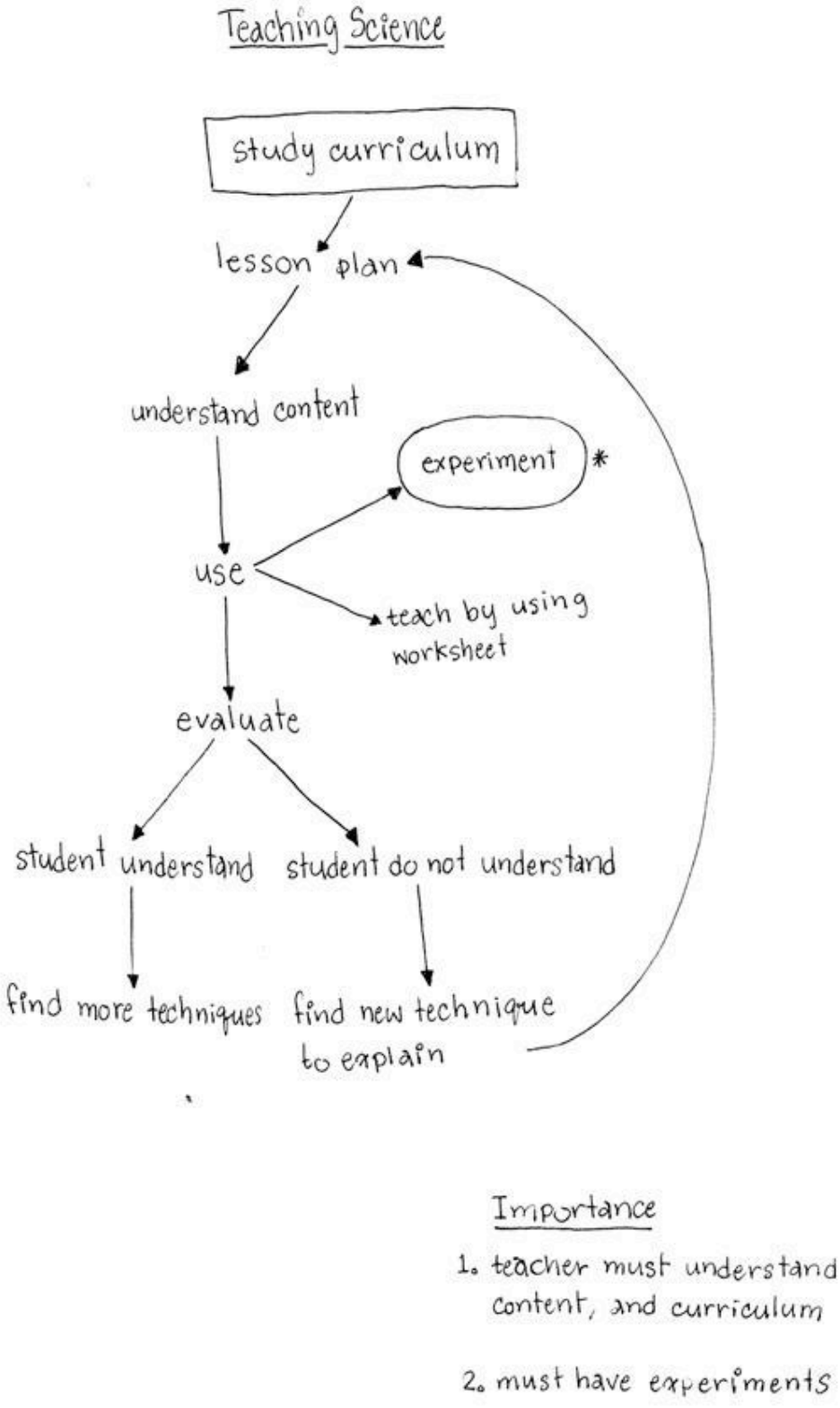

Figure 4.3. Somchai's third concept map

Summary of the Case

Somchai's initial understanding of his teaching was predominantly influenced by his content knowledge with little understanding of forms of teacher knowledge other than what he has developed from his own experience in school and as a learner at university. Toward the end of his practicum, he had an understanding of content knowledge, general pedagogical knowledge, curriculum knowledge, and knowledge of learners and their characteristics. There was no evidence relating to pedagogical content knowledge, knowledge of educational contexts, and knowledge of educational ends, purposes and values and their philosophical and historical grounds.

There was a minor change in Somchai's content knowledge. Content was the sole focus of the first concept map but in his second one it was only one point of the whole presentation. This change was influenced by the university course, his observations and teaching experiences. Somchai developed a major change in his general pedagogical knowledge. His view about teaching shifted from thinking like a student to thinking like a teacher. His experiences from school observations and practicum had an impact on his development of general pedagogical knowledge. There was a major change in Somchai's curriculum knowledge. He realized that it was necessary to understand curriculum as a first step of the teaching process. His view about teaching was changed by his teaching experiences. There was also a major change in his knowledge of learners and their characteristics. Somchai changed his attitude about learners form thinking like a student to thinking like a teacher. This major development was influenced by his prior knowledge as a student, and teaching experiences both from school observations and the practicum.

There were changes in Somchai's concept of science teaching, as reflected in his concept maps. One of the most significant changes was shown in the development between Somchai's first and second concept maps. In the first concept map he concentrated on content knowledge, while in the second he was mainly concerned with lesson plans. The teaching experience convinced him to change his ideas of teaching which he gave his priority to students' understanding.

Chapter Five

The Case of Natee

Overview

This case study investigates the research question in regard to Natee's teacher knowledge as it developed during his teacher education course and the influences on this development. It is presented in four sections. The first section shows Natee's initial view on teaching. The second section represents his data on the forms of his teacher knowledge as it developed at different times during the study. As with each of the case studies, the theory applied to analyze Natee's teacher knowledge is Shulman's (1987) framework of seven types of teacher knowledge. The third section explores the changes in Natee's view of teaching toward the end of the study. The final section summarizes what type of teacher knowledge Natee possessed and examines the influences on why it changed during his teacher education course.

Natee's Views on Teaching at the Beginning of the Study

Natee was a 22-year-old student teacher with a science major. He was a fourth year student of the Rajabhat University. He came from a middle class family in a rural area. There were five members in his family: his parents, an older sister, a younger brother, and himself. His sister also graduated from same Rajabhat University. His younger brother was a Matthayom 4 (Grade 10) student. Natee completed Matthayom 6 (Grade 12) at a secondary school in his district in a north-eastern province. Natee believed that science had an impact on everyone's life, and therefore people should learn about science. This was his reason for being interested in becoming a science teacher. He wanted to teach scientific knowledge to children, especially in remote communities, and he wanted to be a science teacher in his community. His main interest was teaching science to primary students. Natee wanted his students to use the knowledge he taught to improve their livelihood and their community when they grew up. He believed that science is involved in everything around us and that we could make better use of it if we have the relevant knowledge.

Natee thought that the education subjects he learned at the university would benefit him when he started his teaching career. He claimed that he learned at university how to organize classroom activities, to make lesson plans and to know how to evaluate

learners' abilities. In addition, when Natee was asked to give an explanation of what were the influences on his pedagogy in a form of pie-chart, he suggested that approximately 2/6 of his teaching style came from his lesson observations, a half from university courses, and 1/6 from self-study.

Natee thought that his main strength as a teacher was his understanding of students. He also noted that he personally liked to play with children. While he played with the children he would observe their behaviours and consider which teaching technique was suitable for them. "I like to play with children. When I play with them I usually make an observation which teaching method they will like. By letting children play games, I'll know their learning styles" (Int. 1, Aug 2007) he added.

When asked in what area he would like to improve, Natee said that he wanted to improve his subject matter knowledge. He also wanted to catch up with new technologies because it would be helpful to his teaching in a changing world. Thus he identified subject content knowledge and (technological) pedagogical content knowledge as needing improvement, but drew on knowledge of learners and their characteristics as his main strength.

Natee's Views on Pedagogy as Represented by the First Concept Map

Natee drew the first concept map in August 2007, as shown in Figure 5.1, when he began his classroom observations. At the beginning of the interview and he was asked to represent his views about how he taught science. Natee's concept map has three main organizational concepts related to 'teaching science': 'content', 'lesson plan' and 'teaching technique'. His first concept map is arranged hierarchically with one cross-link between 'learning proficiency' and 'teaching technique'.

In the interview in August 2007 after he drew this concept map, Natee explained that the first organizing concept, 'content' meant prepared factual knowledge appropriate to teaching, i.e. content knowledge. In this step he considered what class he would teach, what objective, and the community's needs. Interestingly, he suggested that he would do research on a community before teaching. He wanted to know what the community wanted their children to know so he would apply this to his lesson. Natee said, "A farming community may want knowledge about agricultural technology; if I

can apply this to my lesson, it'll be useful" (Int 1, Aug 2007). This opinion could be related to Shulman's knowledge of educational contexts.

The second organizing concept was 'lesson plan'. Natee suggested that the preparation of lesson plans consisted of an examination of learning proficiency and arrangement of the lesson sequence from easy to difficult topics. The important aspect here is the sequence in the lesson. Moreover, he would add the community's needs in his lesson. This indicates some appreciation of knowledge of educational contexts.

When Natee knew his students' learning abilities, he would adopt a teaching technique that was suitable for those learners. He would follow textbooks assigned from the Ministry of Education and use those teaching materials. According to Natee, teaching materials came from technology, such as computers, visual materials (DVD, video), and Nature.

Natee gave priority to teaching 'content'. He pointed out that he had to carefully choose the content that fitted the students' levels because children at different ages had different capacities to receive knowledge. Natee wanted his students to use the knowledge he taught in their daily lives and as fundamental knowledge for when they continued their study. It appeared that he saw learning as receiving knowledge rather than as students constructing their knowledge, that is, an objectivist rather than constructivist view of knowledge, and a transmission rather than constructivist view of teaching. Natee's first concept map revealed that his views of science teaching were centred on knowledge of learners and their characteristics, and content knowledge, and included knowledge of educational contexts.

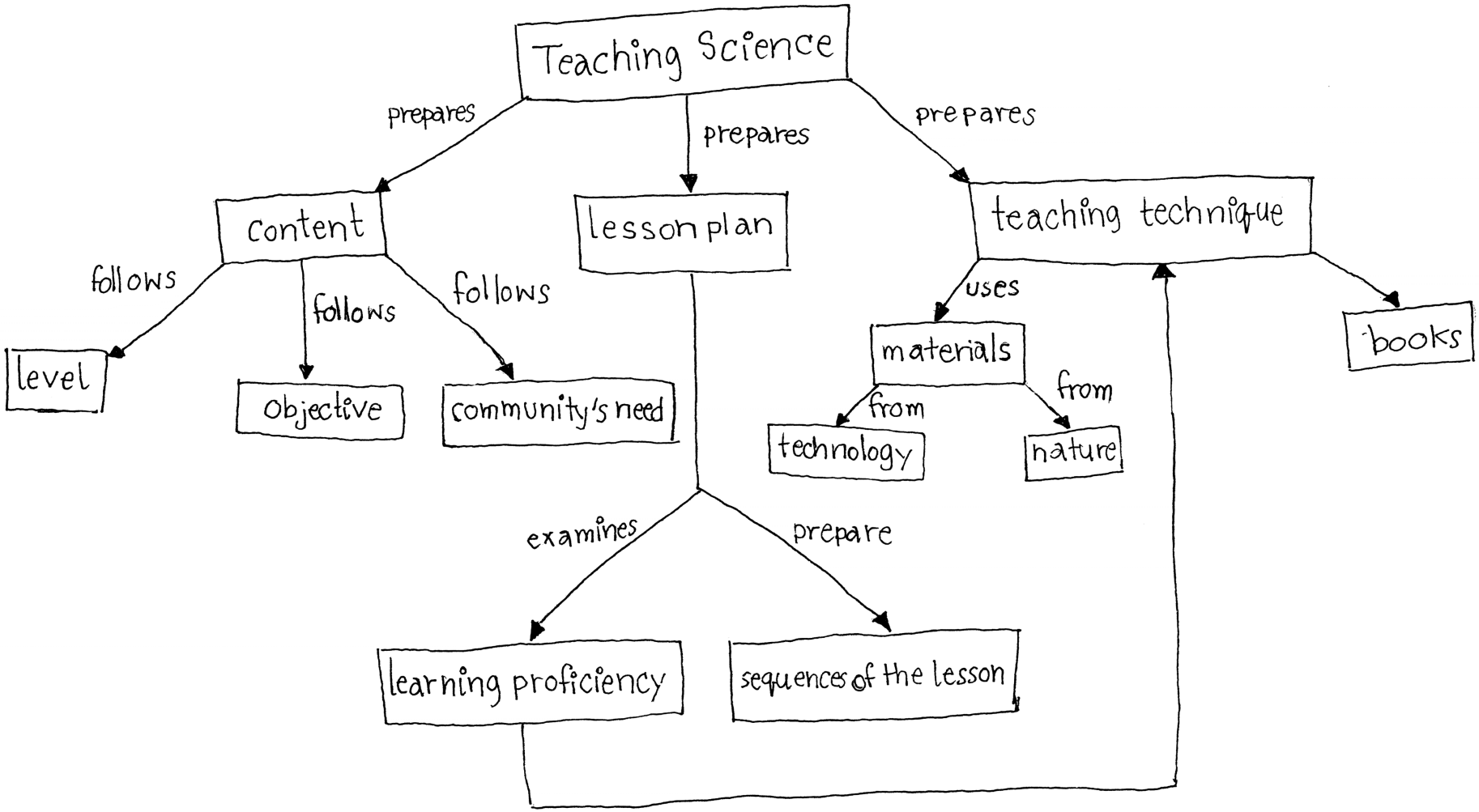

Figure 5.1 Natee's first concept map

Analysis According to Categories of Teacher Knowledge

During the seven months of the study, Natee was interviewed three times. This occurred during his classroom observations in August 2007, after his classroom observations in November 2007, and after his practicum in February 2008. During his practicum, Natee's lessons were observed in order to analyze his teacher knowledge again using Shulman's (1987) theory of teacher knowledge as the framework. By comparing Natee's beliefs over time, the case study proposes claims about change in his teacher knowledge during the teacher education program and any influences on this change.

(a) Natee's content knowledge

In Natee's first interview, during his classroom observations, he was asked to comment whether the science subjects in the university were useful to him. Natee thought that the university's science subjects would be beneficial to him when he taught science because he could use what he had learned from the university for teaching. In the second interview, Natee's views about the benefits of university science subjects were repeated. He considered that the science subjects in the university were important resources for teaching. He reasoned that in order to teach science he needed the knowledge from different science subjects: "I need knowledge I've learned from the University to teach" (Int. 2, Nov. 2007).

In his last interview, after he finished his practicum, Natee still believed that the science subjects in the university served a useful source for his teaching, however this time he recognized the connection between content and curriculum. He noted that he studied the curriculum before teaching to understand what content was necessary for students. Then he could apply this knowledge to suit students' levels and needs.

He was asked the same question on three occasions about the importance of science knowledge taught in university subjects. His responses are shown in Table 5.1 indicating he recognized the connection between content and curriculum because his mentor.

Table 5.1 Data Related to Natee's Content Knowledge

August 2007	November 2007	February 2008
It's very useful. I can teach what I've learned from the university to my students, so, they can use this knowledge in their daily lives	Sciences taught in the university can be divided into biology, chemistry and physics. I can use these for teaching. For example, Biology is about plants and animals. Students will learn about living things or I might teach about plant conservation or let students do science projects about animals. This will make students concerned about nature. Or teach students about chemicals in daily life, which one is dangerous and how to avoid it or which one is useful and how to use it properly. I need knowledge I've learned from the University to teach	I can apply knowledge about science activities, experiments, and theory to teach students. When I study curriculum, I'll understand what content and how deep that is suitable for students in each level. So, I can transfer the knowledge that suits students' needs.

In summary, there was a major change in Natee's content knowledge. This knowledge was developed through the university courses. He maintained his belief that university science subjects were helpful for teaching. According to Natee, the knowledge and experiences he gained from the university served as a useful teaching resource which he could apply to suit his students' needs. However, after practicum, he found the connection between content and curriculum knowledge. In addition, he wanted to improve his content knowledge and keep it up to date: "I want to be up to date because new scientific knowledge happens every day. If I don't keep finding knowledge, I'll fall behind. It's like I'm in the box and don't know what happens in the outside world" (Int. 3, Feb 2008). It appeared that his content knowledge was influenced by university science subjects, teaching experience, and his mentor.

(b) Natee's general pedagogical knowledge

Natee did the first interview in August 2007 during his classroom observation in a small municipal school in a northeastern province with his classmates. He was asked to explain how he planned his lesson. Natee answered that he would study the content first, then study his students, make a lesson plan, and select the teaching method and teaching materials. It appeared that his main concern was his students. Natee would choose a teaching methodology that matched the students. He mentioned that each student was different, and therefore he had to find which teaching technique suited them best, "I'll think about the appropriate teaching technique because each student prefers different teaching styles. I have to find a teaching technique that covers students' needs as much possible" (Int. 1, Aug 2007).

Moreover, Natee considered his students' backgrounds. He did his classroom observation in the municipal school located in an agricultural community; most of the students came from farming families. Therefore, he chose the topic 'plant as a pesticide' as his example lesson because the students could use this knowledge in their working lives even if they did not continue their education. Furthermore, Natee would design lessons plans that used local materials because the school might not have enough teaching materials and facilities. This concern might have resulted from the school where he did his observation being small and having limited facilities.

The second interview took place in November 2007 after Natee finished his classroom observation. In the interviews, Natee said he wanted to teach the students in a way that would help them develop their scientific literacy and good attitudes toward science. He was worried that his students could not cope with new knowledge and might fall behind their classmates when they continued their secondary education in the city. His students did not have a chance to study, and especially could not do experiments in fully-equipped laboratories like students in big schools in the city. Thus, he tried to make his students familiar with fundamental scientific knowledge before they went to high school. Natee noted:

> If I give them fundamental knowledge about science and let them know how to study at a higher level, they can then apply this knowledge in their secondary education. Thus, they won't think science is difficult and boring. (Int 2, Nov. 2007)

Natee discussed the practicum in the third interview, which took place after he finished his practicum in February 2008. He did his practicum in a large school in the city. Natee was aware of the curriculum in determining his pedagogy. He studied the curriculum and objectives before planning the lesson, and then he would select the content and teaching materials. It was clear that his idea about teaching preparation was changing. Natee now used the curriculum as a framework for his teaching. He pointed out that "students will receive knowledge and experience according to what the curriculum expects" (Int. 3, Feb 2008).

Natee was asked the same question, on three occasions about how he planned to teach his science lessons. His responses are shown in Table 5.2 which indicates his view about teaching changed as teaching experiences grew over time.

Table 5.2 Data Related to Natee's General Pedagogical Knowledge

August 2007	November 2007	February 2008
Q: Suppose you have to teach science. How will you teach it? Natee: First, I'll study content then study learners, examine their learning ability, what parts they are good at. Some students like demonstrations, some like hands-on experiments, some like discussions, and others might like to study outside the classroom or do fieldwork. After that I'll make a lesson plan and list topics I want to teach. And I'll think about the appropriate teaching technique because each student prefers different teaching styles. I have to find a teaching technique	Q: Can you give me an example of teaching a science lesson? Natee: A science project about a local medicinal plant … it might be an investigatory project … I'll let students explore their community to search for a plant that is both vegetable and medicinal. So, they can use this plant as a first aid when they feel sick and can advise other people in their community. Q: What class will you teach this lesson to? Natee: Prathom 6 (Grade 6). This will provide the basic knowledge of scientific method to students when they	Q: How do you plan your lesson? Natee: First, I'll study curriculum and content of the class I'll teach. I'll also study an objective, what subject matter that students need to know and what is to be the study outcome. Then I'll choose content and teaching material for preparing a lesson. Q: Why do you plan the way you do? Natee: If I understand what the subject matter in each class is … the students will receive knowledge and experience according to what the curriculum expects. This also benefits me … it makes me always want to study something

that covers students' needs as much possible. Then I'll design a teaching method … I might use teaching materials. Teaching materials can be anything … commercially made, made by me or from natural materials … they can be made by students. Q: Can you give me an example of teaching a science lesson? Natee: Use 'plants as a pesticide' because students live in an agricultural community where they usually have problem with insects. I'll let students do science projects. Q: Why do you plan the way you do? Natee: School may not have high technology facilities … but it would be good if I can apply another thing such as the teaching materials and save money. Plus students can use this in their everyday lives because they might not have a chance to continue their study. If they have this knowledge, they can make use of materials in their local area and help their community to be improved. *Confirmed by the first concept map (Figure 5.1)*	continue their secondary study. Q: Why do you plan the way you do? Natee: I want my students to have basic scientific knowledge … some students may not be good at study. When they study in high school, they cannot follow. If I give them fundamental knowledge about science and let them know how to study at a higher level … they can apply this knowledge in their secondary education. Thus, they won't think science is difficult and boring. *Confirmed by the second concept map (Figure 5.2))*	new. If we know the objective and know what content students need to know, it's easy to find content and teaching material. I can also apply the lesson or find teaching materials beyond textbooks and give my students real experience that they can use in their daily lives. *Confirmed by the third concept map (Figure 5.3)*

In summary, Natee developed a major change in his general pedagogical knowledge because this knowledge changed as he gained his teaching experience. At the time of

the first interview, Natee would study the content, students' background and school environment before determining the teaching methodology and materials. The experience from his observations seemed to have had an influence on how he planned the lesson. In the second interview, after he finished his classroom observation, Natee still thought about the students before he prepared his lesson. However, this time the emphasis of his consideration had changed from students' backgrounds to scientific literacy, attitudes and fundamental knowledge. Natee wanted his students to have good fundamental science knowledge before they continued their secondary education. This change, again, was influenced by his observations in the small school in a suburban area that did not have as comprehensive facilities as schools in the city. Then, in Natee's practicum, he realized the importance of the curriculum. He would study the curriculum and its objectives thoroughly before making his lesson plan. He commented, "If we know the objective and know what content students need to know, it's easy to find content and teaching material" (Int 3, Feb 2008). In addition, Natee stated that his mentor suggested that he study the curriculum first, that is, his pedagogy was influenced by his mentor and his teaching experiences from the practicum. Natee changed the priority of his thinking about teaching from content to considering curriculum and content. This was influenced by the practicum and his mentor.

(c) Natee's curriculum knowledge

It should be noted that in the two interviews conducted in August and November 2007, Natee did not mention anything about curriculum knowledge.

In Natee's third interview in February 2008, he stated that he would study the curriculum before preparing the lesson. He felt he must understand the curriculum and its objectives clearly in order to organize his lesson. Natee pointed out that if he knew what the curriculum required from students, he could easily select the teaching technique and materials that matched the curriculum. Moreover Natee noted that his mentor advised him to study the curriculum thoroughly before planning lessons. Table 5.3 shows that his curriculum knowledge occurred during his practicum.

Table 5.3 Data Related to Natee's Curriculum Knowledge

August 2007	November 2007	February 2008
No discussion about curriculum knowledge interviews.	No discussion about curriculum knowledge in interviews.	Q: How do you plan your lesson? Natee: First, I'll study curriculum and content of the class I'll teach. I also study an objective, the subject matter that students need to know and what is the study outcome. My mentor advised me to study curriculum. She has handbooks about curriculum and how to organize science content for each key stage. If we know the objective and know what content students need to know, it's easy to find content and teaching material. I can also apply the lesson or find teaching materials beyond textbooks and give my students real experience that they can use in their daily life. *Confirmed by the third concept map (Figure 5.3)*

In summary, there was a major change in Natee's curriculum knowledge. After he finished his practicum, he realized the importance of curriculum knowledge which was no evident previously. He used the curriculum as the guideline for planning lessons. He reasoned that if he clearly understood the curriculum, objectives and expected outcomes, he could find teaching methods and materials that matched curriculum and maximized students' learning outcomes. The major influence on this change was his mentor who suggested to him to study the curriculum prior to

planning any lesson, and this made him realize the importance of curriculum for the first time.

(d) Natee's pedagogical content knowledge (PCK)

There was no evidence that relates to Natee's pedagogical content knowledge.

(e) Natee's knowledge of learners and their characteristics

Natee was asked to give his opinion on three occasions about what makes science difficult for students. He pointed out that teachers usually taught only the theoretical part and students just remembered what was written on the blackboard without having a chance to experience real examples or do experiments. Therefore students did not have any understanding about what they had learned, they just remembered what the teacher told them. This made students feel science was difficult and boring. Natee suggested that teachers should give students more chances to do experiments and observe. These would make students gain more understanding of science concepts and build a scientific mindset.

Natee stated that he liked children and loved to play with them. He believed that he understood children. He said, "I understand children, sometimes they may be naughty or behave mischievously but it's normal, children are children" (Int. 2, Nov. 2007). Natee claimed that he observed children's behaviour and tried to find teaching methods that suited their learning styles. However, in the last interview in February 2008, Natee also noted that his mentor gave him advice about how to gain students' attention and thus, control of the class: "My mentor told me it's normal if children are disobedient. She gave me advice about how to persuade and control students" (Int 3, Feb 2008), he added. Even though Natee showed his confidence in his knowledge of learners, he had a problem with classroom management. It appeared that he could not engage his students in the lessons. See Table 5.4 which indicating his belief about learners and their characteristics.

Table 5.4 Data Related to Natee's Knowledge of Learners and their Characteristics

August 2007	November 2007	February 2008
Q: What makes science difficult for children? Natee: Students don't understand scientific concepts because some teachers only write down everything on a blackboard so their students only read what's written on the blackboard. Students don't have a chance to practise and this makes them not understand scientific processes. They cannot explain what they've learned and don't have any idea about science. Q: What could make the study of science easier for students? Natee: Let students practice. Teachers must give their students a direct experience. Let students learn from practice. If they practise, they'll clearly understand the process. Q: What do you believe are your main strengths as a teacher? Natee: I think I understand children. I like to play with children and observe them. While playing with children, I'll observe their behaviors and think about the teaching style that suits	Q: What makes science difficult for children? Natee: Teachers usually teach only theory and students don't have opportunities to see the real process so they cannot understand what the teacher explains. But if we let students practise with real samples, for example in the topic 'plants', teachers should let students observe plants. This will make students understand better than only reading what teachers write on the blackboard. If teachers teach only theory, students cannot imagine the real picture, so they'll think science is difficult and become bored. But if they have a chance to see the real example or practise, they'll understand better and have the motivation to study science. Q: What do you believe are your main strengths as a teacher? Natee: I understand children. Sometimes they may be naughty or behave mischievously but it's normal; children are children. I'll observe their behaviors and find the most suitable teaching method for them.	Q: What makes science difficult for children? Natee: Students don't understand the content because teachers only explain without showing any example to students or letting them practise. Such teachers don't help students to have good attitudes toward sciences. If students don't understand, they'll think sciences are difficult and boring. Q: What could make the study of science easier for students? Natee: Use teaching materials such as Video CD or computer programs about the topic. Because motion pictures or cartoons make students interested in more than pictures. Q: What do you believe are your main strengths as a teacher? Natee: I used to be a kid so I understand children. I know which teaching style they prefer. I'll choose the teaching technique that makes my students understand scientific principles and can use them in their daily lives. I want my students to understand that sciences aren't as difficult as they

them most.		think. My mentor told me it's normal if children are disobedient. She gave me advice about how to persuade and control students. She suggested to me to use games to make students interested in the lesson or let students relax before starting the lesson. It's necessary to make students interested in the topic. If students don't concentrate on the lesson, it's very difficult to control them. *Confirmed by the third concept map (Figure 5.3)* *Disconfirmed by classroom observations of Natee's lessons*

In summary, there was only minor change in Natee's knowledge of learners and their characteristics. It seemed that his confidence in his understanding of children had an impact on his knowledge of learners and their characteristics. He claimed that students' science learning difficulties resulted from students not having the opportunity to do experiments and experience real examples. Because teachers gave priority to the theoretical part rather than the practical part, students did not understand the science concepts. In addition, Natee believed that he understood children and he felt confident of his ability to find a teaching method that was appropriated for his students. He said "I used to be a kid so I understand children. I know which teaching style they prefer" (Int 3, Feb 2008), and "I want my students to understand that sciences aren't as difficult as they think" (Int 3, Feb 2008). However, his classroom practices indicated his problem with classroom management.

(f) Natee's knowledge of educational contexts

Natee showed his knowledge of educational contexts in his first concept map (Fig 5.1), however, this knowledge was missing in his following two concept maps. Table 5.5 shows his knowledge of educational contexts in his fist concept map then disappeared in his following concept maps.

Table 5.5 Data Related to Natee's knowledge of educational contexts.

August 2007	November 2007	February 2008
Natee show his concern related to educational context. *Confirmed by the first concept map (Fig 5.1)*	No discussion about knowledge of educational contexts in interviews.	No discussion about knowledge of educational contexts in interviews.

(g) Natee's knowledge of educational ends, purposes and values and their philosophical and historical grounds.

There is no evidence that relates to Natee's knowledge of educational ends, purposes and values and their philosophical and historical grounds.

Classroom Observations of Natee's Lessons

Natee did his practicum at a large-sized school in the northeastern province. The classes there ranged from Kindergarten through Matthayom 3 (Grade 9). Natee taught science for Prathom 5 (Grade 5). The class period lasted approximately 60 minutes.

Natee's science class was in a science room on the ground floor of the building. A whiteboard was placed on the front wall. Television sets were on both ends of the front wall. There were two doorways, several windows, and two ceiling fans in this room. The teacher's desk was at the front, next to the laboratory bench. The students' desks were arranged in three groups lined up from the front to the back of room. The room was very crowded, and therefore it was quite difficult for the teacher to move around. Two bulletin boards in the front of the room were decorated with seasonal

items. There were three cabinets and two sinks near the left wall beside the windows and three laboratory equipment cabinets at the back. Two bookcases were placed near each doorway. An electrical circuit model was hung on the right wall. There were several science posters hanging on the walls around the room.

The researcher observed Natee's science classes for three lessons on 'Sound' (see Appendix 4D for sample of Natee's lesson plan). Natee taught this subject four times a week, on Tuesdays and Wednesdays. Although the lessons were timetabled for about one hour, students had to move from their previous class to this science room. Therefore, the students took about ten minutes at the beginning of the lesson to enter the room, take their seats, and prepare themselves.

Natee usually went to the classroom early in order to prepare the lesson and teaching materials such as textbooks, pictures, handouts, and worksheets. He then waited for students to arrive from another classroom. When all the students were present, a student who was the head of the class led the students to greet the teacher. After Natee had the students' attention, he told the students what they were going to study. He often reviewed previously-covered topics.

After the review, Natee would present a new topic for the day. This time he talked about 'loud noise'. He asked the students questions relevant to the topic, for example, 'Give a source of loud noise' and 'How do you feel when you hear a loud noise for a long time'. Then he explained the concept 'loud noise' and showed the students pictures related to noise pollution. After that, Natee gave handouts and worksheets to all students and told them to read the article in the handout about the danger of loud noise. He rarely moved around the room due to the limited space. Most of the students did not pay attention to the lesson; they talked to each other or did other activities. Natee tried to draw their attention but did not succeed. The students talked and acted toward Natee in a casual manner. It appeared that they did not respect him as a teacher. However, when the students were too noisy, the class teacher who was also his mentor would come and tell them to be quiet; the students would stop talking and listen to his teaching for a while, then become noisy again. When all the students finished reading, Natee asked questions about the article and made a conclusion.

Near the end of the class, Natee assigned the students to answer questions from the worksheet as homework. During the class time, the students could leave or enter the class with the permission of the teacher. At the end of the class, when Natee allowed the students to leave the class, the head of the students led the class to salute the teacher, and all the students said, "Thank you."

Natee's lesson was teacher-centred, rather than student-centred. He sometimes told the students he would deduct marks when they did not listen to him. Natee's mentor observed every lesson he taught. She sat outside the classroom and monitored through the door from the beginning until the end of the class. The mentor commented that Natee had problems with classroom management, in that he could not control the students. She also gave Natee suggestions about his lesson plans.

Natee worked very closely with his mentor. He mentioned that his mentor advised him about how to gain students' attention, manage the classroom and establish discipline. She told him that he did not know how to control the students and make them concentrate on the lesson. For his pedagogy, his mentor suggested that he thoroughly study the curriculum and content of each key stage before teaching. If he understood the objectives, he would easily find content and teaching materials that matched the objectives. Moreover, he could modify his lesson to suit his students' needs. Natee said:

> If we know the objective and know what content students need to know, it's easy to find content and teaching material. I can also apply the lesson or find teaching materials beyond textbooks and give my students real experience that they can use in their daily lives. (Int. 3, Feb 2007)

As observed in his lessons, Natee exhibited content knowledge, general pedagogical knowledge, curriculum knowledge and knowledge of learners and their characteristics. Natee's mentor influenced his content knowledge and curriculum knowledge. As mentioned above, his mentor told him to study the curriculum and content before planning the lesson. She showed him the curriculum guide, course description and textbooks for him to study. She also checked his lesson plans and gave him advice before teaching. According to Natee, his mentor always observed him during his teaching and she would give him advice when he had a problem. Natee's general

pedagogical knowledge was evident in his instructional method which was mostly teacher-centred. Despite Natee's mentor guiding him on how to gain students' attention and control the class, he could not manage the class effectively. Even though Natee was very close to his students, he could not control them in the classroom.

Natee's Views of Teaching toward the End of the Study

In the second interview, in August 2007, Natee used a pie chart to indicate an equal priority to experience from his university subjects and his classroom observations as influences on his instructional method. Within his university courses, Natee further subdivided that half into roughly 2/5 for the direct impact of his lecturers and 3/5 from his self-study. He stated that:

> The lecturers teach us only basic knowledge then they will assign us to do our own research; it's like self-study. I can use this teaching method with my students. (Int 2, Nov. 2007)

For Natee, lesson observations gave him a chance to gain knowledge of how the students learned, to use in his pedagogy. Natee pointed out that:

> In lesson observations, I tried to understand students' learning styles. I can apply this experience in my teaching method or use it to consider to which part of the content I should add something else that suits my students. (Int 2, Nov. 2007)

In addition, Natee noted that experiences from his travelling and everyday life were important. He would relate his experiences to his students, from which they would gain a broader view beyond their lessons in the classroom.

In Natee's third interview, in February 2008, the weightings of factors that influenced his teaching model changed. He gave more weight to his experience from the practicum (about 60%) than from university subjects. Natee reasoned that in the university, lecturers would teach while following the lesson plan strictly. However, sometimes when teaching young students, they could not cope with all the information he planned to teach, so he had to adjust the content to suit his students' abilities. He sometimes taught other content in his science lesson to help students

learn as much as they could. Moreover, he had to find learning activities that raised the students' interests in studying science because he wanted his students to have a positive attitude toward science. Another factor that affected his teaching was classroom environment. Natee had direct experience with this difficulty at his practicum site. His classroom was very small for the number of students. He commented that a small classroom made students feel uncomfortable and they could not concentrate on the lesson.

The practicum made Natee realize that each student had different characteristics and behaviour. He would use this awareness to make the teaching-learning process more effective. Also he had an opportunity to learn about the teacher's duty both in teaching and in. Natee recognized that being a good teacher required many things more than just content knowledge. He said:

> In order to be a teacher, I must devote my time to teaching. I'll pay attention to my students … listen to their problems and questions. I'll do my best in teaching. (Int. 3, Feb 2008)

Natee pointed out that most problems he had during his practicum were problems with the students, for example the students not paying attention to the lesson, talking to other students, doing other activities, not doing homework and assignments, or skipping class. However, he noted that these problems only happened with some students, whereas most of his students paid attention to his lesson, which was in contrast with what the researcher saw in observed lessons. The other problems were teacher problems. Natee commented that some teachers gave higher priority to other activities than to their teaching. Thus, they could not teach effectively. This meant their students learned less than they should.

Natee's Belief about Pedagogy as Represented by Concept Maps

Natee drew a second concept map to explain his concepts about science teaching after he finished classroom observations; see Figure 5.2. This second concept map contains three main organizational concepts, 'lesson plan', 'content', and 'teaching method'. There are two cross-links between the concept 'design teaching method' and 'teaching method' and 'lecture', 'teaching materials', and 'books' and 'project' and 'laboratory'.

In his second interview in November 2007, Natee explained the second concept map. The first organizational concept is 'lesson plan'; Natee stated that he would prepare his lesson following the content. His lesson plan represented the steps of his teaching method. It showed how he introduced the lesson to students, the learning activities, and evaluation. He would use the lesson plan as his guide in each period. The second concept is 'content'. Natee explained that he would teach by following the objective of the key stage. Then he would study the content and try to understand it clearly before he designed the teaching method.

For the third organizational concept, 'teaching method', Natee would study students' learning styles first. He stated that some students liked to study individually while others liked group study. When he understood his students' learning style, he would select learning activities that comprised a theoretical part and a practical part. The theoretical part contained lecturing and using books and teaching materials. The practical part can be divided into 'project' and 'laboratory'. According to Natee's perception, experiments took place in a laboratory room and 'project' meant group work that students could do outside the classroom. However, students had to study the theoretical part and understand it thoroughly before they could do experiments and projects. Natee viewed 'content' as the most important concept. He reasoned that the content must suit students' ability levels; "we cannot teach high school subjects to primary students" (Int. 2, Nov. 2007) he said.

There are not many changes in Natee's second concept map compared with his first concept map, except the concept 'community's needs' disappears from the second concept map. He explained that if he did research on the community's needs, it might take too much time; moreover, he wanted his students to realize what was necessary for their communities by themselves. At this stage, it appeared that Natee's view of teaching has changed from an objectivist position, to his perception of the learning process as students needing to build their own knowledge, which means he possesses a constructivist view. Natee said:

> It may take time if I do research on the community's needs. But if I teach the students and let them study by themselves, they'll understand and explore what their families and community need. Then they'll know how they can use what they've learned to benefit their community effectively. (Int. 2, Nov 2007)

Natee showed knowledge of content, general pedagogical knowledge, curriculum knowledge, and knowledge of learners and their characteristics in this second concept map. The comment on community needs indicates an awareness of knowledge of educational contexts but its omission in the second concept map and his comments indicated that it was a low priority to him at this stage.

In February 2008 after the practicum, Natee was asked to draw the third concept map of his view of teaching science again. His third concept map is shown in Figure 5.3. It has three organizational concepts which are 'lesson plan', teaching method', and 'evaluation' with one cross-link between concept of 'sets learning activities and teaching model or method' and 'study students' learning styles'.

Natee explained this concept map later in his third interview in February 2008. The concept 'lesson plan' is the first step in Natee's science teaching process. He pointed out that this step is the preparation step. It included studying content and setting learning objectives. Then he would consider which learning activity and teaching method suited the content. After teaching, he would evaluate and make a conclusion to his lesson. If there was any problem related to his teaching, he would seek a solution in order to use it as a guideline for the next lesson plan and for improving his teaching technique.

Natee placed the concept 'teaching method' as the second step in his teaching process. This step comprised students' learning styles, teaching materials, books and activities. He pointed out that the teaching method needed to match students' learning styles. Once he found an appropriate instructional method, he would make a decision about teaching materials, books, or activities for his lesson. Natee noted that teaching materials could be either things around school or technology, for example multimedia. Activities included experiments, field trips and games.

The third step in this concept map is 'evaluation'. Natee stated that the assessment of student achievement was divided into two parts. The first part was evaluated during the students' gathering of data, for example by reading books, before doing activities.

The second part was evaluated after students finished their activities in order to assess whether they gained the knowledge set out in his objectives.

There was no significant change in Natee's third concept map. He mainly altered the place and order of concepts. However, he added the concept 'evaluation' as a last step of his teaching process. He commented that it was necessary to make the evaluation after teaching in order to know whether students gained knowledge as he planned or not. This change was influenced by his teaching experience on the practicum.

> When drawing the second concept map, I was still studying at the university. I didn't have any direct experience about teaching. But when I experienced the real teaching situation, it made me more understanding about the teaching process. I know how to make students understand and gain knowledge of what I want them to know. So, I know how to plan the lesson and which concept should be added or changed to another place. (Int. 3, Feb 2008)

Thus, Natee's third concept map demonstrates his knowledge of content, general pedagogical knowledge, curriculum knowledge, and knowledge of learners and their characteristics.

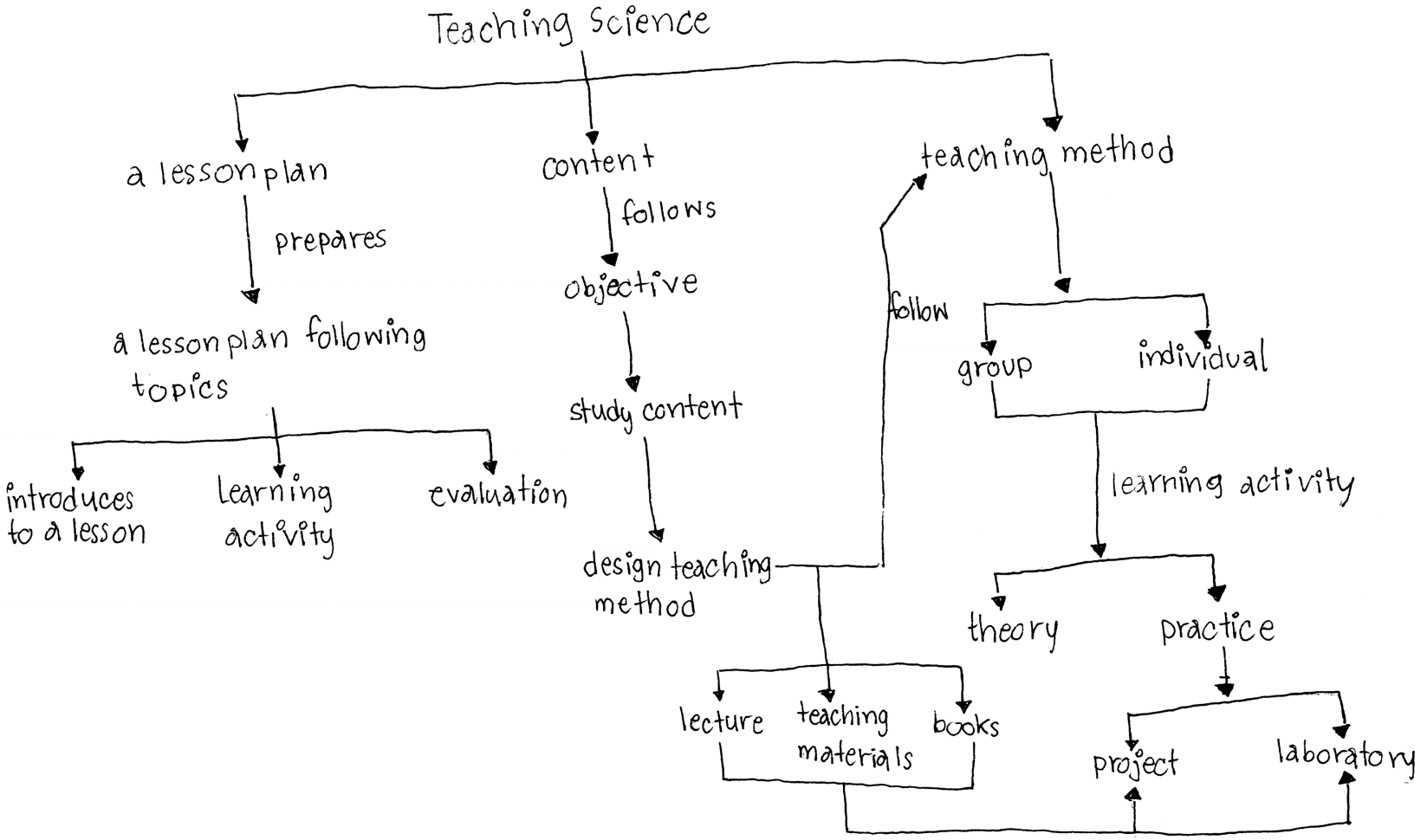

Figure 5.2 Natee's second concept map

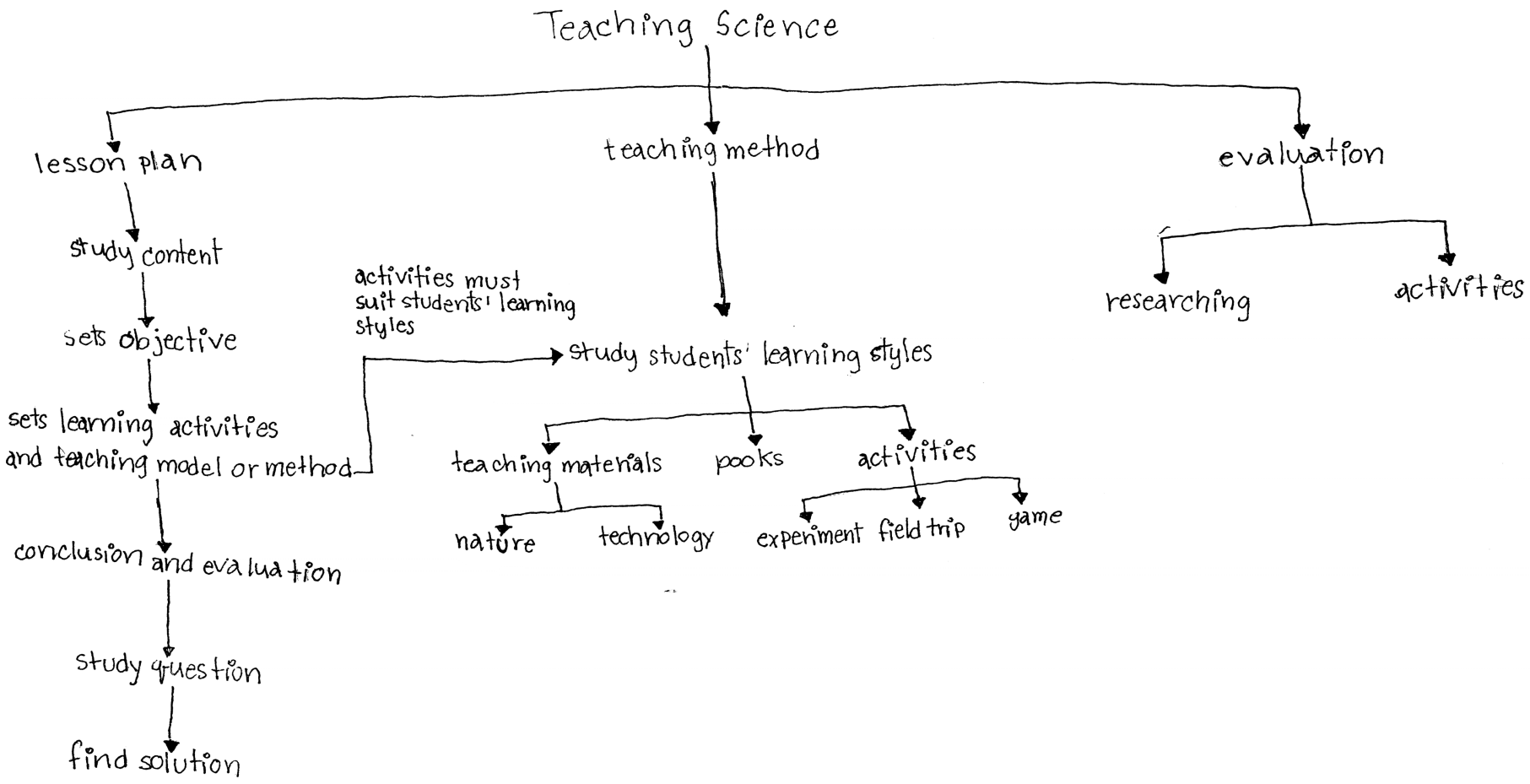

Figure 5.3 Natee's third concept map

Summary of the Case

Natee's understanding of his teaching at the beginning of the study was mainly influenced by his content knowledge and knowledge of learners and their characteristics. These influences were based on his experiences of the university courses and lesson observations. Toward the end of his practicum, Natee had an understanding of content knowledge, general pedagogical knowledge, curriculum knowledge, knowledge of learners and their characteristics, and knowledge of educational contexts. There was no evidence relating to pedagogical content knowledge, or knowledge of educational ends, purposes and values and their philosophical and historical grounds.

Natee developed a major change in his content knowledge. For Natee, knowledge he gained from university was an importance teaching resources. Then after practicum under his mentor's monitoring, he realized the connection between content and curriculum. His content knowledge was influenced by the university course, his teaching experiences, and mentor. There was a minor change in his knowledge of learners and their characteristics. He maintained a belief in his understanding of students and his ability to gained students' attention. However, his teaching practice showed his problem with classroom management. There was a major change in Natee's general pedagogical knowledge. His pedagogy became more systematic. This development was manly influenced by the teaching experiences and his mentor's advice. A major change in Natee's curriculum knowledge was his concern about the importance of curriculum which occurred during his practicum. This development was influenced by his mentor who suggested to him that he should study curriculum thoroughly before planning any lesson. His knowledge of learners was influenced by his own characteristics, that is, his love of playing with children and an empathy with children. Natee showed his concern about knowledge of educational contexts at the beginning of the study but then this concern was ignored indicated it was a low priority to him. There was no significant change in Natee's belief about science teaching as reflected in his concept maps. There was a change that indicated that his view of teaching had changed from an objectivist to a constructivist view, even though there was no evidence shown in his lesson observations.

Chapter Six

The Case of Manee

Overview

This case study investigates Manee's teacher knowledge as it developed during her teacher education course and the influences on this development. It is presented in four sections. The first section shows Manee's initial view on teaching. The second section represents her data on the forms of her teacher knowledge as it developed at different times during the study. As with each of the case studies, the theory applied to analyze Manee's teacher knowledge is Shulman's (1987) framework of seven types of teacher knowledge. The third section explores the changes in Manee's view of teaching toward the end of study. The final section summarizes what type of teacher knowledge Manee possessed and examines influences on why it changed during her teacher education course.

Manee's View on Teaching at the Beginning of Study

Manee was a 22-year-old student teacher majoring in science in her fourth year at the Rajabhat University. She came from a middle class family in Nong Bua Lamphu province. Both of her parents were teachers. Manee graduated from Matthayom 6 (Grade 12) at a high school in her district in Nong Bua Lamphu province. She also had passed the tests to enter education studies in another university in Udon province, but chose to study in this university because she could stay with relatives and save money. Manee stated that she had observed her parents as teachers since she was young and this inspired her to be a teacher like them. Moreover, she chose to study science education because she liked science and she thought this area of education might give her a chance to find a job more easily than others.

Manee believed that what she had learned from the education subjects at university would serve as a guide when she started her teaching career, on how to teach her students. When Manee was asked to give an explanation of the influences on her teaching model in a form of a pie chart, she thought that 3/5 of her pedagogy was influenced by university courses and another 2/5 by her observations in school. Manee said she felt more comfortable at university than in the school where she did her observations. She said, "I am relaxed when I am in the university with my friends,

and teachers that I am familiar with. If I have any problem, I can ask them" (Int 1, Aug, 2007). It seemed that Manee felt uneasy when she stayed with people she was not familiar with. She said that, in the observation school, she was teased by some students and she was embarrassed. "Students are very naughty. I don't have any courage to talk with them; actually I'm very shy. I don't know how to make students not make fun of me, how to get their attention" (Int 1, Aug 2007), she added.

Manee claimed that her strength as a teacher was her calmness even when under pressure. She believed that her calmness could help her control students. However, when asked what areas she would like to improve, Manee said she wanted to improve her confidence, so she could teach more comfortably: "I'm always shy when I'm in front of students, especially when they are teasing me. I want to have more confidence" (Int 1, Aug 2007).

Manee's Views on Teaching as Represented by the First Concept Map

In August 2007, when she began her classroom observations, Manee was asked to draw a concept map to explain her view about how she taught science. Manee's first concept map, as shown in Figure 6.1, contains three organizing concepts: 'content', 'teaching technique', and 'teaching methodology'. The concept map is constructed as three strands under these headings, with no cross-linking.

When Manee explained her thoughts in this concept map in an interview later, she pointed out that she divided teaching conceptually into three parts. The first part was 'content'. She first thought about what content she would teach, then she would study it thoroughly until she clearly understood every point before teaching this content to students. Manee said "I will study content until I understand it. Then I can use this to teach students" (Int 1, Aug 2007). The second was 'teaching technique'. She would find what made students interested in a lesson and what teaching technique they liked most. She would find the teaching techniques that suited students' characteristics and learning styles. "For example, do the students like storytelling or watching video tapes? Do they like watching a slide show? I will find what students are interested in and use this in my lesson" (Int 1, Aug 2007). The last part was 'teaching methodology'. This part included concepts of 'introduction to a lesson', 'draw attention', and 'using teaching material'. Manee would introduce the topic to students.

She would gain students' attention by using teaching materials that suited their learning styles. During the lesson she would make an assessment of whether her students liked her teaching method or not. She said "while I am teaching I'll observe students. Do they like the teaching materials and are they interested in my lesson" (Int 1, Aug 2007).

Manee believed that her teaching technique was the most important part of her teacher knowledge because this would make students pay attention to her lesson. "If I don't have any teaching technique, I don't know how to teach students. Teaching techniques make students interested in my lesson" (Int 1, Aug 2007), she reasoned. Manee's first concept map indicated that her initial views of teaching science were based on content knowledge, general pedagogical knowledge, and knowledge of learners and their characteristics.

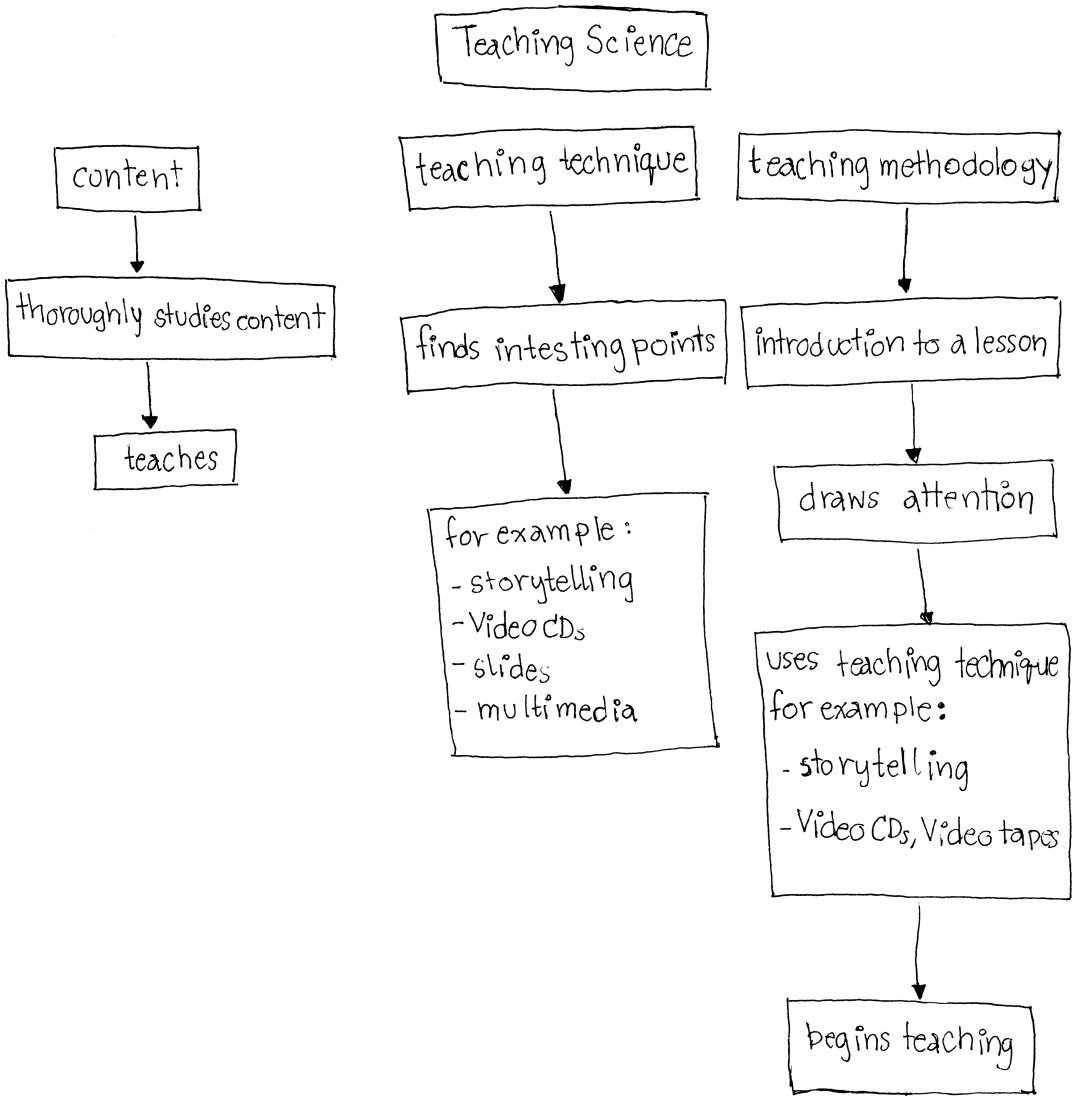

Figure 6.1 Manee's first concept map

Analysis According to Categories of Teacher Knowledge

During the seven-month study Manee was interviewed three times and observed three times, during classroom observations in August 2007, after classroom observations in December 2007, and after her practicum in February 2008. In addition, she sketched three concept maps. During her practicum, Manee's lessons were observed in order to analyze her teacher knowledge. By comparing her beliefs over time, claims about changes in her teacher knowledge and influences on this change during the teacher education program using Shulman's (1987) theory could be made.

(a) Manee's content knowledge

Manee was asked whether the science subjects at the university were beneficial to her when she started her teaching career. In the first interview in August 2007, Manee believed that her university science courses would benefit her a good deal. She pointed out that science subjects she learned from the university provided her with the fundamental knowledge for teaching. In addition, these subjects allowed her to go over the scientific knowledge that she had already forgotten after she graduated from high school. Manee's realization of the importance of content was shown in her first concept map (Figure 6.1). She placed 'content' as the first concept in her concept map, and she explained that she would study the content thoroughly before teaching. In the second interview, in December 2007, Manee's beliefs about the importance of content were reaffirmed. She considered that the university science subjects gave her necessary knowledge for teaching.

The third interview was conducted in February 2008 after Manee finished her practicum. She still thought that science subjects she studied at university equipped her with necessary scientific knowledge. With this knowledge, she felt confident in teaching. Manee said, "If I hadn't studied science, I wouldn't have the knowledge to teach students. If they had asked me a question, I could not have answered them" (Int 3, Feb 2008). Moreover, she studied content from textbooks and used it in her handouts and lessons.

Manee was asked the same question on three occasions about the importance of science knowledge presented in university subjects. Her responses are shown in the

Table 6.1 which suggests that she valued university science subjects as an important knowledge.

Table 6.1 Data Related to Manee's Content Knowledge

August 2007	December 2007	February 2008
It's helpful, because science subjects gave me fundamental knowledge. If I didn't have this knowledge, I could not teach because I had almost forgotten all I learned in high school. I had a chance to revive it in the university. *Confirmed by the first concept map (Figure 6.1)*	If I hadn't studied science, I'd have had no idea about the chemical or what the chemical formula meant.	It's very useful. If I hadn't studied science, I wouldn't have had the knowledge to teach students. If they'd asked me a question, I could not have answered them, or if they'd asked about a beaker or a dropper, I wouldn't have known what it was. I have gained this knowledge from science subjects. *Manee's content knowledge showed in her lesson*

In summary, there was a minor change in Manee's content knowledge. She developed her content knowledge because her university science subjects were beneficial to her. They provided her with the necessary knowledge for teaching and this made her feel confident to teach and answer students' questions.

(b) Manee's general pedagogical knowledge

Manee's first interview was conducted in August 2007 during her school observation. She did her classroom observations in a large school in the city of Mahasarakham province. Manee was asked to explain how she planned her lesson. According to Manee, the first step in her lesson preparation focused on students. She wanted to understand her students, in order to find a teaching method they liked most. "First, I have to know my students, what teaching method they like" (Int 1, Aug 2007), Manee noted. After the lesson, she would let the students do a post test in order to evaluate

either their learning outcomes or the effectiveness of her teaching method. Manee believed that this way of teaching was good for both the students and herself. The students would make good progress. Manee would understand her students and know if her teaching method was effective. She reasoned, "Students will have good improvement, and I will understand the students and know whether they understand what I've taught" (Int 1, Aug 2007). Manee used the topic 'materials' as an example lesson because the class she observed was being taught this topic by the time this interview took place. It seemed that she followed the teaching method that she had seen in her observation.

By the time the second interview was conducted in December 2007, Manee had finished her school observations and begun her practicum in a small municipal school. This time, she used the topic 'soils and rocks in our area' that she taught at the practicum site as her example lesson. She wanted her students to have a direct experience, so she chose a field trip as her teaching strategy. She let her students explore the environment around the school and taught them about rocks and soils they had found in their area. Manee pointed out that it was easier for students to understand the lesson because they had a chance to learn from real examples. However, in Manee's lesson, she generally used a teacher-centred approach, even in the practical part. For example, she herself did the experiment for her students and only let them observe the reaction; she took control of the class.

Manee gave her third interview in February 2008 after she finished her practicum. Manee's teaching began with gaining students' attention by asking them questions. She reasoned that this method would make students think. After she got their attention, she gave them activities to do. The next step was explanation and conclusion, and, again, she used questions to lead to a conclusion. In the exposition of knowledge step, she asked her students to study from handouts and gave explanation if needed. The last step was evaluation, to assess students' outcomes. Her belief about teaching was reflected in her third concept map (Figure 6.3). Manee appeared to give priority to gaining students' attention, emphasising that if she did not fully gain students' attention, they would not listen to her. She said "If I don't get students' attention, they'll not listen to me when I teach" (Int 3, Feb 2008). This concern may have resulted from not having confidence when she was in front of her students; she was

worried that students might not listen and tease her. Manee was asked the same question, on three occasions about how she planned to teach her science lessons. Her responses are shown in Table 6.2 indicated that she used a more comprehensive teaching method as she gained teaching experiences.

Table 6.2 Data Related to Manee's General Pedagogical knowledge

August 2007	December 2007	February 2008
Q: Suppose you have to teach science. How will you teach it? Manee: First, I will have to get to know my students, what teaching methods they like, such as if students like storytelling. I'll tell them a story to gain their attention. Then I'll think about the content, whether the students like it, how I can make it suit them. Q: Can you give me an example of teaching a science lesson? Manee: The topic is 'materials', because the teacher of the class I observe, teaches this topic. I'll use different types of teaching materials to teach students about materials we use in daily life, their importance. The topic will relate to a state of matter. I'll let students do a pre-test to evaluate their knowledge then teach them content. After that I'll make them do a post	Q: Can you give me an example of teaching a science lesson? Manee: 'soils and rocks in our area'. I'll bring students to explore rocks and soils around the school. So, the students will learn about soils and rocks in their area. Q: Why do you plan the way you do? Manee: It's easy to understand for students because it's an environment that's close to them. *Manee's teaching style was teacher-centred rather than student-centred*	Q: Can you give me an example of teaching a science lesson? Manee: First step is gaining students' attention. I'll ask question to urge them to think, for example on the topic 'soils and rocks'. I'll make them think about rocks around the school and their uses. Then let students do an activity such as 'rock hunter'. I'll tell them to explore rocks in their area and show them examples of rocks. Next step is explanation and conclusion. I'll ask a question to lead to the conclusion of the lesson. After that it will be expansion of knowledge. I'll gave students handouts and tell them to study from the handouts and I'll also add more explanation. The last step is evaluation. I'll assess both students and their understanding. To evaluate students by observing such things as how they do an activity and experiment, group work, and cooperation. To

test to measure their improvement. If a result isn't good, I'll explain more. Q: Why do you plan the way you do? Manee: Students have good improvement. And I understand the students and know if they understand what I've taught. *Confirmed by the first concept map (Figure 6.1)*		evaluate understanding by observing their presentation, test result, and worksheet. Q: Why do you plan the way you do? Manee: It'll make students ready to learn. If I don't get students' attention, they'll not listen to me when I teach. *Confirmed by the third concept map (Figure 6.3)*

In summary, there was a major change in Manee's general pedagogical content knowledge. This knowledge developed during the study as she used a more comprehensive pedagogy because of her experiences on practicum. In the beginning, she focused on finding a teaching method that suited the students and evaluating learning outcomes by using a post test. However, she planned her lessons based on what she has seen in the classroom during her school observation. In the second interview, after she finished her classroom observation and began her practicum, her pedagogy changed to letting students learn by direct experience. Her teaching method appeared to be influenced by her experiences in her practicum. After the practicum, Manee pointed out that her teaching was comprised of five steps, i.e. gaining students' attention, activity, explanation and conclusion, expansion of knowledge and evaluation. However, she was aware of gaining students part because she was afraid that the students did not listen to her unless she got their attention. Her worries may have been caused by her lack of confidence in front of the students. In addition, it seemed for Manee that her perception of pedagogy was mainly influenced by herself, students, university study and practical experiences. She noted "there is no other factor that influences my teaching, only myself, students, and experiences from university and practicum" (Int 3, Feb 2008).

(c) Manee's curriculum knowledge

There is no evidence that relates to Manee's curriculum knowledge**.**

(d) Manee's pedagogical content knowledge

There is no evidence that relates to Manee's pedagogical content knowledge.

(e) Manee's knowledge of learners and their characteristics

Manee was asked on three occasions to explain her view about what makes science difficult for students as can be seen in Table 6.3. She stated that students did not have a chance to carry out real experiments, and so they did not understand what really happened in the process. Teachers teach only the theoretical parts without practice, or they simply explain the experiment procedure and its result. Therefore, the students could not picture the process, resulting in this aspect being misunderstood and confusing. Although the students wanted to do the experiment, the teacher usually did not allow them to use laboratory equipment because the teacher did not want to take responsibility in case it was broken. "In the school where I do my observation, teachers don't allow students to use lab equipment because they're afraid that students will break it" (Int 1, Aug 2007), Manee complained. Moreover, the students did not have a chance to do the experiment in her practicum site due to the lack of laboratory facilities. Another problem she mentioned was students' lack of literacy some students could not read, and so they could not keep up with the lesson and fell behind. Manee suggested that teachers should let students carry out "real" examples of authentic experiments. If the school lacked laboratory equipment, they should use other materials as a substitute for the equipment. In addition, teachers should pay more attention to the students making slow progress. However, in the third interview, in February 2008, Manee pointed out that some students did not want to do the experiments because they thought they were difficult and complicated. She believed that good attitudes toward science and teacher's encouragement could solve this problem. Manee was concerned about her students. She usually consulted with her mentor about her students' problems to get advice. See Table 6.3 for her view about learners' learning difficulties.

Table 6.3 Data Related to Manee's Knowledge of Learners and Their Characteristics

August 2007	December 2007	February 2008
Q: What makes science difficult for children? Manee: Because students don't understand. For example in the school where I do my observation, teachers don't allow students to use lab equipment because they're afraid that students will break it. Q: What could make the study of science easier for students? Manee: Give students a good fundamental knowledge. And make them understand that science is not as difficult as they think. Let them develop good attitudes toward science. I tell them 'if I can do it, you can do it too'.	Q: What makes science difficult for children? Manee: Students don't have a chance to do experiments. Teachers just tell them the procedure and result without carrying out the real experiment. In my practicum site, students want to do the experiments but the school doesn't have lab equipment. Another problem is some students can't read. One of my students, he is very pitiful, he comes from a poor family and lacks leaning facilities. He doesn't have a notebook, so, I gave him paper to write on but he worked very slowly. I told him if he didn't understand, I'd explain it to again. He told me 'teacher, I can't do my work because I can't read' even though he is a Prathom 4 student. Q: What could make the study of science easier for students? Manee: I try to use other materials as a substitute for lab equipments, so, students can do experiment. For the students who fall behind in the class, I'll give them additional lesson in the free time.	Q: What makes science difficult for children? Manee: Some students don't like to do the experiment because they think it's difficult and sciences are complicated subjects. Q: What could make the study of science easier for students? Manee: Tell them science isn't as difficult as they think. I'd encourage them to study and do the experiment. I'd let them do the experiment, from the easy one first.

In summary, Manee's knowledge of learners and their characteristics showed minor development. She affirmed that science-learning difficulties resulted from students' lack of opportunities to do experiments. She believed that practical experiences, good attitudes towards sciences and the teacher's encouragement could help solve this problem. Manee observed her students individually. She gradually learned to deal with students' problems with help from her mentor. "I experienced the real situation by myself, now I know how to manage students, for example how to deal with naughty students or how to get students' attention" (Int 3, Feb 2008), Manee said. It appeared that her knowledge of learners and their characteristics was influenced by her experience from school observations and practicum as well as her mentor's advice.

(f) Manee's knowledge of educational contexts

There is no evidence that relates to Manee's knowledge of educational contexts.

(g) Manee's knowledge of educational ends, purposes and values and their philosophical and historical grounds.

There is no evidence that relates to Manee's knowledge of educational ends, purposes and values and their philosophical and historical grounds.

Classroom Observations of Manee's Lessons

In January 2008, Manee did her practicum at a small municipal school in a city. The school comprised Kindergarten through to Prathom 6 (Grade 6). The students lived in a community near the school and most of them came from low-income families. Manee taught science to Prathom 4 (Grade 4). The class period lasted approximately one hour.

Manee's science class was in a science room located on the ground floor of the building. A whiteboard was mounted on the front wall. There were two bulletin boards, one placed beside each end of the whiteboard. The bulletin boards were decorated with seasonal items. The laboratory bench was in front of the whiteboard. The room had two doors and several windows. There were two cabinets with two sinks near the right wall beside the windows. Two laboratory equipment cabinets

were placed at the back. The students' desks were arranged in six groups. There was enough space for the teacher to move around.

The researcher observed Manee's science classes for three lessons studying 'Rocks and Soil' (see Appendix 4E, 4G, and 4F for samples of Manee's lesson plan, handout, and work sheet. Manee taught this subject twice a week, on Tuesdays and Wednesdays. The class comprised 18 students. According to the timetable, the lesson was to last about one hour, but due to the morning assembly beforehand, the students used about ten minutes at the beginning of the class to reach the room, take their seats and prepare themselves. Manee usually waited for a while before going to the room in order to give students time to prepare themselves. When she entered the classroom, a student who was the head of the class led the other students in greeting the teacher. Manee would return the greeting and start her lesson.

For the topic 'the rock cycle', after Manee gained the students' attention, she gave them a handout, which she read aloud to the students. After that, Manee told the students to study the handout and write 'the causes of rocks changing' in their notebooks. She usually circulated around the classroom to see what students were doing. Some students asked her questions and they generally used a north-eastern dialect instead of standard Thai language, which is commonly used in schools. Manee explained later that her mentor commented about her communicating with students by using the local dialect. Her mentor suggested she should use the official standard Thai instead, in ordered to get the students' respect. However, she still used the local dialect together with the standard Thai language. Most students concentrated on their work. They worked quietly and when they finished, they handed their work to Manee. When all the students finished their work, she repeated the question and let the students answer together. Manee also called on students who had problems with reading to read some parts of the handout aloud in front of the class, and she would help them read if they had problems with spelling. Then Manee gave a conclusion for the topic. Before she let the students go she asked them to bring limes and empty cockleshells for next day's lesson. At the end of the class, the head of the class led the students to salute the teacher and all the students said, "Thank you".

In the three lessons observed, Manee's approach was teacher-centred, in a lecture style. She tended to take control of the lesson even in carrying out experiments. For example, in Manee's lesson about the corrosion of limestone, she arranged for her students to do an experiment with empty cockle shells and lime juice that she had asked them to bring. After the students' greeting and gaining their attention, Manee gave the students worksheets and explained the laboratory procedure. Then she arranged the students in groups of 4 or 5. However, she did not allow the students to do the experiment by themselves; she went to each group and dropped lime juice and water on each shell for them. Manee told each group to observe the reaction, write down the result and answer questions in the worksheet. She moved to each group to explain and assist students. After all groups had finished their experiment, Manee gave a conclusion for the experiment. She explained that her mentor advised her to use empty cockle shells as a substitute for limestone which could not be found in that area.

Manee's mentor did not come to observe her lesson, but according to Manee, her mentor was a good advisor. She gave Manee guidance about how to make a lesson plan and helped her when she had problems with teaching. She also gave Manee advice about how to deal with a student who had a problem. Manee stated that her students had little chance to do experiments because the school lacked laboratory equipment. The teachers did not want to let students use laboratory facilities because they did not want to take responsibility in case expensive apparatus was broken. Therefore, she used other things as substitutes for laboratory equipment, for instance, empty cans instead of beakers. In summary, Manee demonstrated development in her content knowledge, general pedagogical knowledge, curriculum knowledge, and knowledge of learners and their characteristics during her lessons.

Manee's Views of Teaching Toward the End of the Study

Manee's second interview took place by the time she finished school observations and began the practicum in December, 2007. This time she considered that the experiences she had gained from the university subjects and her classroom observations had an equal impact on her teaching. She mentioned that she had learned the teaching methods from the university courses whereas she had gained the practical

experience from school observations. She found that what she had learned from education subjects might be different from what happened in the real setting. “I experienced different aspects from school observations. What I’ve seen in my observations were different from what I’ve learned in the university” (Int 2, Dec 2007). In addition, Manee noted that she had had a chance to learn about students’ problems she observed when she later consulted with her lecturers about these problems.

Then in February 2008, Manee was interviewed after she finished her practicum. Her view about the influences of her pedagogy had changed after this practicum. She now valued her teaching experience more than her university subjects. Manee stated that lecturers only taught her theory without practice. Moreover, she pointed out that she had gained more experience and knowledge when she had met with the many challenges in her practicum, especially how to control students in her classroom.

After the practicum, Manee claimed that she gained more experience in several aspects. She understood better the learning-teaching process and developed teaching and planning skills. She also learned how to develop relationships with her colleagues and students. However, Manee encountered some setbacks in her practicum as well. She explained that the problems were mainly from the students and Manee herself. The problems about herself included pedagogical problems and personality problems. She noted that she had little experience in teaching and choosing teaching methods and had low knowledge of subject matter, and was thus not be able to teach as effectively as she wanted. Furthermore, she lost confidence when she was in front of the class, although she tried to overcome her shyness in order to teach effectively. According to Manee, the problems were that students did not pay attention to the lesson and the work, and there was a lack of learning paraphernalia, for example textbooks and stationery, and they did not respect their teachers.

Manee’s Belief About Pedagogy As Represented By the Concept Map

Manee was asked to explain her views of science teaching by using a second concept map, in December 2007 after she finished her school observations. As shown in Figure 6.2, the second concept map consists of four organizational concepts, ‘pre test’,

‘teaching techniques’, ‘teaching materials’, and ‘post test’, again with no cross-linking between the concepts.

Manee explained this concept map in the second interview, later in December 2007. The concept of ‘pre test’ was considered to be the first step in her science teaching. At this step, the pre test was used to assess the fundamental knowledge of students. The second step was ‘teaching techniques’. According to Manee, she would find the teaching method that suited her students by observing what ways the students liked to learn or content they were interested in. She said, “I’ll figure out what topic they are interested in and what teaching method they like most, for example some students are interested in doing the experiment, some want the teacher to explain to them” (Int 2, Dec 2007). Then she would use teaching materials such as video tapes, video CDs, slides and experiments, in her teaching in order to get students’ attention. The last step was ‘post test’, to evaluate students’ knowledge and understanding. Manee compared the mean scores from the pre test and post test and used the results to evaluate her students.

The main difference between Manee’s first and second concept maps is that the concept ‘content’ disappeared and the concepts of ‘pre test’ and ‘post test’ are introduced in the second concept map. She added these two concepts using the reason of evaluating student understanding and assessing the effectiveness of her teaching. Manee explained, “these two concepts were added in order to know how much knowledge students have and to know whether they understood my lessons or not” (Int 2, Dec 2007). In the second concept map, Manee showed general pedagogical knowledge and knowledge of learners and their characteristics.

Manee was asked to draw the third concept map in February 2008 after she finished her practicum. The third concept map is shown in Figure 6.3, and it comprises four organizational concepts: ‘draw students’ attention’, ‘explanation & conclusion’, ‘expansion of knowledge’, and ‘evaluation’. Again, there is no cross-linking shown in this concept map.

It seemed that Manee viewed teaching as a process that comprised of four steps, where each organizational concept represented a step in her teaching process. To

make it clear, Manee used the topic 'Soil' as an example in her explanation of this concept map in her third interview in February 2008. In the step called 'draws students' attention', Manee would encourage the students to think about the topic. For example, she would let the students think about the types of soil, the characteristics of each soil type, and their use. Then she would introduce a learning activity to them such as showing each soil type to the students. The next step was 'explanation & conclusion'. At this step, Manee would use questions that led to the conclusion. She asked the students the questions about the topic e.g. what is the characteristic of each soil type and what is its use? After that she would summarize the information in the lesson. The third step was 'expansion of knowledge', in which Manee would let the students do some self-study by reading the handout about 'soil', then add further explanation if her students did not understand. The last step was 'evaluation'. Manee evaluated her students by attending to different aspects, namely the students themselves, students' understanding, and students' work. The evaluation of students was made by observing students during activities, group management, and cooperation. Students' knowledge and understanding were evaluated by using their presentation and test results. The evaluation of students' work, such as worksheets, was used to estimate their broader learning outcomes.

There was no major change in Manee's third concept map from her previous map, except that she added the concept of 'draw students' attention' in the third concept map. She realized the importance of gaining students' attention before beginning the lesson. This concept was influenced by her teaching experience. Manee noted that,

> Before I did the practicum, I just imagined it should be like this but when I went through the practicum, I experienced the real thing. This made me think and I realized that I should gain students' attention before starting the lesson and explain more to the students. (Int 3, Feb 2008)

Manee's third concept map showed more detail of teaching approaches. This concept portrayed her general pedagogical knowledge and knowledge of learners and their characteristics.

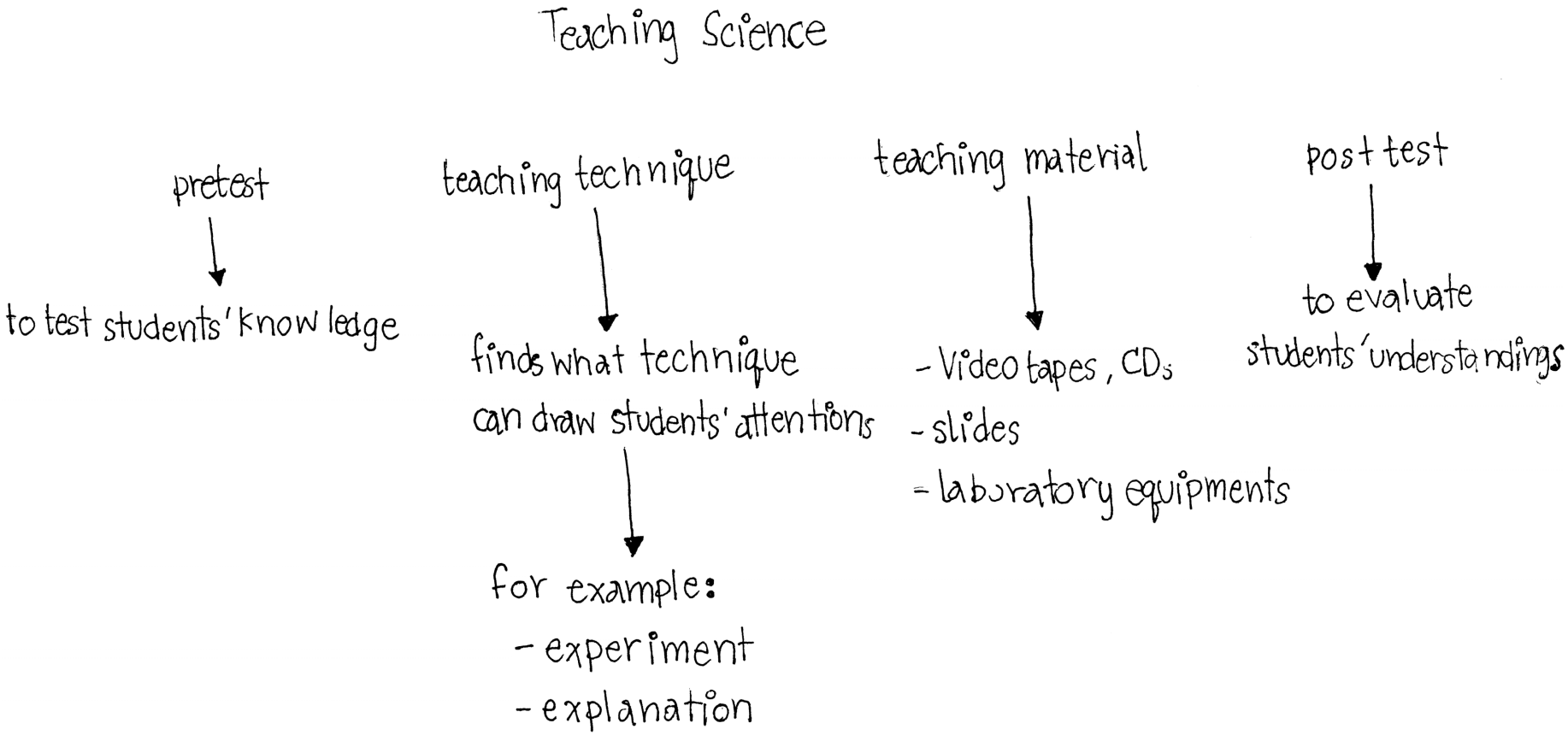

Figure 6.2 Manee's second concept map

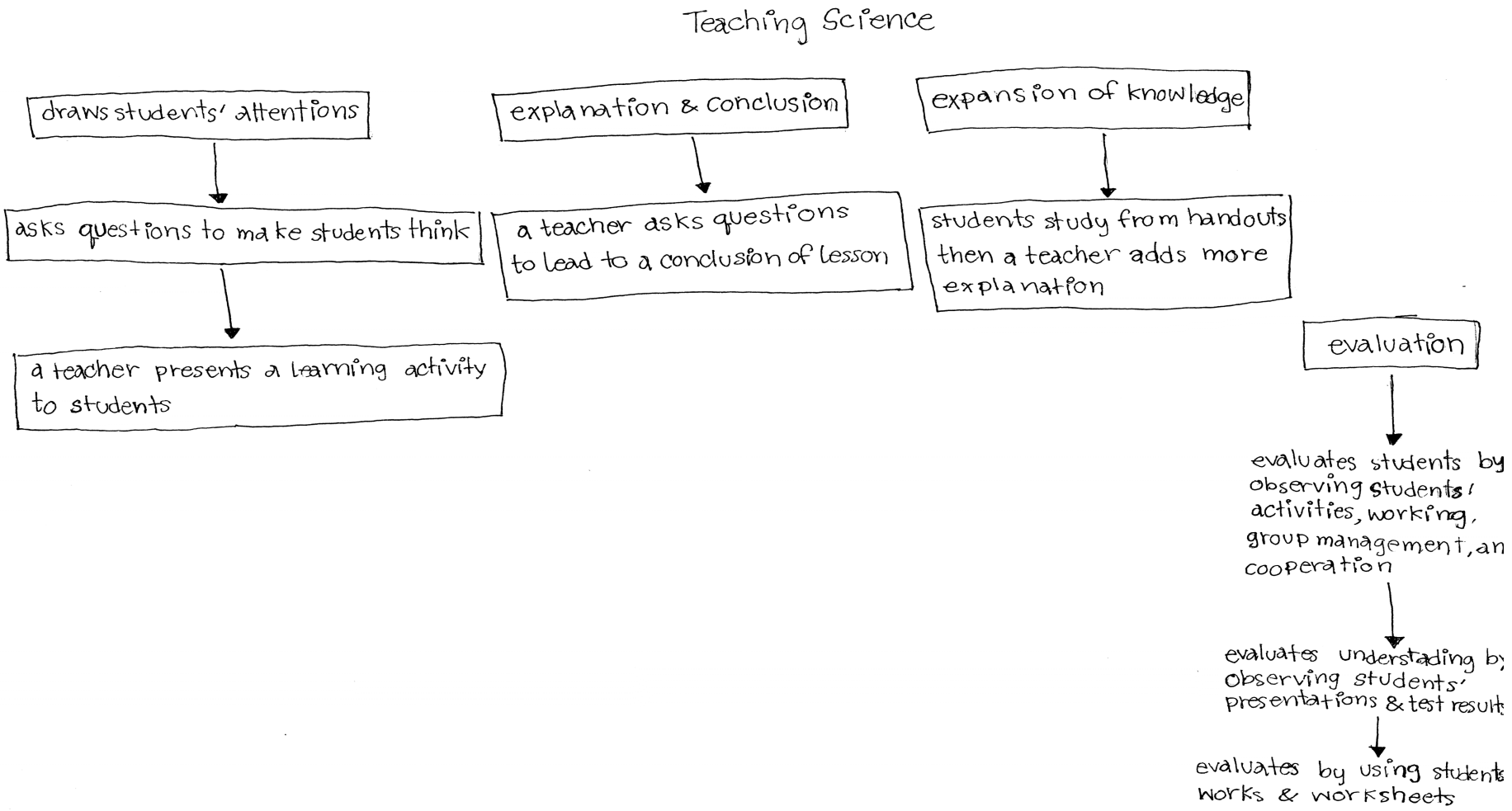

Figure 6.3 Manee's third concept map

Summary of the Case

Toward the end of the study, Manee had developed the following types of teacher knowledge- content knowledge, general pedagogical knowledge, and knowledge of learners and their characteristics. However, there was no evidence that related to curriculum knowledge, pedagogical content knowledge, knowledge of educational ends, purposes and values and their philosophical and historical grounds.

There was a minor change in Manee's content knowledge. She believed that content knowledge provided her either with a fundamental knowledge necessary for teaching or confidence in teaching. This was influenced by the university course. Manee had a major change in her general pedagogical knowledge. She used a more comprehensive pedagogy and gained more confidence as a teacher when she did her practicum. It was clear that her knowledge of general pedagogy was influenced by students, university and practical experiences. There was a minor development in her knowledge of learners and their characteristics. She believed that a students' lack of opportunities to do experiments make learning science difficult. She was also interested in her students' difficulties and learned to solve their problems with help from her mentor. She also gained more confidence even though she still felt shy when she was in front of the classroom. Her teaching experiences and the help from her mentor had an influence on her knowledge of learners. There was no major change in her views of science teaching as shown in her concept maps. She only gave more detail in the third concept map as she gained teaching experience from her practicum.

In conclusion, her low teaching confidence was an importance issue in Manee's beliefs about teaching, however, as she gradually gained in teaching experience, Manee learned to deal with students' problems and classroom management, as well as gaining more confidence through her practicum. Manee progressively developed her teacher knowledge through her university experience, school observation, practicum experience, and her mentor's advice, in particular the knowledge of learners and their characteristics. Her beliefs in science teaching were also influenced by these experiences.

Chapter Seven

The Case of Suda

Overview

This case study investigates the research question in regard to Suda's teacher knowledge as it developed during her teacher education course and the influences on this development. It is presented in four sections. The first section explains Suda's initial view on teaching. The second section represents her data on the forms of her teacher knowledge as it developed at different times during the study. As with each of the case studies, the theory applied to analyze Suda's teacher knowledge is Shulman's (1987) framework of seven types of teacher knowledge. The third section explores the changes in Suda's view of teaching toward the end of study. The final section summarizes what type of teacher knowledge Suda possessed and examines influences on why it changed during her teacher education course.

Suda's Views on Teaching at the Beginning of the Study

Suda is a 22-year-old student teacher with a science major. She is a scholarship fourth-year student of the Rajabhat University. She came from a poor farming family. Suda completed Matthayom 6 (Grade 12) from secondary school in her district in Nong Khai province. Besides gaining a place in the science education course, she also qualified in the tests to enter electrical engineering and nursing. She chose education because this course offered her financial support. Suda said she had to think about her younger brother; receiving the scholarship meant her parents and older sister could support her younger brother's education instead. Moreover, according to Suda, if she had not received the scholarship, she might not have had a chance to pursue tertiary education because her family could not afford the tuition fee. Consequently, Suda decided to enter the course, although as she said, teaching really did not interest her.

In the first interview, in August 2007, Suda was asked to describe herself as a science teacher. She stated that she had no idea about what kind of science teacher she would be because she did not want to be a teacher. She was also not sure she had enough qualifications to be a science teacher.

> …Even though I'm in fourth year, I've never viewed myself as a teacher because I'm not interested in this career in the first place … If you ask me, do I like teaching? I don't like it … I don't like the government service system. But I chose to study science education because I like science. (Int. 1, Aug 2007)

However, Suda noted that if she had to teach, she felt confident that she had the ability to do it. She thought education subjects would serve as a guide for her when she began her teaching career. Also she equally valued her experiences in her university course and classroom observations. Suda pointed out that university subjects focused on science content that were essential for teaching and pedagogical content such as curriculum, teaching methods, and lesson planning which would be useful when she began teaching. At the same time, classroom observations were also important. Suda said that she had a chance to teach once when she did her school observation and this was a good experience for her. This experience helped her gain confidence and prepare her for the real situation in the classroom which was different from when she practised teaching with her friends in pedagogy classes.

Suda claimed that her strength as a teacher was that she remained calm in any situation. She believed that the calmness could control students. When asked what areas she would like to improve, Suda said she was told by her friend that she talked too fast and could not explain things clearly; thus, she wanted to solve this problem before starting her practicum. She said, "I try to improve myself such as when I have presentation, I tell my friends to raise their hands if I talk too fast or ask if they don't understand" (Int. 1, August 2007).

Suda's Beliefs about Pedagogy as Represented by the First Concept Map

Suda developed the first concept map when she began her classroom observations, as seen in Figure 7.1. She was asked to draw a concept map to explain her views about how she taught science. Suda's concept map displayed a linear structure. Each concept linked to others in the same direction. The concept map had only two cross-links, between the concepts 'lesson plan' and 'test students' basic knowledge' and between the concepts 'lesson plan' and 'evaluation/analysis'.

According to her concept map, Suda gave priority to the concepts 'teacher' and 'students'. She believed that teachers should prepare themselves and know their students thoroughly before starting teaching. She stated that:

> … first of all we must prepare teacher and students … we have to prepare ourselves … we have to know students in our responsibilities … what class, how many students in that class … we have to find their characteristics…
> (Int. 1, Aug 2007)

Then she would prepare lesson plans for the entire academic year, for the whole semester, and for the week. Suda also mentioned pre-testing before teaching. In Suda's view, after lesson plan preparation, the teacher should assess students' basic knowledge to see if it was adequate. She would then go back to this plan and adjust it to suit to the students, as illustrated in her concept map. When Suda was satisfied with her lesson plan, she would prepare the teaching material. In the interview, she said that teaching materials could be anything, such as videos, CDs, posters, postcards, real examples or things outside the classroom, depending on the content. Her concept of teaching was to introduce the topic, make the lesson interesting, and pre/post learning activities. She would then post test the students to evaluate their understanding. Suda emphasized that it was important that teachers communicate test results to students because students would be curious about the result and the results would make them want to improve themselves. She gave herself as an example, "like me … when I finished the test, I would be worried what scores I got" (Int. 1, Aug 2007). Moreover, the tested results were used for evaluating the lesson plan, whether it was successful or not. If not, Suda would go back to the lesson plan and improve it for the next class. Suda considered the teacher and students as the most important factors in her teaching process. She also mentioned that she would study content then choose a suitable teaching technique because if the teaching method matched the content, it would promote teaching and learning.

Suda's first concept map revealed that her view of science teaching was centred on knowledge of learners and their characteristics, but also showed her content knowledge and general pedagogical knowledge. The map also showed a loop from evaluation to the lessons.

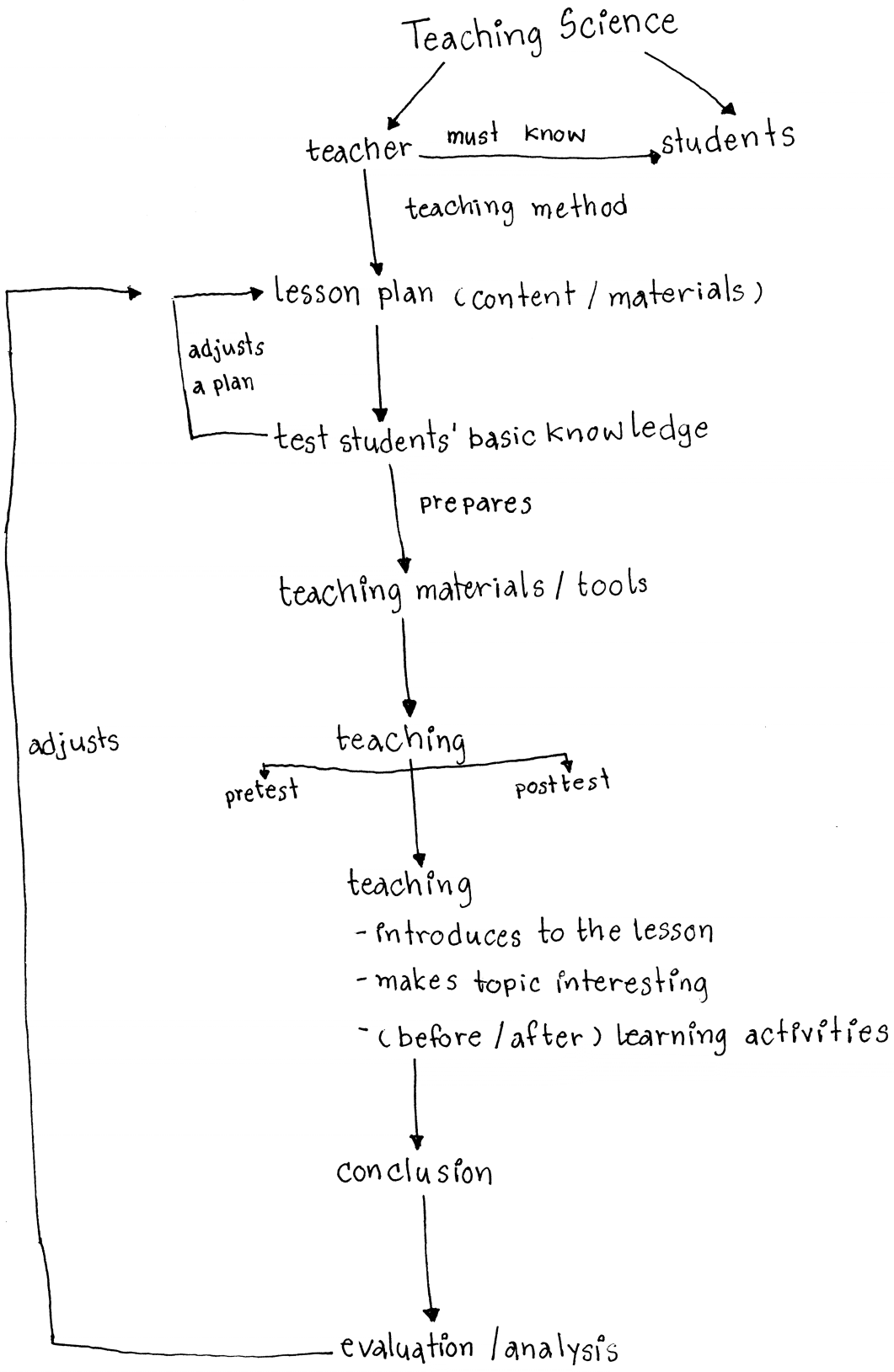

Figure 7.1 Suda's first concept map

Analysis According to Categories of Teacher Knowledge

During the seven-month study Suda was interviewed three times: in August 2007, after classroom observations in December 2007, and after her practicum in February 2008. She was also observed twice, teaching during her practicum in February 2008. In addition, she sketched three concept maps, one before each interview. Data from each of these methods were used in order to analyze her teacher knowledge using Shulman's (1987) theory of types of teacher knowledge. By comparing her beliefs over time, claims about changes in her teacher knowledge during the teacher education program were made and any influences on this change noted.

(a) Suda's content knowledge

In Suda's first interview in August 2007 during her classroom observations, she was asked to explain if the science subjects in the university were useful to her. Suda thought that the university's science subjects would be beneficial to her when she taught science because content taught in the university was similar to the content of the secondary science curriculum. She was satisfied with what she had learned from the university, especially because she had had a chance to practise her experimental skills. According to Suda, she did not have experience with a 'real experiment'. When she was a secondary student, she did not carry out actual experiments in the laboratory; instead, most of time she learned about experiments from teachers' explanations and textbooks. She said:

> It's better in the university although I've learned quite basic experiments, the university's laboratories have lab equipment and I have had a chance to practise how to use it. Thus I can use this knowledge when I teach in school … it's very useful. (Int 1, Aug 2007)

In the second interview in November 2007, Suda's views about the benefits of university science subjects were repeated. She stated that besides the theoretical parts that were similar to the content of secondary science subjects, the practical parts she carried out were also very useful. The knowledge of how to use laboratory equipment properly gave her confidence to teach students.

In her last interview, in February 2008 after finishing her practicum, Suda still believed that the science subjects at the university provided useful knowledge for her teaching, although she could not let her students do any experiments due to the limited access to laboratories and laboratory equipment. Suda commented that the university should teach how to make laboratory equipment or how to use other things as substitutes for actual laboratory equipment.

Suda was asked the same question on three occasions about the importance of science knowledge presented in university subjects. Her responses are shown in table 7.1 indicating a similar view about content knowledge during the program.

Table 7.1 Data Relating to Suda's Content Knowledge

August 2007	December 2007	February 2008
It may be useful because content that I studied in the university is similar to what I learned when I was a high school student. I had very little experience with practising experiments from my high school most of them were 'dry lab'… only listened to teachers' explanations and read text books. It's better in the university although I've learned quite basic experiments. The university's laboratories have lab equipment and I had a chance to practise how to use them. Thus I can use this knowledge when I teach in school … it's very useful.	Yes, even science subjects I've learned in the university aren't as deep as what is taught in Faculty of Science, they are fundamental knowledge like what I studied in high school. When I was a high school student, experiments were 'dry lab', but in the university I had a chance to do real experiments and have experience with real laboratory equipment. This makes me know how to use laboratory tools. For example, at the school that I go to do classroom observation, a laboratory there has many laboratory equipment items although it's not fully equipped … and I can apply or make something else as a substitute. This also makes	Yes, but I couldn't teach the experiments I learned in the university because I couldn't use laboratory equipment at my practicum site … I had to apply from other things but the university doesn't teach how to make laboratory equipment by ourselves or how to use a substitute … they provide us a complete set of equipment. But I could use what I've learned from science subjects in the university because their content is similar to that of high school science subjects.

	me feel confidence when I teach.	

In summary, there was a minor change in Suda's content knowledge. She developed her content knowledge through the university science subjects and her school observations and practicum experiences. It was confirmed that content knowledge was important for Suda. She thought university science subjects were helpful. The knowledge and experience she gained from the university, especially laboratory skills, gave her confidence to teach. Moreover, it appeared that Suda's experience from her studies at high school, her classroom observations and her practicum, had an influence on her content knowledge, in particular on the importance of laboratory skill and practice.

(b) Suda's general pedagogical knowledge

In December 2007, Suda gave her first interview during her school observations in the large secondary school. She was asked about how she planned her lessons. She stated that firstly, she would study her students: "The teacher must know their students … for example what class they are, how many students in the class", (Int 1, Aug 2007) she said. Moreover, in order to evaluate students' prior knowledge, Suda would let her students do a pre test before beginning the lesson. She reasoned that:

> For example if I teach Matthayom 2 (Grade 8) students … I'll test students' prior knowledge before I follow my lesson plan. Sometimes students don't have Matthayom 2's fundamental knowledge … if like that I'll adjust the lesson plan to suite them. (Int 1, Aug 2007)

Suda gained students' attention by trying to make them feel like they are 'playing' rather than 'learning', for instance using a song in her science lesson. She suggested that "this will make students interested because children like something fun" (Int 1, Aug 2007). There was a post test after the lesson to evaluate students' outcomes as well as the effectiveness of teaching approach. Suda also pointed out the importance of telling the test results to the students. She stated that feedback from the teacher would act as motivation for the students. She said:

> An important thing is the teacher must tell the test's result to students … students should get feedback from their teacher. This will make them feel

> good because if students have a test, they want to know their marks. (Int 1, Aug 2007)

Suda said that she would feel more confident if she were well prepared. In addition, she wanted to improve either the lesson plan or herself. These would make the teaching-learning process effective as much as possible. Her view about teaching was reflected in her first concept map (Figure 7.1).

Suda's view about science teaching was reaffirmed in the second interview, which took place in December 2007. She began her practicum in another large secondary school in Mahasarakha province. Her general pedagogy was similar to what she explained in the first interview. This was confirmed by the second concept map (Figure 7.2). However, she also mentioned analyzing the content before planning the lesson then choosing the teaching method that suited her lesson plan. She also reiterated the importance of evaluation. Suda was especially concerned about giving feedback to the students. However, this concern came from her point of view as a student herself rather than as a teacher. Suda said

> There is one thing that I like and I think my students will like it too … that's when I do something, for instance an exam … I'm not sure whether I do it right or wrong. And if I don't know the result, I'll be very worried and curious about it. (Int 2, Dec 2007)

It appeared that Suda's view about teaching was influenced by her own experience as a student. She believed that the instructional practice she experienced as a student and that had brought her success would work equally well for her students. She noted that "I don't follow any principle or theory but this came from my experience when I was a student" (Int 2, Dec 2007), and "I'll teach the way I liked when I was a student and I think this will make students study better" (Int 2, Dec 2007).

However, her third interview, which took place in February 2008, after Suda had finished her practicum, indicated that her view of teaching had changed. She met many challenges during her teaching. It seemed that she had undertaken a process of trial and error and these practical experiences re-shaped her view of teaching science. She realized that she had limited teaching experience and tried to improve herself. She said, "because I have limited teaching experience, I tried to use different teaching techniques to assess which techniques were effective" (Int 3, Feb 2008). However, the

teaching strategy she used in her lessons was mainly a teacher-centred approach. Moreover, Suda highlighted that she began to understand the concepts of teaching, although she was still searching for effective teaching approaches. "For now, I know the concepts but I'm still finding the effective teaching methods" (Int 3, Feb 2008). Her perception was changing from thinking like a student to thinking like a teacher. This was influenced by practical experience from the practicum school combined with experience from the university. Suda's beliefs and practices were confirmed by the observations of her lessons and the third concept map (Figure 7.3).

Suda was asked the same question, on three occasions, about how she planned to teach her science lessons. Her responses are shown in Table 7.2 indicating that she experimented with different teaching approaches on practicum.

Table 7.2 Data Related to Suda's General Pedagogical Knowledge

August 2007	December 2007	February 2008
Q: Suppose you have to teach science. How will you teach it? Suda: First, I must prepare myself, or prepare the teacher, then prepare the students. The teacher must know their students … for example what class they are, how many students in the class … something like that. When I finish teaching, I'll evaluate the learning outcomes. I'll make a lesson plan prior to teaching … for example if I teach Matthayom 2 (Grade 8) students … I'll test students' prior knowledge before I follow my lesson plan. Sometimes students don't	Q: Can you give me an example of teaching a science lesson? Suda: About 'trees'. First I'll consider about my students something like … what class, how many students in that class, what is classroom environment, and what is school context? After that I'll analyze subject content … which content I'll choose … and use these to make a lesson plan, then choose an appropriate teaching technique. For this topic, I'll discuss with students about trees that grow around their houses, what are their uses, and their parts, then I'll give students homework to list	Q: How do you plan your lesson? Suda: When I practised teaching, first I discussed with my mentor about the lessons … which lessons were already taught, which lessons were in my area of responsibility and asked if there was any sample lesson plan … it appeared that there wasn't. So, I had to prepare it by myself and also teaching materials. I studied curriculum and my mentor gave me a textbook. My lesson plan was different in each topic. In my first lesson, I let my students do a pre test but I couldn't let them do post test because of time limit. So, I had to change my

have Matthayom 2's fundamental knowledge … if it's like that I'll adjust the lesson plan to suite them. Q: Can you give me an example of teaching a science lesson? Suda: The topic is 'parts of a plant' for primary students. First, to introduce the topic, I'll let them sing a song called 'king, kan, bai'(branches, twigs, leaves) … this song has gestures and it is fun … this will make students interested because children like something fun. Then I'll bring students outside the classroom to do field work … show them where flowers, branches, stems and roots are. Then back to a classroom to do an activity … tell them to draw a picture of their favourite plants. After that have a test to evaluate their understanding and I'll assess results in order to identify students' performances. An important thing is teacher must tell the test's result to students … students should get feedback from their teacher. This will make them feel good because if students have a test, they want to know their marks. And I can use their test results to modify my lesson plan and myself. Q: Why do you plan the	names of trees at their house and their uses. When they finish, I'll discuss with them again and after that teach them about plant parts. The point is students have the opportunity to learn by themselves … they can experience real things after learning the contents. The evaluation tool is a test … to test whether students understand or not … I'll use these results to evaluate and draw a conclusion. There will be activities during the lesson before I let students go out to do fieldwork. I'll give feedback and test results to students to let them know their performances. This will encourage students to do better. Q: Why do you plan the way you do? Suda: I don't follow any principle or theory but this comes from my experience when I was a student. There is one thing that I like and I think my students will like it too … that's when I do something, for instance an exam … I'm not sure whether I do it right or wrong. And if I don't know the result, I'll be very worried and curious about it. So, if I tell the test results to students, it'll act like a drive … students will think 'I did well, I'll continue' or 'I didn't do well, I must put more effort in next time'. I use my previous experience as	next lesson plan. I cut the pre test and post test part but tried to gain students' attention instead, then made them study from handouts and sometimes let them play games or showed them pictures as teaching materials. Q: Why do you plan the way you do? Suda: I'm still finding the effective teaching method. I'll study content and find a suitable teaching method. For the topics I taught, most of them are theory that students have to memorize and don't have many experiments. So, I let my students play games to gain their attention. I tried to make them think learning was fun. I had to find something that made them interested in the lesson because my students were losing concentration easily. Because I have limited teaching experience, I tried to use different teaching techniques to assess which techniques were effective. I've learned this from experience. For now, I know the concepts but I'm still finding the effective teaching methods. When I studied the subject called 'Professional Development', my lecturer assigned me to read about accomplished science teachers. This made me

way you do? Suda: If I prepare myself prior to teaching, it'll give me more confidence. Moreover, I have time to improve myself and my lesson plan. This will be beneficial to my students … another reason is some students may not like science. If I have a lesson plan … I may find the way to persuade them … this will make them more willing to learn. *Confirmed by the first concept map (Figure 7.1)*	a student … I'll teach the way I liked when I was a student and I think this will make students study better … *Confirmed by the second concept map (Figure 7.2)*	know more about aspects of teaching such as techniques, classroom management, and teaching materials. It made me want to study more. *Confirmed by classroom observation of Suda's lessons and the third concept map (Figure 7.3)*

In summary, there was a major change in Suda's general pedagogical knowledge. At the beginning she perceived the teaching process as the student's thinking after she experienced teaching for herself, she thought like a teacher instead. She developed her knowledge of teaching concepts, but struggled to find effective teaching methods. It appeared that her development of general pedagogical knowledge was influenced by her teaching experience and the university experience.

(c) Suda's curriculum knowledge

It should be noted that in the first interview, conducted in August 2007, Suda did not mention anything about curriculum knowledge and made only little mention of it in the second interview in December 2007.

In the second interview, Suda stated that in order to teach effectively, she must thoroughly understand the curriculum and construct learning objectives before planning any lessons. She placed the analysis of curriculum in the first part in the second concept map (Figure 7.2) and the third concept map (Figure 7.3). She viewed that as the first step of the teaching process and lesson preparation, which could determine whether the particular lesson could be successful or not. Her responses are

shown in Table 7.3 indicating that her curriculum knowledge occurred after her school observations.

Table 7.3 Data Related to Curriculum Knowledge

August 2007	December2007	February 2008
No discussion about curriculum knowledge in interviews.	After analyzing learners, I'll determine learning objectives for the lesson … what I want students to learn. *Confirmed by the second concept map (Figure 7.2)*	Before I develop the lesson plan, I must study the curriculum because I'll use it as a guide to encompass my teaching. If we teach something, we must have the objective. We cannot groundlessly make the objective, unless we understand the curriculum. *Confirmed by the third concept map (Figure 7.3)*

In summary, there was a major change in Suda's curriculum knowledge. She developed her curriculum knowledge through her experiences both from her school observations and the practicum.

(d) Suda's pedagogical content knowledge

There is no evidence that relates to Suda's pedagogical content knowledge.

(e) Suda's knowledge of learners and their characteristics

In the first interview in August 2007, Suda showed she was eager to learn about learners. For example, she requested to change her observation classroom from Matthayom 3 (Grade 9) class 1, which was a class for very capable students, to Matthayom 2 (Grade 8) class 5, which had less-capable students. Other student teachers would have been happy if they had had a chance to observe in a class that

concentrated on study and were well behaved. She reasoned that she was interested in class 2's various learning behaviours rather than the more uniform learning patterns of class 1. Therefore, she could learn more about students' behaviour. Suda also told about her success in convincing a group of students to give up their thoughts of skipping the class and go back to the classroom. She felt confident that she could manage students like she managed her classmates when she was a student. It seemed that she saw the learners from the students' point of view.

In the second interview in December 2007, her point of view as a student was reaffirmed. Although she acknowledged the importance of understanding the learners, the way she taught was influenced by her experience as a student rather than the teachers' experience of learners.

In her third interview, Suda showed a different concern for the students. She understood her students' characteristics. She stated that her students easily lost concentration, and therefore, tried to find teaching strategies that could engage students in the lessons. Moreover, she admitted that she could not manage her class properly and she could not gain students' attention as easily as she had thought. However, she did not believe that punishment would make the students listen to her, as other teachers' advised because she did not like this way of controlling from when she was a student. It appeared that her experiences as both teacher and student had an impact on her knowledge of learners and their characteristics. See Table 7.4 which indicates that she learned a great deal about students during the program.

Table 7.4 Data Related to Knowledge of Learner and Their Characteristics

August 2007	December 2007	February 2008
First, I chose to observe Matthayom 3 class 1 but I found that the students in this class had quite similar learning behaviour. They concentrated in the lessons and had high completion.	I'll teach the way I liked when I was student and I think this will make students study better. If we don't study students' existing knowledge, we'll	I couldn't make the whole class engage in the lessons and I couldn't control the students. I had to find something that made them interested

Then I made a request to change to Matthayom 2 class 5. The students in this class have diverse behaviours. They are less pressured and less competitive here. The students have different characteristics that I can learn from. If I understand their nature, I can manage … it's very enjoyable. At least I think I can control students like I could manage my friends when I was a student. I don't want to be a teacher but I think I can teach because I like children. They remind me about when I was young. They made me think about my school life, my teachers and my friends … An important thing is that the teacher must tell the test's result to students … students should get feedback from their teacher. This will make them feel good because if students have a test, they want to know their marks. Like me … when I finished the test, I would be worried about what scores I got. *Confirmed by the first concept map (Figure 7.3)*	never know how much knowledge they have. Each student has a different knowledge level. *Confirmed by the second concept map (Figure 7.2)*	in the lesson because my students lost concentration easily. Some teachers told me don't get too close to the students. If they were disobedient, they scolded them. Some teachers even told me to give them a whipping if I could not control the students. But I didn't listen to them because I personally haven't liked this method since I was young. So, I tried to use other methods to gain students' attention rather than scolding or punishing. I want to know how I can make the students be happy to learn and without pressure. I want them to gain knowledge, and feel it isn't difficult. *Confirmed by classroom observation of Suda's lessons*

In summary, Suda developed a major change in her knowledge of learners and their characteristics as she gained practical experience. She was aware that her students were different from herself, thus she could not use herself as a standard. She recognized the necessity of understanding her students before beginning teaching. Her knowledge of learners and their characteristics was influenced by her teaching experiences. However, some of her view was influenced by her experience as a student.

(f) Suda's knowledge of educational contexts

It should be noted that in the interviews conducted in August 2007 and December 2007, Suda did not mention anything about educational context.

Suda's concern about educational context is shown in the third concept map (Figure 7.3). Regarding this concept map, she mentioned later in her third interview after she finished her practicum that in her lesson preparation, she would begin by studying the National Education Act of B.E. 2542 (1999). The National Education Act of B.E. 2542 (1999) section 22 states that:

> Education shall be based on the principal that all learners are capable of learning and self-development; and are 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)

Suda used knowledge of educational contexts combined with other knowledge to make her lesson plan. She stated that she realized the importance of the educational context after she had teaching experience in her practicum. Table 7.5 shows change in her knowledge of educational contexts especially in her third concept map.

Table 7.5 Data Related to Knowledge of Educational Contexts

August 2007	December 2007	February 2008
No discussion about knowledge of educational	No discussion about knowledge of educational	No discussion in interviews but Suda's

contexts in interviews.	contexts in interviews.	knowledge of educational contexts were shown in the third concept map (Figure 7.3)

In summary, there was a major change in Suda's knowledge of educational contexts. She developed her awareness of educational contexts through her teaching experience.

(g) Suda's knowledge of educational ends, purposes, and values, and their philosophical and historical grounds

It should be noted that in the interviews conducted in August and December 2007, Suda did not mention anything about knowledge of educational ends, purposes, and values, and their philosophical and historical grounds.

Suda mentioned the school's vision in the third concept map (Figure 7.3) she drew in February 2008 after she completed her practice teaching. She explained later in the third interview that she would study the school's vision prior to planning the lesson, claiming it would steer her in the right direction. Table 7.6 shows her development of knowledge of educational ends, purposes, and values, and their philosophical and historical grounds.

Table 7.6 Data Related to Knowledge of Educational Ends, Purposes, and Values, and Their Philosophical and Historical Grounds

August 2007	December 2007	February 2008
No discussion about knowledge of educational ends, purposes, and values, and their philosophical and historical grounds in interviews.	No discussion about knowledge of educational ends, purposes, and values, and their philosophical and historical grounds in interviews	No discussion in interviews but Suda's knowledge of educational ends, purposes, and values, and their philosophical and historical grounds were shown in the third concept map (Figure 7.3).

In summary, Suda developed a major change her knowledge of educational ends, purposes, and values, and their philosophical and historical grounds through her practicum. It appeared that her teaching experience influenced her construction of this knowledge.

Classroom Observations of Suda's Lessons

Suda did her practicum at a large-sized secondary school in a northeastern province. The school has approximately 957 students in Matthayom 1 (Grade 7) through Matthayom 6 (Grade 12). Suda taught the Matthayom 2 (Grade 8) science class. The class periods lasted approximately two hours.

Suda's classroom was on the first floor of the building. A television set was mounted above a whiteboard on the front wall. There were two doorways and several windows in the room. The teacher's desk was in the right front corner of the classroom which was next to the door. The students' desks were arranged in six groups. There was enough space for the teacher to move around the room. There were a sink in the left back corner and a bookcase with some books at the back of the classroom.

The researcher observed Suda's class for two lessons on 'Our Body' (see Appendix 4H, 4I, and 4J for samples Suda's lesson plan, handout, and worksheet). This subject was taught twice a week. As timetabled, the lessons lasted about two hours. However, due to this class starting after the morning school assembly, the students took about ten minutes at the beginning of the class to reach and enter the room, take their seats and prepare themselves. Suda usually waited for a while before she went into the room, in order to give students time to prepare themselves. When she entered the classroom, a student who was the head of the class led the other students in greeting the teacher. Suda would greet students back and start her lesson.

The topic was 'nutrient deficiency'. When Suda had the students' attention, she gave them handouts and worksheets. Then she showed pictures of nutrition deficiency symptoms and asked her students the name of the disease in each picture. If students answered correctly she would ask for their student numbers and write them down in her book in order to give them extra points. After that Suda put all the pictures on the

whiteboard and wrote down questions about the pictures, for example, about the name of the disease, its symptoms, causes, and how to prevent it. Suda gave each student group paper for a poster and assigned them a question to answer on the whiteboard as group work for ten minutes. Then she asked each group to send their representative to present in front of the class, and she asked each group questions regarding what they presented. However, some groups that did not finish their work continued working and did not pay attention to the presentations, and some students also did other activities while their friends were presenting their reports. Then Suda assigned the students to answer questions on the worksheet. She usually moved around the class to assist her students. She set a time for each activity and told the students how many minutes were left. There were some groups that listened to music from a mobile phone while they were working but Suda did not tell them to stop. She also allowed the students who finished their work to do other activities, for example play games. When all students had finished their work, she told them to change their worksheets with their friend to check each other's work and she gave them the right answers. She asked the students to tell her their marks, which she wrote down before collecting the worksheets from the students. At the end of the class, Suda gave a postcard as a reward to the students who presented in front of the class and candies to the group that finished their work first. Then she allowed the students to leave the class. The head of the students led the class in saluting the teacher. All the students said "Thank you".

In the two lessons observed, Suda's teaching approach was teacher-centred, in a lecture style. However, she tried to let the students take part in the lesson and make the classroom environment relaxed. Some students in Suda's class did not pay attention to her lesson; they talked to each other, did other activities, or left the class without her permission. According to Suda, other teachers told her that she should not get too close to the students, that they would not obey her. Some even told her to punish them if they were not well behaved for her. However, Suda did not follow the other teachers' advice because she did not like this way of controlling students: "when I was young, I also didn't want anyone to scold or punished me" (Int 3, Feb 2008), she said. She wanted to find something that attracted the students' attention rather than punish them.

According to Suda, her mentor never came to observe her class. He helped her check her lesson plans but did not give any comments or advice. Sometimes her mentor just asked her about the class but did not observe. Suda pointed out that her mentor gave her full authority to design the lesson and teach the way she wanted but she was not happy with this; rather, she wanted to learn from him.

In the third interview in February 2008, Suda mentioned that she experienced some setbacks during her practicum. She stated that she could not control the class and could not manage her teaching properly. She could not gain the attention of some students. Also she was not satisfied with her teaching techniques, stating that the teaching methods she had were not enough.

In summary, Suda's lessons illustrated her development of content knowledge, general pedagogical knowledge, curriculum knowledge, and knowledge of learners and their characteristics.

Suda's Views of Teaching Toward the End of the Study

In the second interview in December 2007, Suda stated that both the experiences she had gained from university subjects and classroom observations had an equal influence on her teaching. She stated that university courses gave her knowledge of both content and teaching methods, however, classroom observation gave her opportunity to observe teaching in the classroom. Suda reasoned that some teaching techniques she knew only from the book, but she didn't how to use them and when was an appropriate time to use them in the classroom.

After finishing her practicum, Suda maintained her belief that experiences from university subjects and practicum had same impact on her teaching. She pointed out that "I still have limited teaching experience, so I use the knowledge I gained from the university together with experience I gained from practicum" (Int 3, Feb 08).

After practicum, Suda realized that teaching was not as easy a job as she first thought. She sometime felt discouraged when the teaching was not going well as she expected. She accepted that she could not engage her students to the lesson and did not used

different kinds of teaching method. However, she wanted to learn more about teaching strategies and how to gain students' attention throughout the lesson. She was also interested in learning about school administrative work.

Suda's Belief about Pedagogy as Represented by Concept Maps

Suda developed her second concept map when she began her practicum in November 2007. This concept map provided more detail than the first concept map. It has many sub-concepts under the three main concepts, as shown in Figure 7.2.

Suda divided the concept map into three parts: analysis of context, lesson planning and classroom practice, and after-lesson activity. For the analysis of context, Suda explained that she would analyse learners and their needs and outcomes. She would evaluate learners' knowledge then use the results to consider the content that was appropriate for the students' levels. Following this, she would set the main objective for the particular lesson, then select the content that suited the learners. Then she would think about the context of teaching/learning in detail, for the length of the teaching period, the number of students in the class, location of the classroom, and the classroom environment. Suda also identified learners' characteristics in order to find the most suitable teaching method, "I'll spot students' backgrounds. For example if some students are afraid of lizards or snakes if I show them real samples, these may frighten them" (Int 2, Dec 2007).

After the analysis of context, Suda would plan the lesson. First, she would consider the content. According to Suda, content could be separated into three parts: (1) core content (highly important content); (2) important content (but not main content); and (3) additional knowledge (optional requirements). She would arrange the order of the topic in her lesson by importance, namely core content, important content and additional knowledge. Then she would select the teaching technique that suited the content and select teaching materials that suited the teaching method. After that, she would plan the strategy to engage the students in the lesson and provide motivation, for example praising and telling the test results.

The last part of Suda's concept map refers to the section after the lesson activity. After she let students do activities, she would evaluate them and give them feedback

from time to time. This would encourage the students to improve themselves and give the teacher a chance to modify their teaching techniques to fit the learners. Suda suggested that the pre test and post test allowed the teacher to assess students' learning outcomes and use the results to consider the effectiveness of the teaching method and lesson plan. These evaluations also motivated students to improve themselves. Then after teaching, the teacher should evaluate the overall achievements to assess the effectiveness of her lesson plan, teaching technique and teaching materials. Suda pointed out that these three main strategies must come together; each strategy alone was not sufficient to achieve effective teaching.

In the interview later in December 2007, Suda mentioned that she realized the importance of "how to organize the content". She pointed out that in her first concept map, she just wrote what she wanted to teach, whereas, in the second concept map she divided the content into many parts. This was easier for her to organize the lesson to fit the learners' abilities. The second concept map showed her development of content knowledge, general pedagogical knowledge, curriculum knowledge, and knowledge of learners and their characteristics.

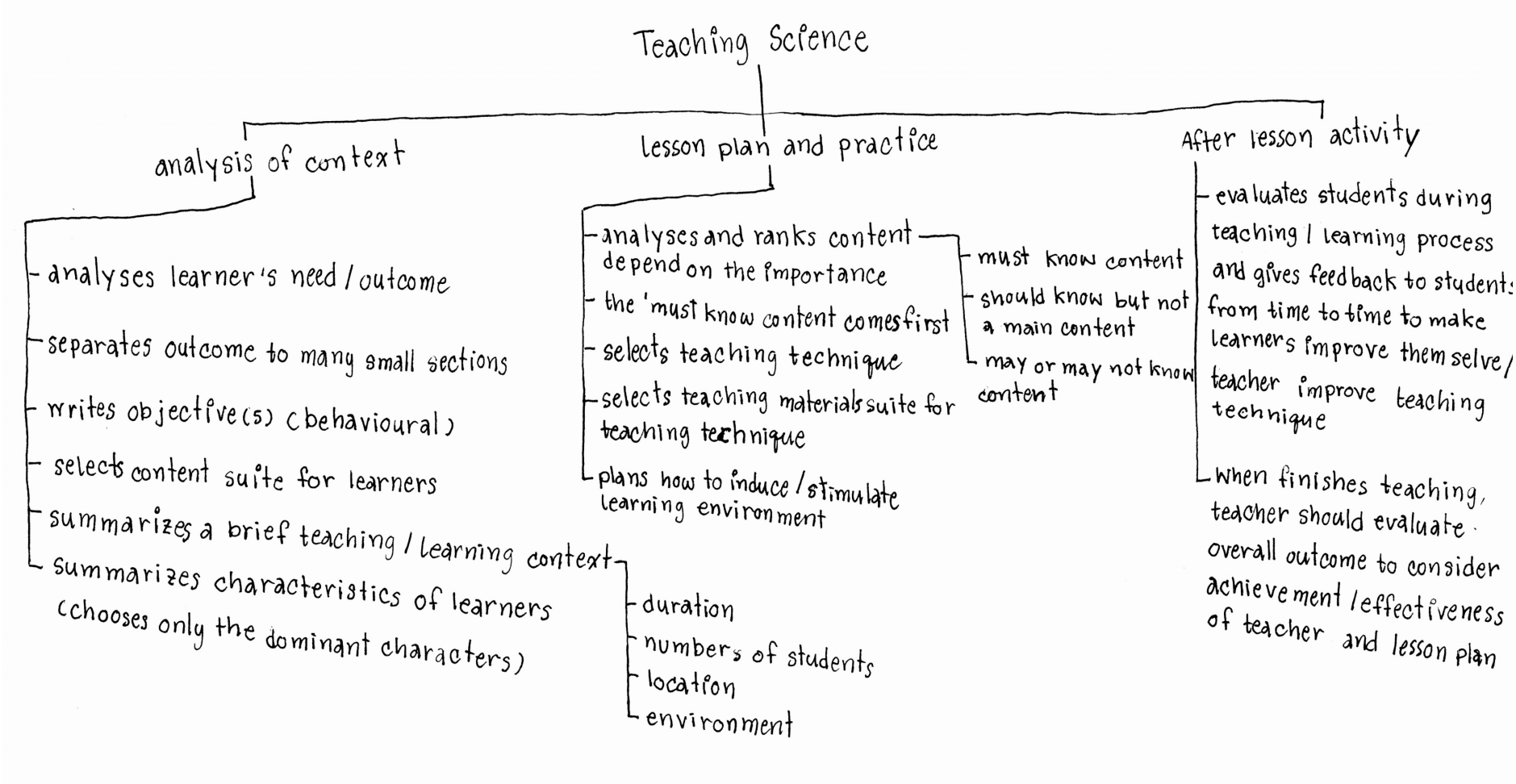

Figure 7.2 Suda's second concept map

The third concept map, that Suda developed after finishing her practicum, was again arranged in a linear structure. The arrows linked each concept together in the same direction with more details in some concepts, as shown in Figure 7.3. This indicated that Suda viewed 'science teaching' as a complex process with each concept represented as a step in the process.

First, Suda would study and analyse the curriculum. She began by studying the National Educational Act, particularly section 22, as mentioned earlier. Additionally she would study the school's vision, academic standards and expected outcomes. She also considered the needs of the community, parents and learners. Then she applied this information in her lesson plan and organized the lesson according to the lesson plan. The formative evaluation tools used during the lesson were exercises. The results were used to estimate students' progress. If the students failed the learning standards, the teacher needed to do research to find out the cause. Then she could make use of the findings for improving both teaching method and evaluation tools. There might have been an extra lesson and supplementary exam for students who failed the test. If the students met the standards, it meant that she could continue to use the particular teaching strategy. In addition, summative evaluations were conducted at the end of the semester and academic year in order to assess students' learning outcomes. Finally, the teaching and learning would be concluded and reported.

Suda realised the importance of curriculum. She commented that before making a lesson plan, she must thoroughly study and analyse the curriculum as well as the school's expected outcomes. She used the curriculum as a guideline for making lesson plans in order to make her teaching relevant to the learning objective. Suda realised that it was necessary to understand the curriculum before planning the lesson and teaching it. She suggested that, "If we teach something, we must have the objective. We cannot groundlessly make the objective unless we understand the curriculum" (Int 3, Feb 08). "I've learned this from experience. For now, I know the concepts but I'm still finding the effective teaching method" (Int 3, Feb 08).

The third concept map illustrated Suda's content knowledge, general pedagogical knowledge, curriculum knowledge, knowledge of learners and their characteristics, knowledge of educational contexts, and knowledge of educational ends, purposes, and values, and their philosophical and historical grounds.

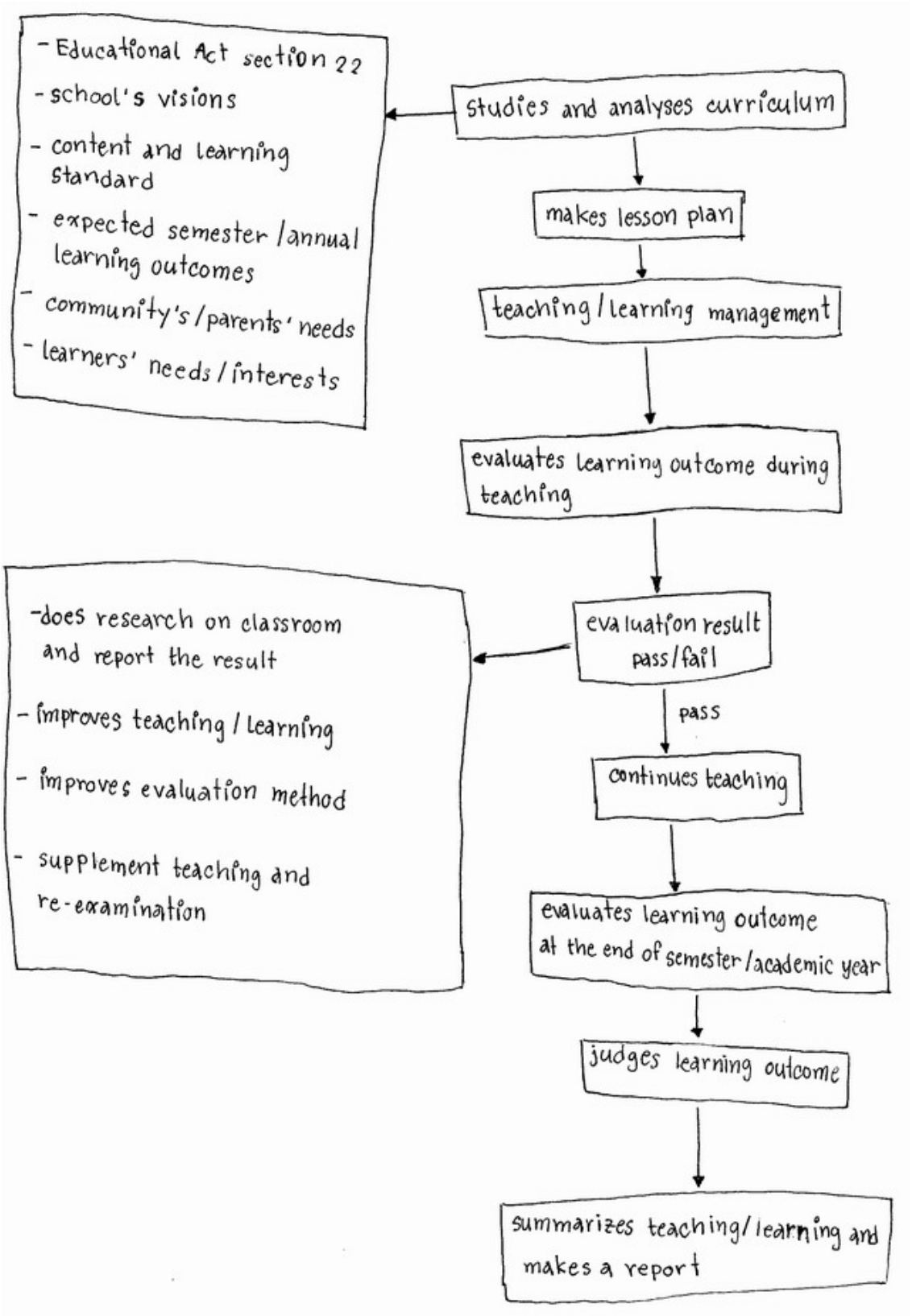

Figure 7.3 Suda's third concept map

Summary of the Case

At the beginning of the study, Suda's understanding of science teaching was mainly influenced by her past experiences as a student. Her content knowledge showed a minor development. She thought knowledge she gained from university course similar to what she learned when she was a student but she had a chance to practice her experimental skills. Her view of content knowledge was influenced by the university science subjects, especially the practical part, and her experiences from her studies of the secondary school. There was a major change in Suda general pedagogical knowledge. Her initial general pedagogical knowledge was based on how she was taught science as a school student, however, by the end of the practicum, her belief about science teaching was mainly influenced by her practical experience rather than her experience as a student.

There was a major change in her curriculum knowledge. She gave a priority to studying curriculum as a first step of teaching process. Her development was influence by her observations and teaching experiences. Suda developed a major change in her knowledge of learners and their characteristics. She firstly felt confident that she could control the students by using her experiences as a student as a standard. After she experienced real classroom practice, she realized that she could not manage her students the way she intended. It appeared that Suda changed her thinking from being a learner to thinking like a teacher. This change was influenced by her prior knowledge as a student and teaching experiences. Apart from the knowledge mentioned above, Suda started to develop curriculum knowledge during her school observation. There was a major development in Suda' knowledge of educational contexts. She realized the importance of the National Education Act. This realization was influence by her practicum experience. Moreover, she was aware of the necessity of educational contexts and she developed knowledge of educational ends, purposes, and values, and their philosophical and historical grounds. This development was influenced by her teaching experiences.

Chapter Eight

Discussion and Conclusions

Overview

The purpose of this study was to identify the development of teacher knowledge that four Thai preservice teachers experienced during the fourth year of their university course and the influences on their development. The study employed a multicase research design to describe and analyse student teachers' development of teacher knowledge at different stages in their education course. The major methods used for gathering data were concept maps, interviews, and lesson observations. This final chapter draws together data from the previous four chapters and is divided into four sections: (i) overview of the findings; (ii) findings of the study in relation to the literature; (iii) implications of the study; and (iv) recommendations for further research.

Overview of the Findings

This study identified the development of types of teacher knowledge in four preservice teachers as they progressed through the fourth year of a five-year teacher education program. It was shown that the preservice teachers developed pedagogical knowledge, knowledge of learners, content knowledge, and curriculum knowledge, and to a lesser extent knowledge of school contexts. The main influences on this development were their own prior experiences as students in school, the practicum, the mentor teacher and university course work. An overview of the findings across the case studies can be seen in Table 8.1

Table 8.1 Comparison of Changes in Student Teachers' Teacher Knowledge

Cases	Forms of teacher knowledge						
	Content knowledge	General pedagogical knowledge	Curriculum knowledge	Pedagogical content knowledge (PCK)	Knowledge of learners and their characteristics	Knowledge of educational contexts	Knowledge of educational ends, purposed and values, and their philosophical and historical grounds
Somchai	There was a minor change in his content knowledge. Content was a sole focus in the 1st concept map but it was only one point of whole process in the 2nd concept map. The development was influenced by university science subjects, his observation experiences, and teaching experiences. *As shown in Table 4.1 and Figures 4.1, 4.3*	There was a major change. His perspective moved from thinking like a learner to thinking like a teacher. His development of general pedagogical knowledge was influenced by the practical experiences he gained from his observation and practicum sites. *As shown in Table 4.2 and Figures 4.1, 4.2, and 4.3*	There was major change in his curriculum knowledge. He understood the importance of curriculum. This development was influenced by his teaching experiences and mentor's advise. *As shown in Table 4.3, classroom observations and Figure 4.3*	There was no evidence that relates to PCK	There was a major change in his knowledge of learners and their characteristics. He changed his view from thinking like a learner to thinking like a teacher. His prior knowledge and experiences from school observations and practicum had the impacts on this development. *As shown in Table 4.4, classroom observations, and Figures 4.2, and 4.3*	There was no evidence related to knowledge of educational context.	There was no evidence related to knowledge of educational ends, purposed and values, and their philosophical and historical grounds
Natee	There was a major development in his content knowledge. He found the connection between content and curriculum during his practicum. University sciences course, his teaching experiences and mentor were the influences in the development. *As shown in Table 5.1 and Figures 5.3*, 5.2, and 5.3	There was a major change in his general pedagogical knowledge. His pedagogy became more systematic. This major development was influenced by his mentor and practicum. *As shown in Table 5.2*	There was a major change in his curriculum knowledge. He used the curriculum as the important guideline for planning lessons. His mentor's advice had a main influence on his curriculum knowledge. *As shown in Table 5.3, classroom observations, and Figure 5.3*	There was no evidence that related to PCK	There was a minor change in his knowledge of learners and their characteristics. He remained confident in his understanding of student nature. This development was influenced by his experiences with a little influence from his mentor. *As shown in Table 5.4 and Lesson observations of Natee's lessons.*	There was a minor change in his knowledge of educational context. *As shown in Figure 5.1*	There was no evidence related to knowledge of educational ends, purposes and values, and their philosophical and historical grounds

Cases	Forms of teacher knowledge						
	Content knowledge	General pedagogical knowledge	Curriculum knowledge	Pedagogical content knowledge (PCK)	Knowledge of learners and their characteristics	Knowledge of educational contexts	Knowledge of educational ends, purposed and values, and their philosophical and historical grounds
Manee	There was a minor change in her content knowledge. She was aware that content knowledge was the necessary knowledge for teaching. She developed her content knowledge because of the university science subject. *As shown in Table 6.1, Figure 6.1 and Lesson observations of Manee's lessons*.	There was a major change in her general pedagogical content knowledge. She used a more comprehensive pedagogy and gained more confidence as a teacher. This development was influenced by students, university, and practical experiences. *As shown in Table 6.2 and Figure 6.3*	There was no evidence that related to curriculum knowledge	There was no evidence that related to PCK	There was a minor change in her knowledge of learners and their characteristics. She developed more concern about her students and could identify her students' difficulties. This development was influenced by teaching experiences combined with the help from her mentor. *As shown in Table 6.4 and Figure 6.2, 6.3*	There is no evidence relates to knowledge of educational context.	There was no evidence related to knowledge of educational ends, purposed and values, and their philosophical and historical grounds
Suda	There was a minor development in her content knowledge. University science content was similar to secondary science content and it offered a chance to improve her experimental skill. This change was influenced by prior knowledge and university science subjects. *As shown in Table 7.1*	There was a major change in her general pedagogical knowledge. Her teaching concept became comprehensive. This development was influenced by her prior knowledge and teaching experiences. *As shown in Table 7.2, Figures 7.1, 7.2, 7.3 and Suda's lessons.*	There was a major change in her curriculum knowledge. She gave a priority to curriculum knowledge as a first step of the teaching process. The change was influenced by her experiences from school observations and practicum. *As shown in Table 7.3, Figures 7.2, and 7.3.*	There was no evidence that related to PCK	There was a major change in her knowledge of learners and their characteristics. At the beginning, this was guided by experience as a learner herself then she understood the students' characteristics and tried to find teaching techniques that suited them. This development was influenced by prior knowledge, and teaching experiences. *As shown in Table 7.4, Figure 7.2, and Suda's lessons*	Suda was aware of the importance of educational contexts during her practicum. This major development was influenced by her teaching experiences. *As shown in Table 7.5, Figure 7.3*	Suda developed knowledge of educational ends, purposed and values, and their philosophical and historical grounds during her practicum. This major change was influenced by her teaching experiences. *As shown in Table 7.6, Figure 7.3*

Findings of the Study in Relation to the Literature

Somchai, Natee, Manee and Suda each developed teacher knowledge in different respects and to different extents during their practicum period indicating that teaching experience played an important role in developing their teacher knowledge. The preservice teachers moved from thinking like a learner based on their own experiences as students in schools to thinking like a teacher. These changes tended to occur as a result of the practicum, as the preservice teachers had to play the teacher role as well (Ineke et al., 1999; Hoban, 2005). The findings from this study are similar to Wickramasinghe (2004) who investigated the change of Sri Lankan preservice teachers' knowledge. That study showed that preservice teachers mainly developed their teacher knowledge during their practice teaching periods.

In the present study, all four cases changed their view of science from thinking like a learner to thinking like a teacher. The expressions of their views about teaching and learning shifted from themselves as science learners to being science teachers concerned about students' learning. Their understanding about teaching became broader and more complex. This is consistent with the study of Erick and Dias (2005), which indicated that during field placement, student teachers initially relied on teaching knowledge from university courses, and their past experiences as a student then began to integrate these experiences with knowledge they gained from their teaching practice. However, their teacher knowledge did not show explicitly in their practice because they had limited teaching experience. A similar finding was shown in Ho and Toh (2000), who explored the impact of Singaporean preservice teachers' teacher knowledge on their teaching. They showed that preservice teachers had limited teacher knowledge, in particular general pedagogical knowledge, thus, taught from textbooks and used a lecture-style teaching approach. The same finding was also found in Da-Silve, Mellado, Ruiz, and Porlan's (2006) work that showed that beginning teachers used a teacher-centred approach in their first years of teaching.

Somchai, Natee, Manee and Suda developed similar views about *content knowledge*, probably because their university subjects preceded their teaching experiences. They believed that the university science subjects provided them with the knowledge necessary for teaching. However, there were differences in the extent of change in

content knowledge between the cases. Somchai's perception of science teaching was initially centred on content knowledge, as confirmed by his first concept map (Figure 4.1), which contained mainly science content. Natee also believed that university science subjects were critical for teaching. Under his mentor's supervision during the practicum, he came to appreciate the connection between content and curriculum. He noted that, "When I study curriculum, I'll understand the content and how deep it should be to be suitable for students in each grade. So, I can transfer the knowledge that suits students' needs" (Int. 3, Feb 2008). He also wanted to improve his content knowledge and keep it up to date. Natee said, "I want to be up to date because new scientific knowledge happens everyday. If I don't keep [up with] that knowledge, I'll fall behind. It's like I'm in the box and I won't know what happens in the outside world" (Int. 3, Feb 2008). This indicated that the major development in Natee's content knowledge was mainly influenced by his teaching experiences and his mentor's advice.

For Manee, university science subjects not only gave her necessary knowledge for teaching, it also gave her confidence in teaching. She stated, "If I hadn't studied science, I wouldn't have had the knowledge to teach students. If they'd asked me a question, I could not have answered them" (Int 3, Feb 2008). Likewise for Suda, the knowledge and experiences she gained from university science subjects, in particular laboratory skills, gave her confidence to teach. However, there was no evidence indicating that the participants developed their content knowledge by gaining access to other resources than university science subjects and textbooks for particular class in their responsibility in teaching. The exception was Somchai whose subject did not have any particular textbook, thus he had to find his content from the internet. From observed lessons, all preservice teachers tended to depend on textbooks and their lesson plans. They used explanations and examples selected from the lesson plan. These indicated a low level of content knowledge amongst the preservice teachers. Many studies have emphasized inadequate content knowledge in preservice and beginning teachers (Sigmuang, 2002; Killion, 1998; Jones, 2000; Davis, 2003; Leinhardt & Greeno, 1986; Johnston & Ahtee, 2006). A similar situation was found in Singmuang's (2002) study in Thai preservice mathematics teaching, which revealed preservice teachers with low subject matter knowledge used examples from their

lesson plans and could not make up examples when students asked questions. If they did not know an answer, they simply ignored the questions or repeated the previous explanations.

Although the university science subjects were one of the influences on all four preservice teachers' content knowledge, there were some problems in the course itself. The science course consisted of lecture sections where the science concepts are taught to student via a teacher-centred approach. The laboratory activities are conducted by strictly following experimental procedure. Student teachers have to learn too much information in too brief a time, so it is impossible for them to understand science concepts, principle, and theories (Arons, 1989 cited in Cobb & Koballa, 1996). This learning experience also impacted on the student teachers' own teaching style. The finding we consistent with Adams and Krockover's (1997) study on preservice secondary teachers which indicated that the preservice teachers used the instructional approach demonstrated in subject matter courses as a model for teaching.

In all four cases, the student teachers changed their views about *general pedagogical knowledge* to a major extent after they experienced teaching in schools on their practicum. It appeared that their practicum was the main influence on the changes in their general pedagogical knowledge. There are studies indicating practicum has a major influence on general pedagogical knowledge. Ho and Toh (2000) pointed out that practicum provided preservice opportunities for reflection and the reflection is an important part in the development of the teaching process. Bryan and Abell (1999) highlighted the importance of teaching experience, "experience plays a significant role in developing professional knowledge" (p.121). For Somchai, there was a major development in his general pedagogical content knowledge during the study. At the beginning, his view of teaching was based on his experience as a student - he planned his lessons based on how he was taught at school. He reasoned that, "I think the students will understand this because I have been taught like this and I understood, so the students should understand it too" (Int. 1, Aug 2007). However, his way of thinking about science teaching gradually changed due to his school observations and his experiences of the practicum. His pedagogy became more comprehensive and he became more concerned about the students' understanding, as shown in Figures 4.1

and 4.2. Somchai also wanted to improve his teaching method. He said, "I want to have a much better teaching technique. I wish I could teach with more fun" (Int. 3, Feb 2008). In the case of Natee, his interest at first was focused on students. He considered the students before planning the lesson. The major development of his general pedagogical knowledge occurred during his practicum under the influence of his mentor and as a result of his teaching experiences. Natee changed his first priority for teaching from the students to the curriculum. He reasoned, "If I understand what the objective in each class is, students will receive knowledge and experience according to what the curriculum expects" (Int. 3, Feb. 2008).

There was also a major change in Suda's general pedagogical knowledge, which progressively developed and became more complex during her practicum. She also grew more confident in her teaching. Suda's initial perception about teaching was based on her own experiences as a student in school. As with Somchai, her teaching was based on the way she was taught herself at school and she believed it would work equally well for her students. She pointed out that, "I don't follow any principle or theory and this came from my experience when I was a student" (Int. 2, Dec. 2007) and "I'll teach the way I liked when I was a student and I think this will make the students study better" (Int. 2, Dec 2007). She began to change her view about teaching from thinking like a learner (the view she formed when she was a learner at school) to thinking like a teacher during her practicum (the view she formed when teaching, reflecting her perspective as a teacher). She expected the students' performance based on her prior knowledge as a student. This idea changed as she experienced actual classroom practice. She also started to develop her teaching concepts, although she realized that she had limited teaching experience. She tried to improve herself, claiming that "For now, I know the concepts but I'm still finding the effective teaching methods" (Int. 3, Feb. 2008) and "because I have limited teaching experience, I tried to use different teaching techniques to assess which techniques were effective" (Int. 3, Feb 2008). It appeared that the teaching experiences helped shape her view of teaching.

An interesting point across the cases was that a strong influence on the teachers was their own experience as students in school. The data showed that the student teachers'

own prior experiences as school students was a strong influence on the way they thought about teaching and learning. Because they had experienced mostly conventional pedagogical approaches in their own learning as students at school and at university, they used those experiences as a teaching model for their own practice. This finding, supporting Lortie's (1975) notion of an "apprenticeship of observation", in that teachers tend to teach the way they were taught when they were students. According to Kagan (1992), student teachers held the images of good teachers, images of self as teacher, and a prior knowledge as a student before entering the teacher education program and these beliefs and images remained unchanged by the program and tagged along preservice teachers to practicum. They viewed teaching from a students' perspective and used their previous experiences as learners as a guide for good teaching (Calderhead, 1991; Davis, Petish & Smithey 2006). A longitudinal study of a biology teacher conducted by Da-Silve et al. (2006) showed that the image of the teacher was influenced by one's own experience as a student, and at the beginning of a teaching career the participant tended to imitate the teaching style of some of her previous teachers. The present study's finding is also similar to other studies (Ineke et al., 1999; Watzke, 2007; Veal, 2004; Black and Halliwell, 2000) which affirmed the view that the preservice teachers used their prior experiences as a learner when teaching their lessons.

Even though there were major changes in Somchai, Natee, Manee and Suda's general pedagogical knowledge, in all four cases they used only a teacher-centred, lecturing style in the observed lessons on practicum. Simmons et al. (1999) studied over 100 beginning science teachers and found that 90% of first year teachers used a teacher-centred approach and they were mainly concerned with surviving day-to-day tasks and classroom management rather than experimenting with various teaching methods. Hughes (2005) affirmed the view that beginning teachers struggled with classroom management and survival, so they abandoned the interest in exploring new curriculum, content, or new ways of teaching.

All four student teachers reported a major changed the way they discussed general pedagogical knowledge, but they did not actually change the practice in their teaching on practicum so it is questionable to what extent they changed their core beliefs about

teaching. They reproduced the teacher-centred approach they experienced when they were students. Although the education subjects at the university introduced to them a variety of teaching methods, most of their lecturers did not model this variety when teaching the student teachers; that is, the students did not have a role model for a innovative approach to teaching. Somchai claimed, "If the lecturers don't do it [teaching] as an example, then I can't do it at all …" (Int. 1, Aug 2007). In addition to this, almost all the teachers encountered in the school classroom observations and practicum used only a lecture style of teaching as well. According to the interviews, it appeared that the student teachers had many ideas about teaching but could not put them into practice because of limitations with resources in the practicum sites and restrictions imposed by the supervising teachers. This problem was caused both by a lack of teaching and laboratory facilities and the absence of permission for the preservice teachers to use the schools' teaching equipment. Manee recalled that during the practicum there was inadequate laboratory equipment saying, "In my practicum site, students wanted to do the experiments but the school didn't have lab equipment. Students told me that they wanted to do experiments but they've never had any chance" (Int. 2, Dec 2007). Some schools did not give permission for preservice teachers to use teaching resources freely because they were afraid that expensive equipment would be broken, and no one wanted to take the responsibility. Consequently, the preservice and even school teachers themselves were reluctant to use those teaching materials. In many schools, teaching and laboratory equipment was merely put in the cabinet for display. Somchai pointed out that, "I really wanted to use the computer laboratory to let my students use multimedia and the internet but I didn't know how to ask permission" (Int. 3, Feb 2008). These factors contributed to the student teachers having a restricted teaching experience on practicum, reducing their choice to using conventional teaching methods that were the most convenient option for them.

In short, the present study showed that all preservice teachers explained a change in their concept of general pedagogical knowledge, but they used only a teacher-centred approach in their teaching. Simmons et al. (1999) concluded that while beginning teachers described their student-centred beliefs, they used a teacher-centred approach in their practice. The same finding was acknowledged in Calderhead (1991) who

stated that changes in teacher knowledge and beliefs do not necessarily result in changes in practice. Besides the limitation of resources, this could be explained by Doyle's (1983 cited in Kagan, 1992) progression in understanding. The progression included the three following stages:

> Rote knowledge of classroom strategy (a teacher can talk about an instructional strategy but cannot perform it, performs it poorly, or performs it with only a superficial understanding); routine knowledge (the teacher can talk about the rationale underlying the strategy and can apply it but only with much effort and thought and in specific context); comprehensive knowledge (the teacher can talk about the strategy and can apply it across context automatically, thus freeing mental space to focus on pupils. (p. 144)

It appeared that all four cases were in the first stage of this progression. However, in order to develop to the next step, they needed the support of university supervisors, mentors, school, and the education program and to have the freedom to experiment with their teaching. Unfortunately, this was not the case as although they spoke about innovative teaching, they could not demonstrate it. A possible reason for this could be cultural influences of Thailand. Preservice teachers were reluctant to discuss their practice openly with their mentors. Teaching is a highly respected profession in Thai culture. Students are taught from a young age that they should always show their teacher respect and they are not supposed to argue with teachers. This belief was firmly established in all four student teachers and it led them to obey and do everything they were told without questioning their university instructors and mentors. They were afraid to talk with their mentors and ask for resources, and raise problems. Because their mentors were their assessor, the preservice teachers thought if they did something against their mentors, their mentor might fail them. Another reason is the long found passive learning style they experienced since they were young. They had become used to sitting quietly and listening to their teacher rather than discussing in both school and university. Hence, there are strong cultural influences on the preservice teachers in both the university and school that stop them speaking for themselves to express opinions resulting in them conforming to traditional practices.

The three cases other than Manee showed development of *curriculum knowledge* during their classroom observations and practicum. There was no evidence relating to Manee's curriculum knowledge. For the others, though, their teaching experiences and mentors' advice influenced these changes. Somchai's curriculum knowledge began to develop during his school observation. He realized the importance and role of the curriculum and thought that content was a 'subset' of curriculum. When he practised his teaching, he was aware that he should study the curriculum thoroughly before planning the lesson. This major change was influenced by his experience of school observations and the practicum. Natee developed his curriculum knowledge during his practicum, mainly due to his mentor, who enabled him to realise the necessity of understanding the curriculum before planning a lesson. Suda developed her curriculum knowledge through her experience from both school observation and practice teaching. She placed the analysis of curriculum as the first step of her teaching, as seen in Figures 7.2 and 7.3.

There was no evidence relating to Somchai, Natee, Manee and Suda's *pedagogical content knowledge*. The four student teachers did not show any development of this knowledge either in their ideas or in their practices. It would seem that this was due to their limited teaching experiences. Hence, it is questionable whether preservice teachers can develop pedagogical content knowledge which is "how particular topics, problems, or issues are organized, represented, and adopted to the diverse interests and abilities of learners, and presented for instruction (Shulman, 1987, p.8). It appears, therefore, that extensive experiences as teachers in schools is needed to develop pedagogical content knowledge.

All four cases developed *knowledge of learners and their characteristics*. Somchai and Suda changed their view of learners and their characteristics from a perspective formed when they were students themselves to a perspective based on their current experience as teachers. Manee exhibited a concern with students' problems in her class, which was influenced by her teaching experience and her mentor's advice. With Natee, there was a minor change in his belief about the students. He still felt confident in his ability to understand children's nature. With Somchai, he initially used his experience as a learner in identifying students' science learning difficulties. He

claimed, “from my experience, I don’t like Physics. Biology needs memorization and boys don’t like reading. Children don’t like memorization but they like experiments. Doing experiments in laboratory … they like it very much” (Int. 1, Aug 2007). Somchai came to identify his students’ characteristics and problems and their solutions from a teacher’s perspective. This major development was influenced by his teaching experiences.

On the other hand, only a minor change occurred in Natee’s knowledge of learners and their characteristics. He maintained a belief that he understood students’ nature. He claimed that, “I used to be a kid so I understand children. I know which teaching style they prefer” (Int 3, Feb 2008). However, he also noted that his mentor gave him advice about how to gain students’ attention and classroom management. The development of his knowledge of learners and their characteristics was mainly influenced by his experience with little influence from his mentor. Manee developed her concern about students’ learning difficulties during her practice teaching. She tried to help these students with help from her mentor. There was a major change in the case of Suda. At the beginning, she felt confident that she was able to control the students because she could manage her classmates when she was a student. She claimed that, “I felt at least I could control students. It reminded me how I could manage my friends when I was a high school student” (Int 1, Aug 2007). This indicated that she understood learners from her own experiences as a student. However, she began to realize that her students were different from herself and therefore she was not able to use herself as a standard. She needed to know her students in order to teach them effectively. The major change in Suda’s knowledge of learners and their characteristics was influenced by her practicum experience.

At the beginning of the study, all four cases showed their knowledge of learners and their characteristics from the views of learners. They believed that students shared the same nature as themselves. Ineke et al. (1999) discovered that preservice teachers “are aware of their own conceptual problems, or have overcome conceptual problems, will expect the same problems with their pupils” (p. 72). They felt confident in teaching because they thought they understood students and knew how to manage them in the classroom before they experienced practicum. Geddis (1993) pointed out

that preservice teachers held simplistic views of teacher roles and relationships with students and "the role of teacher is viewed as that of a guide and friend, and the teacher-pupil relationship is envisaged in terms of warmth, co-operation, and mutual respect" (p. 674). However, when they entered the practicum phase, they found that the students were different and they could not easily control or engage them in the lesson as they thought.

No *knowledge of educational contexts* was shown in the cases of Somchai and Manee. Natee exhibited his knowledge of educational context in his first concept map (Figure 5.1) but it was excluded in his second concept map indicating it became less important for him. Suda showed a concern about educational contexts after her practicum as she drew in her third concept map (Figure 7.3). This major development emerged following her teaching experience.

The three cases except Suda did not show knowledge *of educational ends, purposes, and values, and their philosophical and historical grounds*. Suda demonstrated her concern about this teacher knowledge in the third concept map (Figure 7.3). This major development emerged from her teaching experiences in the practicum site.

In summary, the major findings from the study are consistent with findings from some researchers in western countries. First, the preservice teachers' strong influence from their own experiences as school students is consistent with Lortie's "apprenticeship of observation" as demonstrated in numerous studies (Calderhead, 1991; Davis, Petish & Smithey 2006; Da-Silve et al., 2006; Ineke et al., 1999; Watzke, 2007; Veal, 2004; Black & Halliwell, 2000). Second, the influence of the practicum on changing teacher knowledge is key as demonstrated in other studies (Ineke et al., 1999; Wickramasinghe, 2004; Erick & Dias, 2005; Ho & Toh, 2000). Third, the reliance on a teacher-centred approach by preservice and beginning teachers is predominant as from their own school experiences. What is different in this study from other studies in western societies is how changing teaching practice is possibly more difficult particularly because of the strong culture influences in Thailand.

The presentation of the findings in this study may suggest that the forms of teacher knowledge act independently. As stated by Shulman (1987), all seven types of teacher knowledge are interrelated. In order to teach effectively, teachers have to possess all types of knowledge, which work collectively with other knowledge to influence pedagogy. None of the particular types of knowledge alone can make good teaching. An explained by Roehrig and Luft (2004) is:

> A teacher with a strong understanding of the nature of science and a desire to implement inquiry instruction might ultimately be hindered by perceptions of the students' abilities and their school context. Or a teacher with a strong background in science and inquiry might have not thought much about inquiry instruction in the classroom, and thus little inquiry instruction may be evident in the classroom. (p.19)

Therefore, to make teaching successful, all forms of teacher knowledge must be woven together into the expression of practices. This claim was support by Exley (2005) who pointed out that teachers must have all type of teacher knowledge in order to teach successfully.

Implications of the Study

One implication of this study is that it is important for teacher education programs to encourage preservice teachers to reflect upon and understand the importance of their prior school experiences. Hence, lecturers in teacher education programs should discuss more with student teachers about their prior knowledge when they were students at the beginning of teacher education subjects. These problems and misunderstandings need to be made public, addressed and understood at the beginning of their teacher education programs. The education program should revisit those prior experiences throughout the program and should help student teachers connect their prior experiences to new knowledge they receive during the university courses. Costa (1995) affirmed that:

> "What teachers do in the classroom is determined by their perceptions of their role, their knowledge about and repertoire of the instructional strategies, and their knowledge of their students and how they learn, as well as about the structure of the discipline of knowledge the are responsible for teaching. To install, alter, or refine instructional behaviors, supervisors must mediate by

> inviting teachers to become aware of and to evaluate their perceptions and cognitive maps of their own reality". (p. 11)

The data showed that different components of the university program influenced the development of teacher knowledge. For example, the university coursework in science provided the subject matter knowledge to give teachers confidence to teach school science content. Education subjects provided pedagogical knowledge for the student teachers, which also gave them the confidence to teach. Although the preservice teachers learned many teaching strategies in their coursework, on practicum they still used teacher-centred approaches similar to a lecture style. The study showed that although they developed pedagogical knowledge about the use of different strategies, they did not demonstrate this in their teaching practices**.** It is strongly recommended that university courses employ teachers with appropriate expertise to serve as role models of innovative practices in teacher education programs. In order to become qualified teachers, the student teachers need an effective role model to learn from. Interestingly, the lecturers in the university pedagogy subjects never used or demonstrated the teaching methods in their lessons that they advocated. Thus, the student teachers learned only theory without seeing any practical implementation. Lecturers should model many different and innovative teaching approaches for their students.

Teaching is a complex job and therefore student teachers require a range of knowledge to help them deal with the challenges, and develop confidence and capacity before entering practicum. The data indicated that the education program should put more emphasis on classroom management. In order to be successful in the classroom, the courses should give the student teachers essential knowledge and skills especially for difficult circumstances. Preservice teachers need to know how to engage students in the lesson and what kind of strategies would support and encourage them in their studies. For curriculum knowledge, preservice teachers need to know how to assess their students and plan instruction that meets the students' needs to covers the required content. They must know about national and local standards for students' learning. Even though lecturers might try hard to equip the preservice teachers with knowledge crucial for teaching, there are still many

challenging problems waiting for them in school classrooms. So it is also important that prospective teachers should learn how to acquire knowledge they need by conducting their own study from other resources beyond what they have learnt from the university.

A major finding of the study was that the practicum was the most influential part of the course in terms of developing forms of teacher knowledge. Bryan and Abell (1999) stated that "experience as a professional provides perturbing encounters that highlight tensions in thinking about teaching" (p. 136). The mentor had a lesser but major influence on the development of teaching in preservice teachers. It is the mentor teacher who guides the preservice teacher in many different aspects of teaching and learning. If the preservice teacher has a chance to work under the direction of an expert mentor, who carefully supervises and is a good model, that preservice teacher will grow to be a confident, effective and committed teacher (Darling-Hammond & Baratz-Snowden, 2005). Advice from skilled veteran teachers can help the preservice teacher develop their teacher knowledge. Preservice teachers should be closely supervised by an experienced mentor to coach, model, and be a consultant in various areas relating to curriculum, pedagogy, and classroom management. In the beginning, the preservice teachers should act as assistants and practise teaching under the more direct supervision of their mentors, then become increasingly independent, under the guidance of the mentors. The mentors should support lesson planning, provide coaching, and be available to address problems that arise.

In addition, the university education program needs to maintain strong relationships with schools. The program should closely monitor the preservice teachers' performance and make sure they are constantly assessed and provided with feedback. School observation enables the student teachers to understand the school context in addition to teaching. It also provides an opportunity to study and become familiar with the classroom and school environment before the practicum. The practicum helps speed up the development of teacher knowledge. However, there were many constraints that limit this development. The main problems were the inaccessibility of school resources and lack of guidance from their mentors. The preservice teachers

did not get permission to use teaching materials and laboratory equipment freely, hence they were reluctant to use these materials for their teaching. This problem, combined with the lack of support from their mentors, limited their choices to conventional teaching styles because teaching using rote learning required little teaching material or pedagogical skill. Therefore the school needs to give the preservice teachers full access to its resources to encourage them for use to enable diverse teaching methods. As mentioned above, the practicum helped the preservice teachers develop their teacher knowledge. There are studies that support an extended student-teaching period (Roehrig & Luft, 2006; Cobb & Koballa, 1996). Because of the importance of the practicum, it is recommended that it be extended, as well as linked more closely with coursework, to be carefully monitored by both mentors and lecturers. However, all of these recommendations take resources, including more time and planning on behalf of the lecturers and mentor teachers. In order to improve the quality of the practicum environment, the government needs to put in more funding for school resources as well as payment of reward entitlements for mentors for their supervision.

Not only should the practicum be longer, but another important consideration is how it should be structured. Hopkins (1995) highlighted that:

> "Theoreticians and practitioners agree that quality field experiences produce quality beginning teacher. Conversely, field experiences that limit preservice teachers to constrictive roles produce beginning teachers without a vision, predestined to spend years engaging in robotic actions that provide their students with less than the best". (p. 8)

Cobb and Koballa (1996) found that when it came to practice teaching, preservice teachers tended to concentrate on finding easy teaching methods or fancy demonstrations that could engage student rather than planning for innovative lesson plans. Researchers suggested that "student teaching should be a gradual assumption of responsibilities rather than a sudden immersion into the culture of science teaching" (p. 474). In particular, preservice teachers need time to observe classes and be supported by university lecturers when they are in school. Although the education program organizes training for a mentor in order to understand mentor roles and does provide a mentor's handbook as a reference for mentoring, the long-established belief

of the practicum is maintained, "traditional views of the practicum are of an apprentice-model, where the naïve apprentice is immersed into the work situation, observing, absorbing, and intimately imitating the master" (Keogh, Dole, & Hudson, 2006, p. 1). Many mentors see preservice teachers as their assistant who comes to ease their workload rather than as a trainee that they need to closely oversee. Thai teachers usually teach 40 hours per week, which is higher than teachers from many countries (Chaingkool, 2009). In the present study, most preservice teachers were usually assigned to teach as soon as they started their practicum, or even during their school observation in some cases. They took full responsibility for the lesson without receiving proper instruction, coaching, or modeling from their mentor or lecturers. It seems that they were left to "sink or swim" without strong support to ensure that they could successfully teach and manage the class. As stated by Cobb and Koballa (1996), "completion of student teaching does not signal a readiness to take all the responsibilities of science teaching without assistance" (p. 474).

Therefore, the teacher education program should organize the training for the supervisors, school administrators, and mentors to provide them the information on how to correctly supervise the preservice teachers. This should be a co-ordinated approach with communication between the schools and university. Additionally, there were not any school visits from the education program lecturer during the practicum. Thus, there was no way to identify preservice teachers' problems, errors, weak points, and misunderstandings. A research study suggested that beginning teachers without support tended to use conventional practices and hold traditional beliefs (Luft, Roehrig, & Patterson, 2003) or adopt a habit of science-avoidance (Appleton, 2003). The preservice teachers' teaching performances need to be analyzed as well as their problems need to be solved before these student teachers enter the one-year internship in their fifth year. Hence, preservice teachers need to observe the classes for three weeks to understand the type of children and resources before they start teaching, with appropriate guidance from their mentors and the university program.

There is no evidence to indicate that any of the four cases developed pedagogical content knowledge. Development of pedagogical content knowledge requires the integration of other teacher knowledge such as content knowledge, pedagogical

knowledge, and knowledge of learners and their characteristics and experience of teaching to a regularly period of time. However, these preservice teachers lacked the deep knowledge of subject matter and the knowledge of how students learn and perform. These problems, combined with the lack of teaching experience necessary, led to the low ability to transform knowledge into effective practice.

Considering the problems relating to cultural aspects, it is not recommended to discard the respect towards teachers especially those with seniority since it is an essential part of Thai culture but it is recommended that the mentor encourage the preservice teacher speak openly. There should be more open communication between the mentor and preservice teacher when they can discuss and express their opinion freely. Mok, (2005) emphasized that "student teachers' thinking and learning are critical in their teaching practicum and their thinking has to be made explicit through dialogue and interrogation" (p. 53). Preservice teachers need to discuss with mentors their problems, teaching performances, actions and decisions, and so on. Therefore the mentor should adopt the role of 'co- enquirer' as well as the act as role model, coach, and consultant. Furlong and Maynard (1995) defined the role of co-enquirer as:

> "as a co-enquirer, they will have a more open and equal relationship with their student, spending more time working as equal professionals. Such a relationship has the advantage of encouraging the student to take greater responsibility for their own learning and allows both student and mentor to address some of complexities of teaching in a spirit of open enquiry". (p. 193)

A preservice teacher-mentor relationship should develop to be more of equal partnership, which they both taking responsibilities for planning lesson and teaching. A study conducted on secondary student teachers of a Flemish teacher training collage by Schepens, Aelterman, and Van Keer (2007), compared five preservice teachers who attend the practicum program based on traditional 'apprenticeship' style with five preservice teachers who joined the practicum based on the principles of collaborative partnership style. The study indicated that preservice teachers in the partnership arrangement tended to develop more practical knowledge than preservice in traditional arrangement. The collegial relationships should be made not only between preservice teachers and mentors but also with other teachers and other professionals. Mok (2005) suggested that, " through expressing their reflections to, and entering into

collaboration with, others, students teachers and cooperating teachers help to build shared language and a shared knowledge of practice" (p.53) and preservice teacher who experienced the collegial relationships tended to maintain a good attitude in teaching when they entering teaching career.

Recommendation for Further Research

Since Shulman introduced the idea of multiple categories of teacher knowledge in 1987, other researchers have refined and developed their own models of teacher knowledge based on his categories of teacher knowledge. However, there are only a few studies that use all Shulman's seven categories of teacher knowledge as their analytical framework (e.g. Corrigan, 2007). Most studies have taken only selected forms of teacher knowledge as their framework such as Pedagogical Content Knowledge (Grossman, 1990; Cochran, DeRuiter, & King, 1993; Fernandez-Balboa, & Stiehl, 1995; Van Driel, Verloop, & De Vos, 1998; Gess-Newsome, 1999; Magnusson, Krajcik, & Borko; 1999). According to Shulman (1987), the seven forms of teacher knowledge are interrelated, so in order to teach effectively, each category of teacher knowledge cannot be treated separately; all of them have to bind together. Therefore further studies that address all seven forms needs to be conducted to understand how all forms of teacher knowledge are built relate to each other and developed to improve the effectiveness of efforts to train highly-qualified teachers.

This study has implications for further research in teacher knowledge of preservice teachers in Thailand and elsewhere. First, since this five-year teacher education program has just started, more studies need to be done in order to identify whether or not this new program is an improvement on the old four-year program. Second, follow up research should be conducted as the preservice teachers continue their practicum in their internship in the fifth year of the education program and subsequently into schools. It would be informative to monitor how they develop their teacher knowledge and whether there are any differences between their first and second periods of practicum.

Third, the number of classroom observations should be increased. The classroom observations were made only two or three times for each preservice teacher due to the

time limitation. Therefore, it might be possible that their practices may not be clearly identified. Finally, the participants in this research came from only one university. This research should be carried out in another university where a teacher education program is available in order to compare the results. In this way, a more complete and generalisable picture of the development of preservice students' teacher knowledge could be created.

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Appendices

Appendix 1A: Interview Questions

Background Questions

1. What is your family background?
2. What is your educational background?
3. Tell me about the best and the worst teachers you ever had?
4. What made you decide to become a science teacher?
5. What role model do you have for yourself as a science teacher?
6. How would you describe yourself as a science teacher?

Main question I: Can you give me an example of teaching a science lesson?

1. How do you plan your lesson?
2. Why do plan the way you do?
3. Do you use any particular strategy for each topic?
4. Can you give me an example?

Main question II: Why did you teach it in this way?

1. Are there any things at the school or university that influence the way you teach?
2. What are some examples of this?
3. Are your education/pedagogy subjects beneficial to you when you begin teaching? Why or why not?
4. Are your science subjects beneficial to you when you begin teaching? Why or why not?
5. In reference to the teaching model that you have developed, if you had to divide that up into a pie chart, how much of that chart would come from university course, your practicum experience, or any thing else that you can think of?

Other questions

1. What area would you think makes science difficult for students?
2. What could make the study of science easier for students?
3. What do you believe are your main strengths as a teacher?
4. In what areas would you like to improve as a teacher?

(Adapted from Grossman, 1990)

Appendix 1B: Sample interview data of the pilot study

Site: University of Wollongong

Responder: Yoko

Interviewer: Kanyaarat Sonsupap I = Interviewer

Transcriber: Kanyarat Sonsupap R = Responder

Typist: Kanyarat Sonsupap

Date: 11/06/07

Start: 7.30 pm End: 8.30 pm

I: Now I'd like to talk to you as an English teacher. What made you decide to become an English teacher?

R: yeah…don't laugh at me …when I was junior high school student, I met a great, great English teacher…ah…one of reason why I became an English teacher because that great English teacher. She taught English…not only English but also culture and society in different countries…so…oh…if I can speak English, I can…you know…travel all over the world and I can met …you know…people…a lot of people from other countries…I'd to do that …so…yes…at that moment…may be I'd like to get the job to continue to study English….and also this is not direct reason but in high school…I wrote to Tom Cruise…I liked him… I got a letter from him so that mean again made motivation to study English…may be he gave me the reason…I always talked about that to my student…you need some kind of motivation to study English.

I: Tell me about what you see as the reasons for studying English in secondary education

R: If they study English, they can learn about lot of countries, people, culture,

I: What areas would you want cover in your class?

R: In English class, I want to teach them not only English, but also…oh…have a look in the world we have a lot of countries…I wanna show them.

I: What area would you think makes English difficult for students?

R: Can I talk to you from the point of view of Japanese high student….yeah…like me ….I think it's listening and speaking….I thing for them…unfortunately…the reason

why they study English…one of the reason is to prepare for entrance exam to university… so at this moment they need to study reading and writing very hard and very well…but listening and speaking….now we have listening test as well but for them, it's not important….and also they don't have opportunity to speak English in my country.

I: What areas do you think they might have problem with?
R: I think oral communication…I mean English communicative areas…

I: What is easy for secondary students?
R: Reading

I: What could make the study of English easier for student?
R: I think if I can give them their favorite things about English may be English study…not only…you know…we don't have order…first, blah, blah, blah second blah, blah, blah…no, no…just what kind of think do you like…may be movie, music or chatting something like that….
I: So…you have to understand your student?
R: Yes…some of them…oh I love reading….if they love reading…ok for you…you can enjoy reading, no worry about speaking…. Or some of them…oh I'd like to writing…writing is my favorite…ok you can…like that…yeah…a bit difficult…because we have curriculum for…you know…we have to follow….but…we have extracurricular subject….like a hobby…. I can do that….

I: Tell me about the class you have taught before?
R: ah…I taught English to high school level…year ten, had 40 students…average class in Japan…I and another native speaker teacher…two teacher teach English conversation….and this class…one lesson in 5o minutes….and twice a week…and also….the class size is the same, 40 students but just only I teach 40 students…this is a general English course so…um…I taught them writing, reading, listening, speaking….everything…and one lesson is 50 minutes and 3 lessons a week…

I: How were the classes organized?
R: 40 students per one class

I: What books or units were you teaching?

R: Basically, we must use text book approved by minister of Education…so sometime…it's difficult to use my teaching material…because I have to teach English following this textbook and also…another teacher teaches the same subject….that mean I can't do differently….I think test book is not so good…I'd like to change…yeah…every textbook, even though textbook for communication….not good …because always focusing on grammar

I: Have you familiar with those books?

R: Yes…very…and also since I was student almost the same the content is the same…just now every things in the book have color…that all…

I: Have you read them before?

R: Yes

I: Have you tough them before?

R: Yes

I: Tell me about the students in your class?

R: They are average level….not so god but middle level and…at the beginning of the class I always ask them…I mean a questionnaire…and everybody answer I'd like to speak English very well so I want to study very hard…every said like that….but when they start to study English that mean using text book and very focusing on grammatical issue…gradually they don't like to study…because it's boring….so for me it's very hard to keep their motivation….so sometime I gave the sweet…like a treat….

I: Can you tell me what made effective teaching?

R: I think…not only…um …if teacher can become not a teacher but a facilitator… I think including me…teacher is very talkative…but English lesson….I'd like to tell teachers…children should speak English…so I think Japanese English teacher speak too much in the class…just make them think something…think about that…don't give them the answer….yeah…so for Japanese English teacher….I think it's a big issue…we have curriculum and text book so we'd like to finish everything very

quickly…so it mean teacher would like to tell every things in the class but...no, no…but how can we teacher teach basic knowledge very simply very easily…so his is big issue…today topic is this one …after give them on or two topic of knowledge after that our job is how can I make them use English, speak English, like English….so…like a P education, in PE class at first you have to learn about the rule like the soccer rule…and after that you'll start to play the game…like that…but Japanese language education class…we teach them rule…how to use English but the don't have chance to play game…I mean speaking in class…outside they'll not do that…. Now my decision is teach English simply make them do very hard…lazy English teacher is the best….teacher is director…students are actors or actresses….why teacher speak too much…so that mean when student think at the moment….facilitator mean teacher should observe student…teacher should give them support and help…like a supporter…this is my ideal teaching style.

Appendix 2A: Concept maps

Concept map topic: Teaching Science

Instructions

"Concept maps are hierarchically displayed with the broadest and most general concepts at the top of the map and the more specific, less general concepts position below, respectively"

The students attended a special class to receive instruction from the researcher on how to draw concept maps, as indicated by the following instructions:

1. Think about a topic.
2. Make a list of all concepts you can think of that are related to the topic.
3. Consider the relative importance of each concept and rank them, from the most important to the least important, and write them down.
4. Arrange the concepts into clusters then drew in and label linking line.
5. Reconsider how the hierarchy is developing and rearrange any concept to ensure the map makes sense to you.
6. Consider whether adding more connections or link words between concepts can show further meaning.
7. Focus particularly on the concepts at the sides of the map, then on those at the top and bottom in order to ensure the linking words and hierarchies accurately reflect your ideas.
8. Now attempt to add more concepts about the topic to your map, reorganizing the hierarchy, if necessary.

Then, the student teachers will draw practice maps for selected sample topics before being asked to draw the first concept map (Adapted from Wickramasinghe, 2004).

Appendix 2B: Concept map Questions

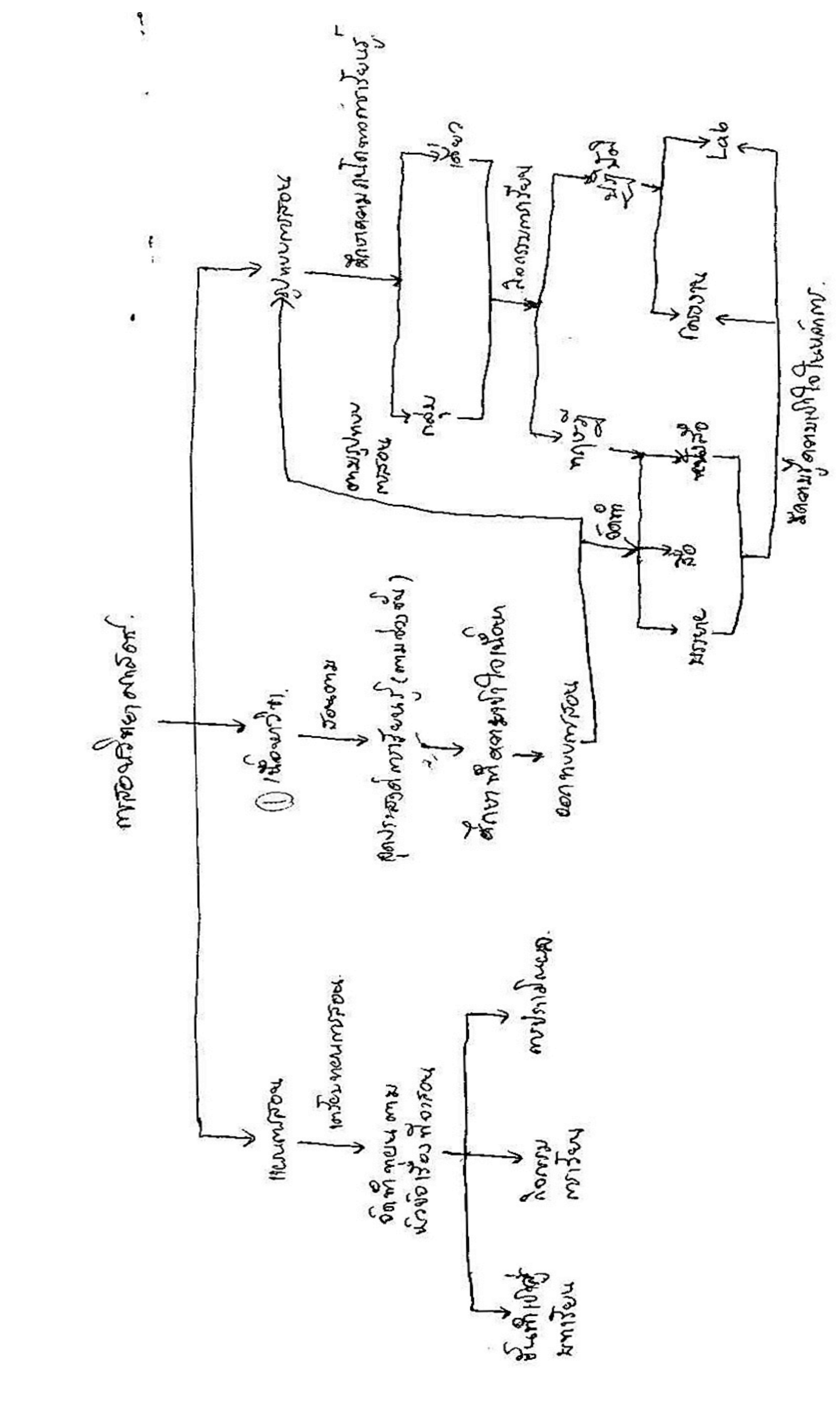
Questions about the first concept map:

1. Please explain your concept map.
2. Which concepts in your map are of the most importance?
3. Why?

Questions about the second and third concept maps:

1. Please explain your concept map.
2. Can you see any concepts in your map that you did not include in your previous map?
3. What are they?
4. Why did you add them at this stage?
5. What factors influenced you to make these changes?
6. Which concepts in your map are of the most importance?
7. Why?

Appendix 2C: Sample concept map



Appendix 3A: Questions about observations

1. Can you tell me about the lesson you just taught?
2. Can you show me the lesson plan?
3. Why did you do it in this way?

Appendix 3B: Sample filed note

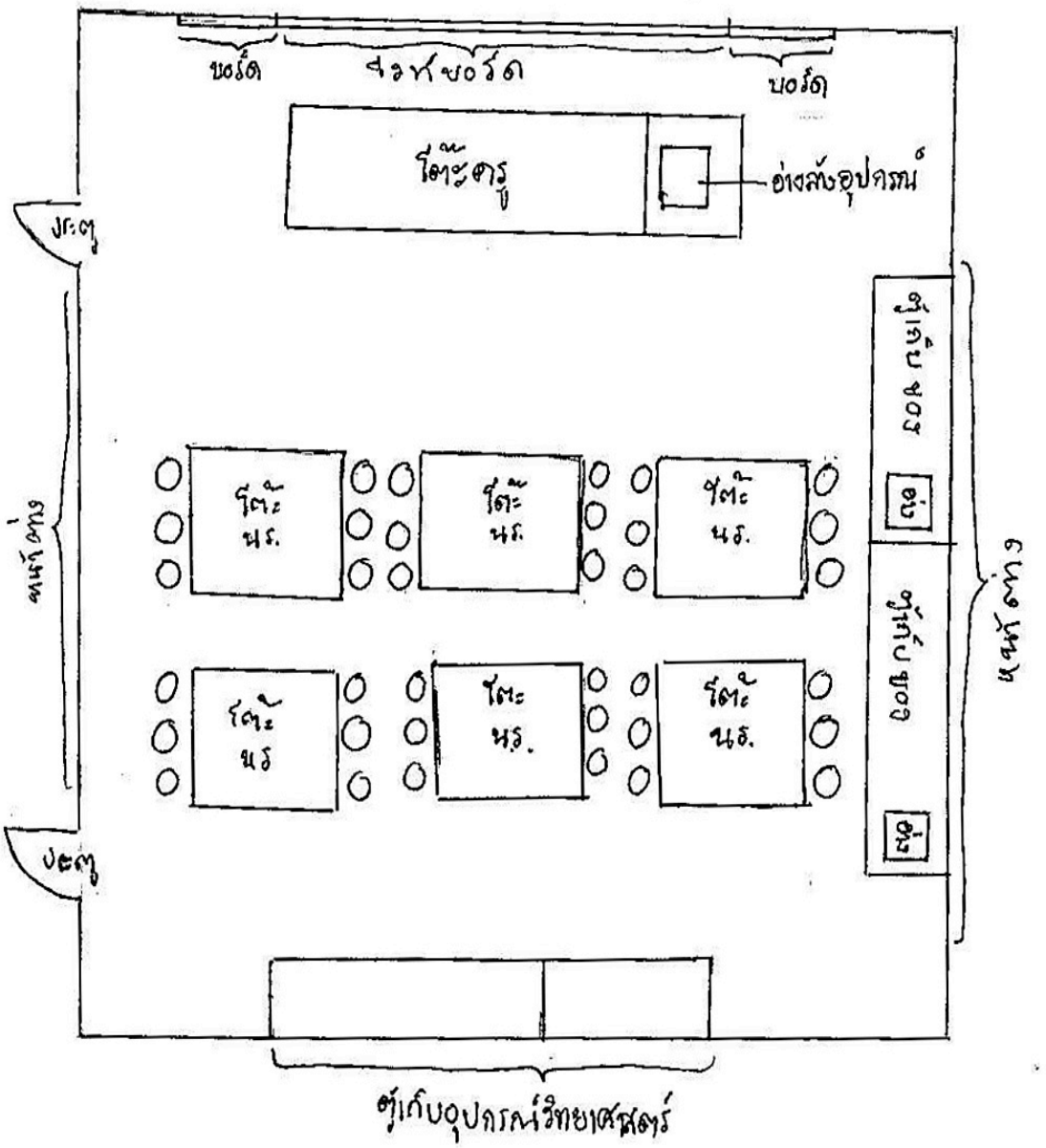
First Lesson Observation

22 / 01 / 08

8.30-9.30 น

สถานที่: ห้องวิทยาศาสตร์ (อยู่ชั้น 1 ของตึก)

ชั้น : ประถม 4



22 01 08

"กระบวนการเปลี่ยนแปลงของหิน"

อุปกรณ์การสอน : ใบความรู้

① ครูเข้ามาในห้อง เด็กๆ ทำความเคารพ
② ครูแจกใบความรู้ แล้วอ่านให้เด็กฟัง
③ ครูให้นักเรียนเขียน "สาเหตุของการเปลี่ยนแปลงของหิน" อย่างน้อย 5 ข้อ ลงในสมุด ระหว่างทำงาน มีเด็กบางคนไปถามครูที่หน้าชั้น
④ ระหว่างทำงาน ครูบอกให้เด็กๆ นำ มะนาวและเปลือกหอยแครง จากบ้านมาทำการทดลองพร้อมนี้
⑤ ครูเดินดูเด็กๆ ตามโต๊ะต่างๆ ทั่วห้อง
⑥ เด็กที่ทำงานเสร็จแล้ว เอางานไปส่งหน้าห้อง
⑦ ครูตรวจงานของเด็กที่นำมาส่ง
⑧ เมื่อเด็กๆ ทำงานเสร็จทุกคน ครูทบทวนคำถาม เกี่ยวกับเรื่องที่เรียน ให้นักเรียนช่วยกันตอบทั้งชั้น เด็กๆ ตอบโดยการอ่านใบความรู้
⑨ ครูเรียกเด็กๆ ที่มีปัญหาทีละคน ออกมาอ่าน ขัดสามข้างส่วนจากใบงาน ให้ฟังหน้าชั้น
⑩ ครูสรุปเรื่องที่สอนอีกครั้ง ก่อนเก็บ-ปล่อยเด็กเมื่อหมดเวลา

* ครูไม่ได้อธิบายอะไรนอกเหนือจากใบความรู้

* เด็กๆ มีจำนวนน้อย (18 คน) ทำให้การ manage เด็กๆ เป็นไปได้ง่าย
* เด็กๆ ตั้งใจเรียน / ทำงาน
* เด็กๆ ให้ความร่วมมือ กับครูค่อนข้างดี
* เด็กๆ บอกว่าครูสอนสนุก พอเรียนเสร็จจะได้เล่น (แต่ตั้งใจเรียนให้เสร็จก่อน)
* เด็กๆ บางคนมีปัญหาค่อนข้างอ่อน
* เด็กส่วนใหญ่พูดกับครูด้วยภาษาอีสาน
* student management ค่อนข้างดี (เทียบกับ case อื่น)

Appendix 4A: Sample of Somchai's lesson plan

Lesson Plan

Subject: Physical Sciences

Content Area: Sciences Key Stage 4 Matthayom 4 2nd Semester

Topic: Optical instruments, camera, slide projector

Teacher's Name: ……

Key Concept: Knowledge about lenses can be applied to make many useful devices, such as a slide projector, a camera, a microscope or a telescope.

Objectives

Students will be able to:

1. Describe the concept of optical instruments.
2. Identify the usefulness of optical instruments.
3. Analyze and present a particular topic.

Content

1. Camera
2. Slide Projector
3. Microscope

Lesson Procedure

Gaining attention

1. Teacher asks questions individually, e.g.
   - What is the name of an optical instrument?
   (Such as magnify camera, camera, movie camera, slide projector, etc.)
2. Teacher states the learning objectives.
3. Students show they are able to describe the concept of optical instruments
4. Students show they are able to identify usefulness of optical instruments
5. Students show they are able to analyze and present a particular topic

Investigation and Inquiry

1. Teacher divides students into five groups, 4-5 students per group with varying capabilities.
2. Students study a handout about optical instruments.

Explanation and Conclusion

Students discuss within each group what they have learnt from the handout then a group member presents to the class. Teacher elaborates any part that students do not understand.

Knowledge Expansion

Students state the names of some optical instruments. Teacher asks open-ended questions leading to discussion and application of knowledge.

Conclusion

1. Teacher evaluates students' understanding from worksheet.
2. Teacher praises students for cooperating in the learning activity.

Teaching materials

Learning materials

1. Handout
2. Worksheet

Sources

1. Library
2. Internet

Evaluation and assessment

Method

Checks from a worksheet.

Instrument

Worksheet

Criteria

Score not less than 60% to meet the standard.

Teaching Record

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Problems

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Suggestions

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Mentor's Suggestions

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Mentor

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Preservice Teacher

Appendix 4B: Sample of Somchai's handout

Handout

Optical Instruments

A camera is a device that records light reflected from an object through the lens. The camera captures the image on a light-sensitive object (i.e. film or image sensor) then develops a photographic film through the development process. A basic camera consists of three main parts:

1. An enclosed box.
2. A convex lens.
3. Ammonia-processed paper.

The picture is recorded on ammonia-processed paper and developed in an ammonia solution. The paper changes colour from pale yellow to blue or violet depending on the light intensity from the object. The image that appears on the paper is a smaller virtual and inverted image.

Single Lens Reflex Camera

A single lens reflex camera is the most widely used of cameras, consisting of:

1. An enclosed box that acts like a darkroom.
2. An objective lens that is a convex lens; the object needs to be located more than twice the focal length from the lens.
3. A diaphragm that is a metal sheet used for opening/closing the aperture.
4. A shutter release.
5. A viewfinder, an eyepiece for adjusting the picture.
6. A film to capture an upright image.
7. A flash.

Slide Projector

A slide projector consists of:

1. A high power halogen lamp that acts as a light source.
2. An objective lens that consists of one or more convex lenses producing an enlarged virtual inverted image.
3. A reflector that is a mirror or a chromium coated metal.
4. A focusing lens consisting of two plan-convex lenses stuck together to focus a light from a lamp and reflect it to make a parallel beam go to a slide.
5. A slide tray to carry slides in an inverse manner to make an upright image on the screen.
6. A fan to cool the lamp.

Operation of a slide projector

1. Place a slide far from focusing lens in the range between f to 2f of convex lens
2. Place the slide upside down to get an upright image on a screen.

An image from a slide projector is an enlarged virtual inverted image. This is a basic principle for making a slide projector, overhead projector or movie projector. However, the brightness of the image on the screen decreases as the size of the image increases. Therefore, these devices have a special lens, reflector and lamp that increase the brightness of the light to the screen to make a clearer vision.

Appendix 4C: Sample of Somchai's worksheet

Name…….. Student number …….. Group ……

Worksheet

1. Write the names of five optical instruments
   1. ……...
   2. ……...
   3. ……...
   4. ……...
   5. ……...

2. Write the parts of a single lens reflex camera
   1. ……
   2. ……
   3. ……
   4. ……
   5. ……
   6. ……
   7. ……

3. What type of image is captured on a film?

…….

4. Write the parts of a slide projector
   1. ……...
   2. ……...
   3. ……...
   4. ……...
   5. ……...
   6. ……...

5. A slide projector produces …….. image on the screen.

Appendix 4D: Sample of Natee' s lesson plan

Lesson Plan

Subject: Sciences **Unit Plan: Sound and Hearing**

Topic: Loudness **Lesson Time: One hour**

Objective

Students will be able to identify the danger of loud noise and explain how to protect themselves and avoid aural damage from loud noise.

Key Concept

Sound intensity increases with the amplitude of the vibrating source.

Lesson Structure

1. Gaining Attention

- Teacher discusses with students the concept of sound in everyday lives, then asks students how loud noise can harm the hearing.
- Teacher explains characteristics of loud noise, sound intensity, and danger from noise pollution and how to protect themselves and avoid aural damage from loud noise.

2. Investigation

- Students study information about sound and its danger from a worksheet, then summarize the information in their notebooks

3. Discussion and Conclusion

Students present the results from their studies

- Explain the danger from loud noise.
- Describe how to protect themselves and avoid aural damage from loud noise.

4. Expansion of Knowledge

Students develop their knowledge about sound and its dangers, and understand how to protect themselves and avoid the danger of loud noise.

5. Assessment

Students can explain the danger of loud noise and how to protect themselves from it.

Evaluation

1. Evaluation during an activity
   - Investigation skills
2. Evaluation after an activity
   - Discussion and conclusion

Teaching Materials and Sources

- Pictures of ear-protection devices
- Knowledge sheet about sound
- Knowledge sheet about danger of loud noise
- Library
- Internet

Teaching Record

Teaching Outcomes

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Problems

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Suggestion/Solution

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Teacher's Name: ……

Date: / /

Opinions and Suggestions from a School Principal or Authorized Person

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Signature of Assessor: ……

(……...……)

Date: / /

Appendix 4E: Sample of Manee's lesson plan

Lesson Plan

Science 4 Key Stage 2 (Prathom 4) 2nd Semester

Unit 5 Soil and Rocks Lesson Time 1 hour

Lesson Plan 3 The Rock Cycle (flexible)

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Standard: Students understand processes occur on and inside the earth, the relationships between different processes that cause change in weather, geography, and shape of the earth. Possess investigation skill, science literacy, and communication skills, apply knowledge to personal life.

1. Desired Outcome

Students will be able to investigate, observe and explain the process of rock weathering and erosion.

2. Main Content

Rocks decompose to form sands and soil trough the process of weathering and erosion caused by wind, water, chemical reaction, and other factors.

3. Lesson Structure

3.1 Gaining students' attention

3.1.1. Students discuss and answer questions related to how rocks change in nature, then record the discussion.

3.1.2. Students do an experiment. Students drop water and vinegar on empty cockle shells, investigate, and record a result.

3.2 Investigation and inquiry

3.2.1. Students discuss and answer the following questions:

1. In high mountain elevations where night-time temperatures are low, what will happen to rocks if water in cracks in the rocks freezes?
2. What will happen to rocks if cycles of hot and cold temperature make them expand and contract?

3. How do trees growing on rocks cause change in those rocks?

3.2.2. Is there any factor other than ice, trees, and temperature cycles that causes weathering?

3.3 Explanation and conclusion

3.3.1 Each group studies content from books.

3.3.2 Each group does experiment following procedure in a work sheet.

3.3.3 Group representative presents a result.

3.3.4 Teacher and students make a conclusion together.

3.4 Knowledge expansion

3.4.1 Students investigate and plan an experiment to explain:

1. Why do pebbles in a river have a round shape?
2. What are the causes of weathering?

3.4.1 Study from books, the internet, and textbooks to develop better knowledge.

3.5 Evaluation

3.5.1 Students are able to study and do an experiment to describe weathering process, and erosion, and discuss an experimental result.

3.5.2 Teacher asks questions to assess students' understanding.

4. Evaluation and Assessment

4.1 Procedures

4.1.1. Observe

4.1.1.1. Discussion

4.1.1.2. Questioning and answering

4.1.1.3 Planning and working

4.1.1.4 Report-writing and brainstorming

4.1.1.5 Conclusions and answers

4.1.1.6 Engagement

4.1.2 Check

4.1.2.1 Laboratory report

4.1.2.2 Experiment

4.2 Tools

4.2.1 Laboratory report

4.2.2 Result

5. Materials, Teaching Materials, and Sources

5.1 Materials

- 2 empty cockle shells
- 4-5 drops of vinegar or lime juice
- 1 glass of water
- 2 droppers
- 2 small ceramic plates

5.2 Teaching materials and sources

- Worksheet
- Handout
- Library
- Books

6. Suggestions

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Appendix 4F: Sample of Manee's handout

Handout

The Rock Cycle

1. Weathering

Weathering is the process that breaks rocks into small pieces. This process is caused by wind, rain, trees and microorganisms, and temperature.

1.1 Weathering caused by change of temperature

Cycles of hot and cold temperature make rocks expand and contract. These processes eventually lead to rocks cracking and breaking up into small pieces.

1.2 Weathering caused by frozen water

When water in cracks in rocks freezes, it expands, making cracks larger, and eventually breaks the rocks.

1.3 Chemical weathering

Acid rain dissolves rock.

1.4 Biological weathering

Microorganisms, plants and animals can cause weathering, for example, tree roots go into cracks in rocks and eventually break the rock apart.

2. Erosion

Erosion is caused by rocks breaking up into small pieces. There are four major ways erosion can occur: river, sea and wave, glacier, and wind.

2.1 Water erosion

Rocks are swept away by water, leading to erosion.

2.2 Wind erosion

Wind blows small particles against rocks, causing erosion.

2.3 Ice erosion

Ice erosion is caused as debris in a glacier scrapes an underlying rock, causing erosion.

Appendix 4G: Manee's worksheet

Worksheet

Erosion of Limestone

Group ……. **Prathom 4**

Date / /

Direction

1. Divide into groups, each group containing 5-6 students to plan an experiment in the erosion of limestone.
2. Do activity as planned.
3. Record a result.
4. Discuss the result in class.
5. Answer questions.

Process

1. Problem

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2. Guess answers

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3. Materials

- 2 empty cockle shells
- 4-5 drops of vinegar or lime juice
- 1 glass of water
- 2 droppers
- 2 small ceramic plates

4. Procedure

4.1 Place each cockle shell in small plate, drop water on a shell, then observe and record a result.

4.2 Drop vinegar or lime juice on a shell, then observe and record a result.

5. Data table

Experiments	Results
1. When drop water on a shell	
2. When drop vinegar or lime juice on a shell	

Questions

1. What causes rocks to change?

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2. What do you think about this activity?

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Appendix 4H: Suda's lesson plan

Lesson Plan

Sciences Key Stage 3 (Matthayom 2) 2nd Semester

Unit Plan: Our Body Lesson Time: 2 hours

Learning Plan 3: Nutrient deficiency and its symptoms (flexible)

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Learning Standards: Understands units of life, structure and function of systems in living organisms. Has a scientific inquiry and communication skills. And know how to apply knowledge to enhance one's own and other living things' well-being.

1. Key content

The medical conditions in the pictures are goiter, kwashiorkor, eye inflammation, and scurvy. The cause of symptoms is deficiency of nutrient requirements of the human body.

These conditions can be prevented and alleviated as follows:

1. Foods rich in iodine prevent and alleviate goiter.
2. Foods rich in protein prevent and alleviate kwashiorkor.
3. Foods rich in vitamin A prevent and alleviate eye inflammation.
4. Foods rich in vitamin C prevent and alleviate scurvy.

2. Expected outcomes

Students will be able to:

1. Recognize the medical conditions in the pictures.
2. Recognize the causes of particular medical conditions.
3. Recognize the prevention and alleviation of particular medical conditions.
4. Suggest to people with the particular conditions how to prevent and alleviate the symptoms.

3. Lesson procedure:

3.1. Gaining attention

3.1.1 Teaching process

1. Introduction to a lesson by discussing the causes of disease in human, for example microorganisms, abnormal cell division, and malnutrition,

which leads to the following question: what medical conditions are people in the pictures suffering from? What are the causes?

3.2 Investigation and inquiry

3.2.1 Students study Activity 5.7 Nutrient deficiency and its symptoms.

3.2.2 Teacher discusses with students and asks the following questions:

- What is an objective of the activity?
- What is the medical condition in the picture? What is the cause of the condition?
- How to prevent or alleviate the condition?

Then students write a discussion on flip chart paper, present to a class, and write down in a worksheet.

3.3 Explanation and conclusion

3.3.1 Students make a conclusion of the activity together by answering the following questions:

- What is the medical condition in the picture?
- What is the cause of the condition?
- Have you ever seen people suffer from some forms of malnutrition?
- Have you ever been suffering from some forms of malnutrition?
- How do you suggest people should be treated whose bodies are suffering from malnutrition?

Then students answer questions in the worksheet.

3.4 Expansion of knowledge

3.4.1 Study from other books and the internet for better understanding.

3.5 Evaluation

Students are able to search for information, identify the importance of nutrients and symptoms caused by deficiency of particular vitamins and minerals.

4. Teaching content

- Types of nutrient deficiency
- Symptoms

5. Measurement and assessment

5.1 Method

5.1.1 Observe

5.1.1.1 Considering from student's behaviour during the lesson.

5.1.1.2 Considering from student's self- evaluation.

5.1.1.3 Considering from student's work.

5.1.1.4 Considering from student's answering in the class and worksheet.

5.1.1.5 Considering from student's participation in a discussion

Teacher uses laboratory rubrics to assess students' performance

Criteria: Score 3 means Exemplary

Score 2 means Good

Score 1 means Fair

Criteria	Score		
	3	2	1
1. experimentation follows a procedure			
2. using laboratory equipment			
3. data record			
4. data analyzing and presentation			
5. conclusion			
3. care and maintenance of laboratory equipment			

Students' experimental skills will be scored using the following scoring rubrics.

Criteria	Score		
	1	2	3
1. Experimentation follows a procedure	Correctly follows procedure with some adjustment.	Correctly follows procedure with assistance from teacher. Some adjustment.	Follows procedure but missing some steps; no adjustment.
2 Using laboratory equipment	Uses equipment correctly and proficiently.	Uses equipment correctly but not proficiently.	Uses equipment incorrectly.
3. Data record	Data neatly recorded, organized, complete and accurate.	Data accurate but not neatly organized.	Data missing and inaccurate.
4. Data analyzing and presentation	Analysis of data is well organized, accurately and explicitly shown.	Analysis of data is well organized, accurately but not explicitly shown.	No analysis of data. Illogically presented.
5. Conclusion	Accurate conclusion and addresses all findings.	Accurate conclusion but does not address all findings.	Illogical explanation and does not address any finding.
6. Care and maintenance of laboratory equipment	Correctly cleaned and maintained.	Cleaned but not correctly maintained.	No maintenance.

5.1.2 Checking

- Activity record

5.2 Assessment instruments

- An observation sheet.

6. Materials, teaching materials, and sources.

6.1 Materials

- 4 Pictures of people suffering from nutrient deficiency.
- 1 flip chart paper.
- 1 magic pen.

6.2 Teaching materials and sources

- Work sheet/ handout about nutrient deficiency.

7. Suggestions

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Teaching Record

Subject ……. Code …… Lesson plan ……Unit……

Day……. Month …… Year ……..

1. Learning outcomes (Students develop knowledge/understanding content and past standard. In case student has a learning problem, write down student's name).

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2. Learning outcomes from teaching activity.

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3. Learning outcomes from teaching materials.

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4. Teacher performance

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5. Suggestion

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Signature ……..…. Preservice Teacher

Signature ……..…….. Mentor

/ /

Suggestion of School Principal or Authorized Person to Supervise/Suggest/Recommend

Content Standards …….

Teacher's name …… Class ……Semester ……. Academic Year ……...

Subject ……. …Code …….. Lesson Plan ……. ……Unit …….

1. Supervisor

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Signature ……..……..

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2. Program Coordinator

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Signature ……..

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3. Academic Administration

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Signature ……...

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4. School Principal

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Signature ……..…..

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Appendix 4I: Sample of Suda's handout

Handout

Nutrient Deficiency and its Symptoms

Nutrient deficiency is a medical condition caused by an inadequate nutrition which leads to deficiency of the particular nutrient.
There are many types of nutrient. Each type has a different effect on the body. The human body needs different quantities of nutrients depending on nutrient types. Improper diet leads to deficiency of nutrients.

Medical conditions in the pictures are:

1. Goiter

Symptoms	Cause
Swelling of the neck	a lack of iodine

2. Kwashiorkor

Symptoms	Cause
Amyotrophy, a distended abdomen	a lack of protein

3. Eye inflammation

Symptoms	Cause
Affected eye is smaller than a normal one, a reddened eye	a lack of vitamin A

4. Scurvy

Symptoms	Cause
Pale gums, bleeding	a lack of vitamin C

These conditions can be prevented and alleviated with:

Foods rich in iodine prevent and alleviate goiter.
Foods rich in protein prevent and alleviate kwashiorkor.
Foods rich in vitamin A prevent and alleviate eye inflammation.
Foods rich in vitamin C prevent and alleviate scurvy.

Appendix 4J: Suda's work sheet

Work Sheet

Nutrient Deficiency and its Symptoms

Activity 5.7 Nutrient deficiency and its symptom

Objectives

Students will be able to:

- Recognize the medical conditions in the pictures.
- Recognize the causes of particular medical conditions.
- Recognize the prevention and alleviation of particular medical conditions.
- Suggest to people with particular conditions how to prevent and alleviate the symptoms.

Materials

- 4 Pictures of people suffering nutrient deficiency.
- 1 flip chart paper.
- 1 magic pen.

Lesson Procedure

1. Students study 4 pictures.
2. Each group discusses the following questions:
   - What is the medical condition in the picture?
   - What is the cause of the condition?
   - How can these conditions be prevented or alleviated?
3. Write down the discussion on flip chart paper.

Pre-activity Questions

1. What are the objectives of the activity?

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2. What is the medical condition in the picture? What is the cause of the condition?

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Report

Table shows causes, prevention and alleviation of some forms of nutrient deficiency

Medical Conditions	Symptoms	Causes	Prevention and alleviation

Post-activity Questions

1. What is the medical condition in the picture? What are its symptoms?

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2. What is the cause of the condition?

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Name …… Student number ……. Class ……...

Appendix 5A: A copy of the information sheet for participants in Thailand

University of Wollongong 

PARTICIPATION INFORMATION SHEET FOR UNIVERSITY STUDENTS IN THAILAND

TITLE: *The development of teacher knowledge in preservice science teachers in Thailand*

PURPOSE OF THE RESEARCH

This is an invitation to participate in a study conducted by researchers at the University of Wollongong. The purpose of the research is to study what form of teacher knowledge fourth year secondary science student teachers develop in their teacher education program and use in their school practice. This study will focus on secondary science student teachers in their fourth year of their five-year teacher education program.

INVESTIGATORS

Kanyarat Sonsupap	Assoc. Prof. Garry Hoban	Dr. Gordon Brown
PhD student	Associate Professor	Senior Lecturer
Faculty of Education	Faculty of Education	Faculty of Education
02 4225 3850	02 4221 4450	02 4221 3792
ks689@uow.edu.au	ghoban@uow.edu.au	gordon_brown@uow.edu.au

METHOD AND DEMANDS ON PARTICIPANTS

If you choose to be included, you will be asked to give three interviews about teacher knowledge. The first interview will be conducted during first semester, the second at the end of first semester, and the last after the finish of practicum in the second semester. You will be audio recorded during interview. Documents (lesson plans, hand outs, student works, etc.) will be asked for from the participants. We will also request your permission to observe your studying in science curriculum class in the first semester and your classroom teaching at your practicum site in the second semester. We also wish to audio record an interview with your mentor about their response to your teaching and your teacher knowledge.

CONFIDENTIAL

All interviews, artifacts, data, and information will be kept confidential and secure to ensure privacy for each and every individual. Information used in the final report (thesis- an academic paper) will not have real names published but be assigned pseudonyms which will be overseen by the supervisors and the Ethics Committee of the University of Wollongong.

Your involvement in the study is voluntary and you may withdraw from the study at any time and withdraw any data that you have provided to that point. Refusal to participate in the study will not affect your relationship with the Faculty of Education or the University.

Thank you for your interest in this study.

Appendix 5B: A copy of the information sheet for a pilot study participant in Australia

University of Wollongong 

PARTICIPATION INFORMATION SHEET FOR A PILOT STUDY PARTICIPANT IN AUSTRALIA

TITLE: *The development of teacher knowledge in preservice science teachers in Thailand*

PURPOSE OF THE RESEARCH

This is an invitation to participate in a pilot study conducted by researchers at the University of Wollongong. The purpose of the research is to study what form of teacher knowledge fourth year secondary science student teachers develop in their teacher education program and use in their school practice. This study also will focus on the lecturer of the secondary science student teachers in their fourth year of their five-year teacher education program.

INVESTIGATORS

Kanyarat Sonsupap	Assoc. Prof. Garry Hoban	Dr. Gordon Brown
PhD student	Associate Professor	Senior Lecturer
Faculty of Education	Faculty of Education	Faculty of Education
02 4225 3850	02 4221 4450	02 4221 3792
ks689@uow.edu.au	ghoban@uow.edu.au	gordon_brown@uow.edu.au

METHOD AND DEMANDS ON PARTICIPANTS

If you choose to be included, you will be asked to give two interviews about your teacher knowledge. You will be audio recorded during interview.

CONFIDENTIAL

All interviews, artifacts, data, and information will be kept confidential and secure to ensure privacy for each and every individual. Information used in the final report (thesis- an academic paper) will not have real names published but be assigned pseudonyms which will be overseen by the supervisors and the Ethics Committee of the University of Wollongong.

Your involvement in the study is voluntary and you may withdraw from the study at any time and withdraw any data that you have provided to that point. Refusal to participate in the study will not affect your relationship with the Faculty of Education or the University.

Thank you for your interest in this study.

Appendix 5C: A copy of the consent form for participants in Thailand

University of Wollongong 

Consent Form for University Students in Thailand

The development of teacher knowledge in preservice science teachers in Thailand

Researcher: Kanyarat Sonsupap

I have been given information about *"The development of teacher knowledge in preservice science teachers in Thailand"* and discussed the research project with Kanyarat Sonsupap who is conducting this research as part of a PhD degree supervised by Associate Professor Garry Hoban and Dr Gordon Brown in the Faculty of Education at the University of Wollongong.

I am willing to participate and give my consent to use the information/data given by me in three interviews, three classroom observations and three sets of concept maps, documents, and samples (if any) for the above purpose.

☐ 3 interviews (audiotape record) ☐ 3 concept maps ☐ Documents

☐ 3 classroom observations ☐ Samples (if any)

I understand that my participation in this research is voluntary, that I am free to refuse to participate and that I am free to withdraw from the research at any time. My refusal to participate or my withdrawal of consent will not affect my treatment in any way or my relationship with the Department of Education or my relationship with the Rajabhat Mana Sarakham University.

If I have any enquiries about the research, I can contact Kanyarat Sonsupap (043 721411), Associate Professor Garry Hoban (02 4221 4450) and Dr Gordon Brown (02 4221 3792) or if I have any concerns or complaints regarding the way the research is or has been conducted, I can contact the Ethics Officer, Human Research Ethics Committee, Office of Research, University of Wollongong on 02 4221 4457.

By signing below I am indicating my consent to participate in the research. I understand that the data collected from my participation will be used primarily for a PhD thesis, and I consent for it to be used in that manner.

Signed ..... Date ...../...../.....

Name (please print)

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Appendix 5D: A copy of the consent form for a pilot study participant in Australia

Consent Form for a Pilot Study Participant in Australia

The development of teacher knowledge in preservice science teachers in Thailand

Researcher: Kanyarat Sonsupap

I have been given information about *"The development of teacher knowledge in preservice science teachers in Thailand"* and discussed the research project with Kanyarat Sonsupap who is conducting this research as part of a PhD degree supervised by Associate Professor Garry Hoban and Dr Gordon Brown in the Faculty of Education at the University of Wollongong.

I am willing to participate and give my consent to use the information/data given by me in two interviews, two concept maps and samples (if any) for the above purpose.

☐ 2 interviews

☐ 2 concept maps

I understand that my participation in this research is voluntary, that I am free to refuse to participate and that I am free to withdraw from the research at any time. My refusal to participate or my withdrawal of consent will not affect my treatment in any way or my relationship with the Department of Education or my relationship with the University of Wollongong.

If I have any enquiries about the research, I can contact Kanyarat Sonsupap (02 4225 3850*)*, Associate Professor Garry Hoban (02 4221 4450) and Dr Gordon Brown (02 4221 3792) or if I have any concerns or complaints regarding the way the research is or has been conducted, I can contact the Ethics Officer, Human Research Ethics Committee, Office of Research, University of Wollongong on 02 4221 4457.

By signing below I am indicating my consent to participate in the research. I understand that the data collected from my participation will be used primarily for a PhD thesis, and I consent for it to be used in that manner.

Signed ..... Date ...../...../.....

Name (please print)

.....

Appendix 5E: the letter of approval from Dean of Education

June 19, 2007
Dear Ms. Kanyarat Sonsupap

Thank you for the request from Kanyarat Sonupap. We approve that the study on 'The development of teacher knowledge in preservice science teachers in Thailand' can be conducted in the Faculty of Education during July 2007 until February 2008.

Sincerely yours,

(Asst.Prof. Dr. Wilun Chumpafaet)
Dean of Education
Faculty of Education