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An investigation of physics instructors' beliefs and students' beliefs, goals and motivation for studying physics in Thai Rajabhat universities

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AN INVESTIGATION OF PHYSICS INSTRUCTORS' BELIEFS AND STUDENTS' BELIEFS, GOALS AND MOTIVATION FOR STUDYING PHYSICS IN THAI RAJABHAT UNIVERSITIES

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USE OF THESIS

The Use of Thesis statement is not included in this version of the thesis.

DECLARATION

I certify that this thesis does not, to the best of my knowledge and belief;

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ABSTRACT

Students' interest in physics seems to be decreasing at all levels of education in most countries including Thailand. This problem is likely to be influenced by physics teaching and learning processes. Instructors' beliefs influence teaching strategies whereas students' beliefs, goals and motivation influence learning strategies. The investigation of factors influencing teaching and learning will provide useful information for improving the teaching and learning of physics.

This research aims to explore physics instructors' beliefs about teaching and learning physics, students' beliefs, goals and motivation for studying physics in Thai Rajabhat universities. A questionnaire was administered to instructors who teach introductory physics courses in Rajabhats throughout Thailand at the beginning of second semester in 2002. Questionnaires were administered to first year students who enrolled in introductory physics courses at two Rajabhat universities in the south of Thailand at the beginning and the end of that semester. Four case studies were conducted with instructors and students at the two Rajabhats during the semester.

Questionnaire data were coded, categorized and analysed using descriptive statistics. Case studies were compiled from instructor and student interviews, document analysis and classroom observations. Assertions were derived from the data analysis and summarised as general assertions to answer the research questions.

The findings of this study are:

1.) Thai Rajabhat physics instructors believe that: students should understand and be able to apply physics; both knowledge transmission and constructivist approaches are effective teaching strategies; the limitations of their teaching are factors associated with students and administration; student-centered strategies are most effective for learning physics; and, motivations for studying physics are the intellectual challenge of the subject, good teaching, enhanced employment prospects and application of physics to real life situations.

2.) The instructors prefer to explain lessons, give notes and laboratory work to verify theories. These teaching strategies are influenced by their beliefs about knowledge transmission rather than their beliefs about constructivist and student-centered strategies.

3.) Thai Rajabhat students have low motivation in studying physics. They believe that: physics is difficult and not interesting, giving clear explanations and student-centered activities are effective teaching strategies; the goal of studying physics is to pass examinations or get good grades; and, being attentive to the classes and hard working are effective learning strategies.

4.) The students are passive learners because they have low motivation, their goal of studying is only to pass exams, and their belief that being attentive to the classes is an effective learning strategy.

5.) The traditional didactic pedagogy and classroom environment limit opportunities for learning, and students' attitudes towards physics

The thesis makes some recommendations for improving teaching and learning of physics, and for further research in physics education. The recommendations are hopefully useful for Rajabhat universities and Thai education.

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DEDICATION

This thesis is dedicated to three of my beloved children; two daughters, Ananya (Paeng) and Chayanan (Prae), and son Panyapat (Petch) to encourage them in enthusiastic education.

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CHAPTER 1: INTRODUCTION

Background

Science is the study of natural phenomena and it develops descriptions and explanations of the world around us. Science has been developed systematically since the seventeenth century and now has an important influence on all aspects of our lives through technology, health, the environment and the economy.

Physics is a very important branch of science that considers physical phenomena. Physics is "the oldest and most basic of the sciences, is the science of matter and energy and of the relation between them" (Mulligan, 1991, p.1). Physics includes studies of phenomena such as light, sound, mechanics and thermodynamics and develops models of these phenomena, many of which are mathematically based. Students consider physics to be an abstract and difficult subject and often achieve poor grades.

While the world is developing rapidly through the application of science and technology, there is a problem of the students' diminishing interest in physics, at all levels of education (Fischer & Horstendahl, 1997). Thai education is also facing this problem. Students study physics where it is a required subject in the curriculum, however, fewer and fewer students in colleges and universities select physics as their major subject. Unfortunately, any substantial studies about this problem have not been reported in the Thai context. The concerns with situations in studying physics among Thai educators are therefore relied on anecdotal evidences.

This problem is a great challenge for all science educators. The models of teaching in science and physics must be reformed and improved. The traditional didactic model of teaching is based on the assumption that knowledge is transferred from the teacher to students. Teachers provide intact knowledge as an input to the students and the output is the students' score on the examination. The ultimate goal of this model of teaching is the equality between input and output (Johnstone, Watt, & Zaman, 1998).

Psychological research has focused for many years on the mind of learners. This research has led to the introduction of better pedagogy based on new theories, such as generative learning and constructivism (Osborne & Wittrock, 1983).

Motivation should play a more important role in teaching physics, if we are to maintain students' interest in the subject. Teachers always teach physics emphatically in the cognitive domain, however, the teaching and learning of physics should also involve emotion, motivation and commitment (Woolnough, 1998).

Rajabhat Universities

Rajabhat universities are tertiary academic institutes in Thailand that originated from teacher training colleges. The first Thai teacher training college was established in 1893. Thai teacher education developed gradually, and 36 teachers colleges were established by 1976. In 1983, every teachers college began to provide academic fields in addition to teacher education. All of these teachers colleges became Rajabhat institutes in 1994. Five more Rajabhat institutes were established later in the northeastern part of the country in 2001. Finally, in 2004, all Rajabhat institutes were upgraded to Rajabhat universities.

Rajabhat universities are expected to support and encourage the development of their local communities. The Rajabhat universities have five main responsibilities, which are teaching, research, fostering Thai culture, academic services to communities, and teacher education. The 41 Rajabhat universities are all expected to play an important role in the development of Thailand.

Rajabhat universities continue to play an important role in teacher education. Both pre-service and in-service teacher training courses are the most conspicuous roles of the universities.

Introductory Physics in a Rajabhat University

Introductory physics courses in Rajabhat universities are generally taught using a calculus-based approach. These courses are provided for the first or second year students in various fields. The contents of the courses consist of fundamental knowledge in mechanics, thermodynamics, waves and electricity. The students who enrol in these courses have normally studied algebra and trigonometry-based physics at the upper secondary school level. But very few students achieve high grades at that level, and a similar problem occurs in Rajabhat introductory physics courses.

Methods of Teaching

Anecdotal evidence suggests that the general method of teaching introductory physics is often the traditional didactic pedagogy in which the lecturer behaves as an expert who transmits knowledge to the students. It is a teacher-centered approach in which the teacher plays the most significant role in the classroom. Teachers typically explain the content according to the textbooks and give students notes to copy. The content is inflexible and is based on the physics of the 17^{th} – 18^{th} century (Coleman, Holcomb, & Rigden, 1998). Consequently students' interest in physics is low and their development of understanding of physics concepts is limited. Researchers and physics educators recognise this problem and continuously try to improve their methods of teaching physics.

Learning Process

Learning is the process that causes permanent change in an individual's knowledge or behaviour (Woolfolk, 2001). Modern learning theories emphasise that learners must be actively engaged in the learning process (Deci & Ryan, 1985; Deci, Vallerand, Pelletier, & Ryan, 1991).

Anecdotal evidence suggests that the traditional method of teaching physics in Rajabhat universities, students are obedient; they study by listening to the lecturer and taking notes quietly. There are very few students who take part in arguing or discussing ideas in the class, consequently students do not develop good understandings of physics concepts and get low grades as the final result.

Motivation

Ferguson (2000) defines motivation as a dynamic internal process that energizes and directs action and action tendencies; it pushes or pulls the individual.

Environmental antecedents and goals provide sources of motivation. Motivation has an energizing effect. Anyone who is highly motivated will be more alert and responsive and exert more effort in actions (Ferguson, 2000).

Woolfolk (2001) concludes that student motivation to learn is both a trait and a state. It involves approaching academic work to get the best results from it and engaging actively in the process. In the classroom, teachers should set appropriate tasks that affect motivation. Tasks have attainment and intrinsic values for students. Students often avoid risky and ambiguous tasks. Strategies that encourage motivation to learn should improve students' confidence and reduce their fear of failure.

In education, motivation is very important for effective learning. There are many theories and techniques of motivation involved with the teaching and learning process. A very important notion is that motivation in education is based on teachers' ability to challenge and encourage students to take on an active role in their learning (Ferguson, 2000).

Problem Statement

Students perceive physics to be a very difficult, mathematical and abstract subject. Most students get poor grades, lose interest and have negative attitudes to physics. Research is needed to investigate the relationships between; instructors' beliefs about teaching and learning physics, and students' beliefs, goals and motivation for learning physics; on the teaching and learning of physics.

Rationale and Significance

Approaches to teaching and learning physics need to be improved at all levels of education in Thailand. Of particular concern for Rajabhat universities, are the students in the field of education who will be the science teachers in the future; if they develop poor attitudes, goals, and beliefs about physics they will not be effective teachers of physics in secondary schools. This will have a detrimental effect on physics education throughout Thailand. The investigation of motivational constructs of Thai Rajabhat students and instructors' beliefs about teaching and learning physics, and how these influence the teaching and learning of physics, will provide direction for reforming physics teaching in Thai Rajabhat universities.

Purpose

The purpose of this study is to investigate: (a) physics instructors' beliefs about teaching and learning and the effect these have on their teaching behaviours; (b) students' beliefs about teaching and learning, goals and motivation for studying physics and the effect these have on students' learning behaviours; and (c) the influence of (a) and (b) on classroom environment, opportunities for learning and students' attitudes to physics.

Research Questions

1. What are Thai Rajabhat physics instructors' beliefs about teaching and learning?
2. To what extent are instructors' approaches to teaching physics influenced by their beliefs about teaching and learning?
3. What are the students' beliefs about teaching and learning, goals and motivation for studying physics in Thai Rajabhat universities?
4. To what extent are students' approaches to learning physics influenced by their beliefs, goals and motivation of studying physics?
5. What combination of factors appears to influence classroom environment, opportunities for learning and students' attitudes to physics?

CHAPTER 2: LITERATURE REVIEW

Introduction

Since physics is concerned mostly about the quantities in natural phenomena and the relationships between these different quantities, then physics usually expresses its explanation in terms of abstract mathematical relationships. Thus physics is considered by students to be a difficult subject and we are confronted with the problem of students' interest in physics decreasing all over the world (Fischer & Horstendahl, 1997). For example, in Australia, the proportion of Year 12 students enrolling in science public examination subjects has decreased continuously from 1980 to 1998, and the percentage of the Year 12 cohort enrolled in physics has reduced from 29% in 1980 to 18% in 1998 (Goodrum, Hackling, & Rennie, 2001).

Research in science education during the last two decades concerned with this problem has investigated methods of teaching and the effects of different teaching and learning factors on motivation (Barlia & Beeth, 1999; Elton, 1997; Lijnse, Klaassen, & Eijkelhof, 1993; Metz, 1991). This problem is a very interesting challenge for science education researchers and physics teachers all around the world.

Traditional Pedagogy in Physics

Traditional didactic teaching is based on behaviourist learning theory developed by Skinner and his followers. Behaviourists consider the mind of the learner to be a 'black box' and view learning in terms of inputs and outputs. Many traditional teachers believe that knowledge is an intact truth, which is transferable from teachers to students without any change (Johnstone, Watt, & Zaman, 1998). In this input – output model of learning, the input knowledge provided by the teacher and the knowledge received by students are expected to be equal. The students' performance in learning, the output product, is measured in term of scores on tests or examinations (Johnstone et al., 1998). Therefore, most students employ a rote or surface approach to learning to obtain high scores on tests rather than using deep approaches to learning to develop a good understanding of the physics concepts (Biggs, 1999). This is of concern to teachers and educators (Tsai, 1998).

Students who learn under the traditional pedagogy try to memorize factual information in textbooks by rote learning. They set their goals to achieve grades (Houston, 1975), and avoid punishment from failing examinations. It is a surface approach to learning, in which students memorize, look for facts and are uneasy about looking for meaning and using previous experiences (Entwistle, 1981).

As this model of teaching relies on the assumption of knowledge transferring, the role of teachers is to operate the process of transmission. This method of teaching requires control and tight structure. Teachers, who structure and control learning activities, reduce the level of engagement of students and limit opportunities for deeper and meaningful learning.

Attitude is a very important factor for enhancing an individual's engagement in learning. A positive attitude to any subject leads students to learn better in that subject than if they have a negative attitude. Woolnough (1996) explained that students' attitudes to science are affected by factors that vary and depend on the individual student. He found that a large number of students, both pre-16 and A-level in the UK had negative attitudes to school science courses because of the difficulty and nature of the content. The belief that science is only for very clever people and those who were born to work with it (Woolnough, 1994), is a barrier for many students to study science. Students in the UK comment that school science lessons are boring, tedious or uninteresting (Woolnough, 1994). Similarly, in Australia, secondary students indicated that science rarely deals with things that they are concerned about (Goodrum et al., 2001). The science curriculums in the UK and Australia are crowded with content and the sophisticated processes of working scientifically, so that it is difficult for students to meet the required standards of academic achievement (Goodrum et al., 2001; Newton & Rogers, 1996). Even talented students who are competent at science may be put-off by a dull and didactic approach to teaching school science (Woolnough, 1994).

The situation seems to be worse in physics compared with the other branches of science. Students perceive physics to be very difficult, abstract and mathematical. Physics teaching has not changed for a century, physics teachers teach in the same manner as they were taught (Farmer, 1985). A recent study indicated that physics is the least popular science course for students (Jones, Jones, & Zander, 1998). It is not surprising, therefore, that many students have negative attitudes towards physics and enrolments in physics are less than for other science subjects. For example, the number of Year 12 students in Australia enrolled in physics in every year from 1980 to 1998 is less than both chemistry and biology (Goodrum et al., 2001), and the number of A-level students in the UK who studied physics was less than biology in every year since 1982 (Woolnough, 1994).

Thomsen (1975) argued that textbooks have a very important role in traditional teaching of physics. He explained that most teachers believe their responsibility is to provide a good explanation of the subject matter in textbooks to students. Textbooks are used for notes, guiding experiments, doing homework and exercises. Students are expected to learn the content that is written in the textbooks.

The main aim of experiments in traditional physics classes is to confirm a previously specified relation between physical quantities. Most of these experiments are planned by the teacher and some of them are conducted by the teacher as demonstrations (Houston, 1975). This is in contrast to inquiry-oriented and investigative approaches to science where investigation provides the experiential base on which conceptualisation is developed, which is consistent within constructivist learning theory (Driver, Asoko, Leach, Mortimer, & Scott, 1994). Changing from verification experiments to inquiry-oriented investigation requires a transformation from teacher-centered to student-centered approaches to laboratory work (Mathew & Earnest, 2004).

Roth, McRobbie, Lucas and Boutonne (1997) explained that laboratory work in physics normally consists of exercises for verification or illustration of theories, and students follow the teacher’s instructions when doing experiments. Students may not make the observations or discoveries and interpretations which teachers want them to make and this may arise from two problems. First, students seem to interpret situations differently from the teacher because of differences in their theoretical commitments.

Second, students frequently construct explanations that do not exemplify the concepts at hand because they lack the necessary experimental competencies and language skills. Many experiments produce unpredicted results and the students may explain them in various ways that do not correspond to accepted scientific views. Traditional laboratory work may not result in students understanding the physics concepts, and the activities are often not relevant to students' daily-life experiences. Although the laboratory work is conducted by 'hands-on' activities, students may not develop appropriate understanding.

Goodrum et al. (2001) have argued that assessment should be "an integral part of the teaching and learning process" (p. 21). In traditional assessment, grades are derived from tests at the end of topics, term or year. This kind of assessment is generally based on pencil and paper tests, and focused on factual knowledge which students have memorized.

In his comprehensive review of assessment, Black (1993), summarized the main disadvantages of traditional assessment as:

- Reducing science to learning of isolated facts and skills;
- Lowering the cognitive level of classroom work;
- Students work at too great a pace for learning to be effective as they race through the content that is to be included in the test;
- Considerable teaching time is devoted to direct preparation for test;
- Students' questioning is inhibited;
- Learning follows testing in focusing on aspects that are easy to test rather than focusing on competencies that are valuable learning outcomes;
- Laboratory work stops unless the tests include laboratory tests;
- Creative, innovative methods and topical content are omitted;
- Teachers' autonomy is constrained and their methods revert to a uniform style as teachers are forced to violate their own standards of good teaching.

(p. 52)

Hodson (1992) also criticized traditional approaches to the assessment of practical work, which focuses on assessing isolated process skills in science. He argued that these approaches are not science, meaningless to learning, and encourage inappropriate pedagogy. He suggested that teaching and assessment of practical work should involve authentic tasks and real-world contexts.

In term of evaluation, many traditional assessments are norm-referenced for grading. Students are classified by the level of success compared with the other members in their group. The results from such evaluation cannot reveal the true level of understanding or learning (Goodrum et al., 2001). Teachers must recognize the important role of assessment for monitoring students' progress, to gain feedback and reflect on the quality of both teaching and learning. Assessment tasks must be developed as a part of the teaching and learning processes and be used to improve teaching and learning.

In conclusion, at least four aspects of traditional pedagogy in physics are problematic. First is the epistemological problem of both teachers and students holding beliefs of intact and transferable knowledge and an input-output model of learning. Second is the problem of teacher-centered strategies, which focus on transferring knowledge and the curriculum having an enormous amount of factual information from textbooks to be taught. Third is the problem of the learning strategies used by students who prefer to employ rote and surface strategies, memorising content, and aim to achieve scores and grades rather than develop understanding. Finally, traditional pedagogy linked to traditional assessments, which are summative and based on recall of a wide range of content. Traditional pedagogy is therefore not effective for the vast majority of students who enrolled in physics (McNiel, 2005).

Anecdotal evidence suggests that physics education in Thailand has many of the problems described above. Thai science teachers transfer factual information to students in the same manner that they had been taught. As in other countries, Thai students try to memorize factual information for examination. The Institute for the Promotion of Teaching Science and Technology (IPST) was established in 1972 to develop science and mathematics curricula for primary and secondary schools in Thailand (Seng, 1980). One of the main aims of the curriculum is to engage students in learning science by inquiry rather than being passive recipients of information presented by the teacher. In 1976 all secondary schools in Thailand started to teach science and mathematics under the IPST curriculum. Upper secondary students in a science program study physics for three years before they enter universities. Some attempts have also been made to improve physics teaching at the tertiary level without much success. Rajabhat universities play an important role in preparing science and physics teachers for both primary and secondary schools throughout Thailand. Instructors must therefore realize the problems involved with traditional pedagogy in physics, and must attempt to improve their physics teaching. As Woolnough (1996) suggested, much of science education emphasises the "cognitive and psychomotor domains - what a student knows and can do" (p. 370) rather than the affective domain - such as, love to study physics; this needs greater attention.

Learning in Science

During the last two decades science educators and science teachers have been interested in the conceptions which students bring with them to science lessons and the impact of science lessons on these ideas. Many studies attempted to establish whether children's ideas are similar to those of scientists. The research revealed that some ideas which students acquired from their experiences are different from those of scientists' views and from the ideas taught in science lessons (Osborne, 1981; Osborne & Gilbert, 1980; Stead & Osborne, 1980). Osborne and Wittrock (1983) summarized the results of this research in terms of three main findings: children have prior views about science that they bring to science lessons; these views are often different from scientists' views, and are tenacious and resistant to change; and these views may be unchanged or may be changed in unanticipated ways by science teaching. For many decades science teaching and learning has not always been successful in developing scientific concepts. Tasker (1981) suggests that science teaching has not been as effective as science teachers have expected. Reasons for this cited by Tasker include: students consider each lesson as an isolated event rather than making links between lessons; students invent a different purpose for lessons from the purpose intended by the teacher; students often show little interest and engagement in the lesson; and students' prior knowledge was not what the teacher assumed students had. Consequently the understandings developed by students were frequently not those that teachers assumed were developed.

Contemporary Learning Theory: Constructivism

Osborne and Freyberg (1985) state that there are similarities between the way scientists construct knowledge and the way children learn science:

> Young children and scientists have much in common. Both are interested in a wide variety of objects and events in the world around them. Both are interested in, and attempt to make sense of, how and why things behave as they do.
> (p.1).

Scientists differ from children in bringing accurate, rich and well-organized prior knowledge to learning tasks whereas many students bring alternative frameworks as their prior knowledge.

Constructivists assume that children construct hypotheses about natural phenomena and confirm these hypotheses from their daily life experiences. Children's notions are adapted and refined so that they are plausible to explain common phenomena. Students frequently have difficulty in learning science, their notions concluded from daily life experiences are often inconsistent with scientific knowledge, and their explanations of the world are influenced by their culture (Solomon, 1993). Contemporary learning theory is concerned with the processes of knowledge construction and the influence of social factors on students' construction of scientific knowledge.

Generative Learning Model

The Generative Learning Model is a constructivist model, which is consistent with cognitive approaches to research on learning. The essence of this model is that the brain is not a passive consumer of information and the learner must actively construct meaning to learn with understanding (Osborne & Wittrock, 1983).

The basic principle of generative learning is that people tend to generate perceptions and meanings from their experiences using their prior knowledge. The generative learning model is concerned with the influence of existing ideas on what sensory input is selected and given attention, the construction of meaning from sensory input and information retrieved from long-term memory, and the evaluation and possible subsumption of constructed meanings (Osborne & Wittrock, 1983).

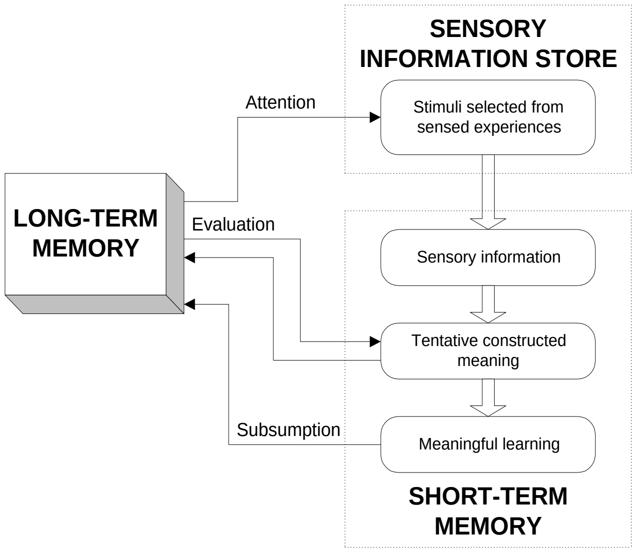


Figure 2.1. The generative learning model

Osborne and Wittrock (1985) summarise the key postulates of the generative learning model, which are:

- the learner's existing ideas influence what use is made of environmental stimuli and in this way the brain can be said to actively select sensory input;
- the learners' existing ideas will influence what sensory input is attended to and what is ignored;
- the input selected or attended to by the learner, of itself, has no inherent meaning;
- the learner generates links between the input selected and attended to and part of memory store activated from long-term memory;
- the learner uses these links to actively construct meaning;
- the learner may test the constructed meaning against other aspects of memory store and against meanings constructed as a result of other sensory input;
- the learner may subsume constructions into the long-term memory store;
- the need to generate links and to actively construct, test out and subsume meanings requires individuals to be active in learning and accept a major responsibility for their own learning

(pp. 64-66)

Hewson (1981) proposed that only the constructed meanings, which are intelligible, plausible, and useful to the learner, would be incorporated into long-term memory. An individual's determinations at each step of the model are influenced by his or her existing ideas, and many of these ideas are likely to be alternative frameworks, because of this students often generate unanticipated conceptions (Osborne & Freyberg, 1985).

It is very important for science teachers to be aware of and interested in, the prior ideas that students bring to science lessons. Students have their own meanings for words used in science and have views about how and why natural and technological phenomena behave. Many words used in science such as 'work' are used in everyday conversations. Students learn to construct the meanings and explanations of these words from their daily-life experiences, before they come to the science lessons. The meanings of these words are already stored in the long-term memories of learners (Osborne & Wittrock, 1983). However, the same words may have quite different meanings in science.

In terms of the generative learning model, the way that learners construct meanings from their experiences and long-term memory is not different from the way scientists construct scientific knowledge. But, the ideas students generate are often different from those of scientists because students tend to view things from a self-centered perspective, their experiences are limited, they are interested in particular events, and words learned in everyday contexts and language have different meaning from the words used in science (Osborne & Wittrock, 1983). Learners also tend to construct mini-theories to explain specific events but scientists construct macro-theories to generalise about natural phenomena (Osborne & Wittrock, 1985).

From the constructivist perspective, all individuals attempt to construct meaning from experiences. Students must be actively engaged in learning and accept responsibility for their learning, with this awareness learners often increase their motivation and effort. Students need to understand that effort is required to construct meaning and generate appropriate links. They have to recognize and believe that success or failure strongly depends on their own actions; teachers, parents and other people have a responsibility for facilitating their learning. Good teaching is not sufficient to accomplish good learning, but requires an active effort by the learner (Osborne & Wittrock, 1985).

An important responsibility of teachers is to stimulate students' attention to specific aspects of learning experiences. The stimulation of attention might involve modifying a student's goals and intentions (Osborne & Wittrock, 1985). Teachers need to help their students to activate appropriate ideas in long-term memory to generate links with sensory information. Learners need to aware that meaning is something they construct, it is not something that is transferred from teachers to them. Learning usually involves the restructuring of existing knowledge, or adding new information to existing knowledge structures (Osborne & Wittrock, 1983). The newly developed ideas can be subsumed into the knowledge structures in long-term memory. The success of subsumption depends on making appropriate links between new ideas and the existing ideas.

Social Construction of Science Knowledge

Knowledge is not transmitted to the learner; rather it is actively constructed from previous conceptions, the interactions with phenomena and with other people. This principle is affirmed by various studies in science education research. Driver, Asoko, Leach, Mortimer and Scott (1994) argued that scientific knowledge is both symbolic in nature and socially negotiated. The concepts used to describe and interpret natural phenomena are the constructs that have been invented by people and imposed on the natural world. These concepts are often the results of considerable intellectual struggles and are communicated through the culture and social institutions of science.

Driver et al. (1994) concluded that scientific knowledge is socially constructed, validated and communicated, however it is constrained by the nature of the world, that is, by observations and other data. They also argued that the empirical study of natural phenomena would not reveal the whole explanations of nature, as concepts must be invented.

Individuals usually have their everyday meanings and understandings of natural phenomena because they make sense of these with the assistance of other people in their community, many of whom lack a formal science training. Knowledge and understandings are constructed when individuals engage socially in solving shared problems or tasks. This leads individuals to have a range of informal knowledge schemes or ‘commonsense’ interpretations of the phenomena in their daily lives.

Commonsense knowledge is constructed in a particular culture to interpret and explain everyday events. Commonsense knowledge is different from the scientific knowledge used in communities of professional scientists (Driver et al., 1994).

Solomon (1993) confirmed that students have ideas that they develop from daily life experience out of school, which influence their interpretations of science lessons in the classroom. These ideas are tenacious and difficult to change. It is very clear that learners construct ideas socially to explain life experiences out of curiosity about natural phenomena. The social construction of ideas occurs as people struggle through talking with others to clarify and construct socially acceptable explanations. Children play, talk and interact with other people discussing their experiences and constructing ideas to explain their world.

The items of social knowledge are fixed by the words used in conversation among people. A word may have many different meanings that can give rise to contradictions and disagreements. Some words used in science such as ‘work’ have a different meaning in life-world knowledge. We use words as the means of communication and also to reflect our experiences. Languages and cultures influence the ideas and life-world knowledge constructed by children and adults. In the science classroom we explain natural phenomena and events with scientific knowledge, which is different from life-world knowledge. Students are living in these two different worlds of knowledge. These two domains of knowledge are different in aims, meaning of words, cultural dependence, logical methods, and socialized uses. These differences are summerised in Figure 2.2.

Life-world knowledge	Scientific knowledge
▪ Social exchanges try to achieve a mutual understanding and agreement. ▪ Words used have multiple meanings which are not defined but negotiated socially. ▪ Meanings are dependent on the cultural group and on the physical or affective context. ▪ Apparent contradictions are tolerated. No logical method is thought to be needed. ▪ This knowledge system is well socialized by daily use with familiar people.	▪ The aim of debate is to sharpen differences and to confirm or refute rival opinions. ▪ Concept words are unambiguously defined for exact use. ▪ Concept meanings are symbolic and abstracted from any particular situation. ▪ A tight logical network of concepts and theories is claimed. ▪ This knowledge is not well socialized since its methods are rarely used and then only by teachers outside the peer group.

(Solomon, 1993, pp. 92-93)

Figure 2.2. Differences between life-world knowledge and scientific knowledge

Students have both sets of knowledge and must learn which world of knowledge is appropriate for given contexts. Life-world knowledge is very important in social discourse, is reinforced by social discourse and will therefore not be replaced by formal scientific knowledge when students begin to learn science. Some researchers (Gilbert, Osborne, & Fensham, 1982) suggested that knowledge from the two systems may combine, however, the two sets of knowledge appears to be held separately in memory (Solomon, 1993). Having knowledge about the ‘real’ world and knowledge of science in separate schemata is likely to inhibit students from transferring and applying their science knowledge to their lives beyond the classroom.

People do not finish learning when they leave school. They are still living in their social milieu in everyday-life where they learn their life-world knowledge. Some media such as television have had a large effect on students’ life-world knowledge, however, the classroom remains an important place for the social construction of students’ formal scientific knowledge. Discussion and interaction in the classroom under the supervision of teachers is the best way to construct scientifically accurate knowledge for students. However, teachers sometimes have to introduce scientific concepts that conflict with common beliefs and it is difficult to change the life-world knowledge of learners.

The zone of proximal development and co-construction of knowledge. Vygotsky (1978) argued that the level of a child's mental development could be raised by the assistance of teachers or more experienced peers in the tasks of problem solving. He introduced the concept of the *zone of proximal development,* which is defined as "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adults guidance or in collaboration with more capable peers" (p. 86).

Language and the uses we make of it are also important cultural artifacts and practices, which are learned and mastered through social interaction. Discourse is itself a cultural artifact which learners have to appropriate through participation (Wells & Chang-Wells, 1992). Discussion between students helps them work together in constructing new understandings.

Newman, Griffin, and Cole (1989) describe the zone of proximal development as a zone for the co-construction of knowledge. The support and assistance from adults and peers is the scaffolding to construct knowledge (Wood, Bruner, & Ross, 1976). Goldstein (1999) described scaffolding as an important source of support for cognitive growth, and in order to extend the area of the zone of proximal development, both teacher and student must engage collaboratively to support and assist their learning relationship.

Peters and Armstrong (1998) explained that collaboration involves a group of people who work together in order to construct something that did not exist before the collaboration, something that does not and cannot fully exist in the lives of individual collaborators. In a collaborative learning experience individuals contribute their collective knowledge and actions to the experience. Thus, in this kind of learning experience, individuals learn and the group learns. The product of the constructing cannot be reduced to what either collaborator contributed, because it is more than the individuals' contributions added together. It means that the result is something other than the parts. When two or more people collaborate, each collaborator contributes something to the effort, and the group jointly contributes something to the effort.

New understandings jointly constructed by students can be internalised by an individual and then used by the individual for understanding new phenomena or for solving new problems (Wells & Chang-Wells, 1992).

Crook (1994) suggests that students in collaborative classrooms gain the cognitive benefits of articulation, conflict and co-construction. Students need to communicate through the articulation of their opinions, predictions, and interpretations. Articulation helps the explainer clarify his or her thoughts. In the case of disagreement, conflicts may arise and students must try to solve them. In resolving conflict, participants are forced to justify and explain their views more fully. The resolution of conflict may facilitate the participants to develop and replace or reorganize their central concepts. Students co-construct shared knowledge and understanding by complementing and building on each other's ideas.

Berg and Winsler (1995) stress the significance of the affective component of scaffolding as it influences the emotional tone of the interaction. Students' engagement with a task and willingness to challenge themselves are maximized when collaboration with the teacher and peers is pleasant, warm, and responsive. Coulstock's (2001) research indicates that students are more likely to engage in the learning task when they are in a supportive and friendly classroom, and the teacher is interested in their ideas and discoveries.

Driver et al. (1994) argued that the practical 'hands-on' activities in science classroom do not lead students to the development of scientific understanding unless they are also 'minds-on'. In the collaborative class, the role of teacher is to facilitate by focusing on practices that students themselves can use to regulate their own co-construction of knowledge.

Collaborative intellectual skills such as co-constructing knowledge and reasoning critically through argumentation and persuasion are fundamental to the practice of science, these, too, should be within the purview of science learning objectives whose attainment could be enhanced through metacognitive strategies training (Hogan, 1999).

Conceptual Change Model of Learning

A model of conceptual change was developed by Posner and his colleagues (Posner, Strike, Hewson, & Gertzog, 1982) to explain the factors that influence changes to existing conceptions.

Learning is the result of the interaction between what the learner is taught and his or her current concepts (Posner et al., 1982). Many activities in science lessons and typical assessment procedures do not encourage students to generate the required links (Osborne & Wittrock, 1983, 1985). Students may have some scientific misconceptions, which are highly resistant to change. There are at least four reasons to explain why students' ideas are difficult to change in the way the teacher intended. First, there is a lack of real motivation to change. Second, it is easy for a student to interpret words and construct meanings in ways that are consistent with the existing knowledge structures in long-term memory, thus reinforcing existing knowledge. Third, sometimes the meanings constructed in the classroom, and existing knowledge structures are in conflict; and fourth, a scientific understanding of some aspects of science requires a major restructuring of student's earlier ideas (Osborne & Wittrock, 1983).

In science itself, most research programs are generated from central commitment paradigms that Lakatos (1970) labels as 'theoretical hard core' and this research adds to and extends the core constructs. When anomalous cases and data accumulate these central commitments require modification. Kuhn (1970) calls this kind of scientific conceptual change as a 'scientific revolution' and these revolutions create new paradigms.

Posner et al. (1982) believed that there is an analogous pattern of conceptual change in learning science. The first type is 'assimilation' where learners use their existing concepts to deal with new phenomena. Assimilation is the process of conceptual growth where learners generate their own new knowledge easily, which is added, without conflict, to their existing concepts. The second form of conceptual change in learning is 'accommodation', which occurs when learners' current concepts are inadequate to understand and explain some new phenomena. Learners may have well-developed concepts about the topic under study and these concepts may resist constructing new knowledge. They must be then replaced or their central concepts must be reorganised. Accommodation signifies a radical change involving the abandonment of the existing conceptions and the acceptance of a new conception (Tao & Gunstone, 1997). That is, conceptual change refers to the process by which a person changes his or her conceptions by capturing new conceptions or exchanging existing conceptions for new conceptions (Hewson & Hewson, 1991). The process of accommodation is significant for the cognitive development of learners. Most work on conceptual change has focused on encouraging accommodation (Pintrich, Marx, & Boyle, 1993).

Constructivists now believe that personal, motivational, social, and historical processes influence the process of conceptual change; this is the ‘hot’ model of conceptual change. Although core scientific knowledge is determined by rational factors, conceptual changes in classrooms may not be based on rational logic. A student’s conceptual change is not determined solely by cognitive factors, but also by motivational beliefs and the classroom context as well (Pintrich et al., 1993).

Posner et al. (1982) argue that there are four important conditions which are necessary for an accommodation type of conceptual change:

- There must be dissatisfaction with an individual’s existing conception;
- A new conception must be intelligible or makes sense to the learner;
- A new conception must appear initially plausible; and
- A new conception should appear fruitful for extending understanding and problem solving.

(p. 214)

These conditions refer to a very rational process of cognitive change, and appear to be a presumption that academic learning is a ‘cold’ and purely cognitive process. However, there are sufficient reasons to assert the opposite conclusion since motivational beliefs, classroom context, and the interaction between students and the members in a learning community can influence the students’ conceptual change process.

‘Conceptual ecology’ is a metaphor that Posner and his colleague use to explain how current conceptions influence how an individual will view new phenomena. An individual's conceptual ecology will influence the selection of a new central concept. Posner et al. (1982) suggested that there are many kinds of concepts in the conceptual ecology, which are important in determining the direction of an accommodation, they are:

- Anomalies;
- Analogies and metaphors;
- Epistemological commitments: explanatory ideals, and general views about the character of knowledge;
- Metaphysical beliefs and concepts: metaphysical beliefs about science, and metaphysical concepts of science;
- Other knowledge: knowledge in other fields, and competing concepts.

(pp. 214-215)

The conceptual change process may be affected by an individual's motivations and goals. A student has at least two kinds of goals that he or she brings into the classroom, goals for learning and social goals. Although some aspects of students' goals are similar to scientists' goals, and teachers' goals, there are likely to be important differences influencing what learning occurs.

To elaborate the conceptual change model, student's goals and motivations, and classroom contextual factors need to be integrated into the model. These factors, Posner et al's four conditions for conceptual change and the students' conceptual ecology are important influences on learning.

Tyson, Venville, Harrison and Treagust (1997) developed a multidimensional interpretive framework for conceptual change by considering the ontological, epistemological, and social/affective aspects of conceptual change. Ontology is the study of the existence of things in the world. The ontological aspect of conceptual change examines the way a person views the nature of things being studied. Epistemology is defined as the theory of knowledge. A student's epistemological beliefs about the nature of knowledge may influence a person's conceptual changes. Pintrich et al. (1993) argued that the model of conceptual change should not focus only on student cognition but also consider to the social/affective aspect as well. They highlight that students' motivational beliefs about themselves as learners and the roles of individuals in the learning community are important factors that influence conceptual change.

Metacognition

John H. Flavell and his colleagues initiated research on metacognition at the beginning of the 1970s (Jacobson, 1998). Metacognition refers to one’s knowledge of and control over one’s own cognition (Brown, 1987). Hacker (1998) defines metacognition as “thinking about thinking, cognition about cognition” (p. 3).

Metacognition refers to the self-monitoring of, and conscious use of learning strategies to enhance learning. Jacobson (1998) concluded that metacognition is not an automatic process but is a result of long-term development of the cognitive system; that is, metacognitive skills have to be learned. Metacognitive processes include planning, monitoring, and regulating their own behavior, and they may increase academic performance (Jacobson, 1998). Schoenfeld (1987) includes self-regulation as an important component of metacogniton, as he states that “self awareness is a crucial aspect of metacognition, for awareness of one’s intellectual behaviour is a prerequisite for working to change it” (p. 191). Metacogniton, or knowing the process by which one learns is then very important for improving learning. Jacobson (1998) points out that if instructors do not recognize the role of metacognition, the efforts to improve education will be ineffective. She explained that if self-regulation can be used to increase students' self-efficacy and performance, it would be very useful for improving learning. The three components of self-regulation (Zimmerman, 1990); strategies, self-oriented feedback loop, and recognition of the necessity of preparation and effort lead to improve learning and perception of efficacy. Self-efficacy is defined as the “people’s judgments of their capabilities to organize and execute courses of action required to attain designated types of performance” (Bandura, 1986, p. 391). Zimmerman (1989) reminds educators that "learning is not something that happens to students, it is something that happens by students" (p. 22). Bereiter and Scardamalia (1993) state that interest is important for students, however most students seem to have a major problem in taking control of their interest. Collins, Brown and Newman (1989) indicate that it is possible to make improvements in students self-monitoring and metacognition by using cognitive apprenticeship strategies. Pressley and others (Pressley, Goodchild, Fleet, Zajchowski, & Evans, 1989) also stressed that it is the responsibility of teachers to develop students’ metacognitive knowledge about specific strategies by providing information, teaching appropriate strategies that enhance the discovery of the knowledge, encouraging students to ascribe use of strategies, and altering their incongruous beliefs.

Self-regulation of learning. Since the 1980s, studies have focused on the impact of metacognition on a number of variables dealt with improving memory, comprehension, problem solving, and self-control and found a wide range of differences in strategic knowledge and use among learners (Manning, Glasner, & Smith, 1996).

Self-regulated learning is generally defined as setting realistic goals, employing strategies to achieve the goals, closely monitoring their attainment, and evaluating one's own thinking (Risemberg & Zimmerman, 1992). The term self-regulated learner is often used in the literature, but no one is always self-regulated for all tasks (Manning et al., 1996). Self-regulated learning strategies are used more or less depending on the student, task, environment, and a number of possible interactions among other variables. Students can improve learning if they use self-regulated learning strategies. Providing an appropriate instructional program resulted in greater academic learning and productivity, and metacognitive strategies were taught and used by the students, consequently benefits were realised (Manning et al., 1996).

Many researchers such as Zimmerman and his colleagues (Zimmerman, 1989, 1994; Zimmerman, Bonner, & Kovach, 1996; Zimmerman & Risemberg, 1997) were interested in the relationship between students' willingness and capability, and the response for self-regulation in their academic achievement. Their research indicate that learning self-regulatory skills can lead to greater academic achievement and an increased sense of self-efficacy (Dembo & Eaton, 2000).

Yowell and Smylie (1999) argued that self-regulation couldn't be promoted without attention to the social contexts in which it is developed and supported. They also pointed out that change is based not only on individual or intrapsychological processes but also on social or interpersonal processes.

Zimmerman (1989) compared successful and less successful students of similar intellectual ability. He found that successful students monitor and control their learning behavior by setting goals, using their prior knowledge, considering alternative strategies, developing a plan of attack, and reconsidering plans if faced with difficulties. In contrast, less successful students have little awareness of the factors affecting learning and are less likely to take charge of their own learning.

Zimmerman and Risemberg (1997) identify the important dimensions of self-regulatory skills that can help all students promote their own academic achievement. The dimensions include motivation, methods of learning, use of time, managing their physical and social environment, and performance.

Students need to learn how to use self-regulatory processes to improve their performance. Zimmerman et al. (1996) developed a cycle approach involves four interrelated steps to self-regulation that can help students control their behavior. The first step is self-observation and evaluation that will make students understand the nature of their deficiencies. The second step is goal setting and strategic planning, where students analyze the learning task, set goals, and develop a plan or strategy to help them attain their goals. The third step in the cycle is strategy implementation and monitoring, which focuses on the effectiveness of the learning strategy. The final step is strategic-outcome monitoring, which involves expanding monitoring to include performance outcomes. These four steps in the self-regulatory cycle can be used to help students solve their own academic problems.

Goal Orientation

Goals are usually defined as performance standards to be attained (Vandewalle, 1997). A person has his or her own level of aspiration (LA) and level of expectation (LE) in a given task. Level of aspiration refers to the level of performance a person would like to achieve but has a low probability of attaining; LE refers to the level of performance a person expects to attain and has a moderate probability of attaining it. A measurement of goal discrepancy indicates how much future aspiration and expectation differ from prior performance (Ferguson, 2000).

Many researchers have proposed several sets of basic dichotomies in goal orientations to explain students' achievement behaviours: learning versus performance orientation (Dweck & Elliot, 1983), task involved versus ego involved (Nicholls, Patashnick, & Nolen, 1985; Nicholls, 1984) and mastery focused versus ability focused (Ames & Ames, 1984). Students with performance or ego or ability goal orientations believe that their learning achievement depends mainly on ability and with little effort, whereas with mastery or learning or task goal orientations, learning success is believed to be dependent on effort (Ames & Archer, 1988).

Meece, Blumenfild and Hoyle (1988) examined the influence of goal orientations on students' reported level of cognitive engagement in classroom activities. They considered three dimensions of goal orientation: task-mastery goals in which students sought to independently master and to understand their work, ego or social goals in which students sought to demonstrate high ability to please the teacher, and work-avoidant goals when students avoid disproving their competence and to avoid negative judgments about it.

Vandewalle (1997) argued that students with a performance goal orientation view ability as a fixed and uncontrollable personal characteristic that is difficult to develop. In contrast, students with a learning goal orientation view ability as a flexible characteristic that can be developed through effort and experience. Different types of goal orientation create different mental frameworks within which students interpret and respond to situations and also influence how individuals respond to task difficulty or task failure. Students with a learning goal orientation, view effort as an instrumental strategy for developing the ability needed for future task mastery. Whereas students with a performance goal orientation, who believe ability is a fixed trait, consider that effort does not develop ability or increase their future mastery. These students consider high effort to be an activity for low ability persons because a high-ability person would not have to exert so much effort.

Students who adopted a learning goal orientation have increased perceptions of self-confidence and success in their studying (Dweck & Leggett, 1988), and usually demonstrate high levels of self-regulated learning (Meece, 1994; Schunk, 1994). Dweck (1986) indicated that students whose focus is based on progress through effort tend to seek out and be energized by challenge, whereas those whose focus is based on ability judgments tend to withdraw from challenges. Schunk (1994) found that learning goal orientation is positively related to self-regulated learning and self-efficacy.

Students' approaches to learning. Students' approaches to learning were originally proposed by Ference Marton and Roger Saljo from their study of Swedish university students (Marton & Saljo, 1976). Biggs (1987) investigated students' approaches to learning by developing his Study Process Questionnaire (SPQ) and the Learning Process Questionnaire (LPQ). Any approach to learning comprises two components: learning motivation - why a student wants to approach a task; and, learning style or strategy - how he or she approaches the task (Biggs, 1987). There are three types of approaches to learning: surface, deep, and achieving (Entwistle, 1981).

Students who employ the surface approach to learning engage in a task with extrinsic motivation and typically with a strategy of rote learning. These students are likely to be motivated primarily by the fear of failure (Ramsden, Beswick, & Bowden, 1989). They focus upon the details and parts of disconnected information to memorize some important topics that they expect to be tested on, without looking for the meaning of text (Entwistle, 1981). This information, they anticipated would be reproduced in an examination (Biggs, 1987). Entwistle (1981) divided surface approach to learning into two categories described as surface active and surface passive. These distinctive categories provide different levels of understanding.

On the other hand, for the students who employ a deep approach to learning, their motivation is intrinsic and their strategy is meaningful learning (Biggs, 1987). These students search for understanding and meaning inherent in the task of learning (Chin & Brown, 2000). They relate the content to personally meaningful contexts or to previous knowledge (Entwistle, 1981). They search for analogies, theorizing about what is learnt, and deriving extensions and exceptions. The deep approach to learning involves processes of a higher cognitive level than rote learning. However, the level of understanding from the deep approach to learning can be different according to the categories of deep active or deep passive (Entwistle, 1981).

Ramsden (1992) suggests that surface learning is, at best about quantity without quality, but deep learning is both about quality and quantity. There is another interesting suggestion from some studies in Australia that students are likely to cease a deep approach to learning as they move through higher levels of education (Rhem, 1995).

The other type of approach to learning is achieving. Students who employ this approach are motivated by getting high grades or winning prizes, whether or not the content is interesting. The achieving motive is based on competition and ego-enhancement (Biggs, 1987). These students' strategy is to maximize the chance of obtaining high scores and they behave as model students (Biggs, 1987). At any given time, an achieving approach may be linked to either surface or deep approaches. Surface-achievers select details by using a rote strategy to obtain high scores while deep-achievers organize and plan the learning tasks both for meaning and for high grades.

Biggs (1987) proposed the general model of student learning known as the '3P' (Presage, Process, Product) model. In this model, student factors and teaching context (Presage), ongoing approaches to learning (Process), and the learning outcomes (Product) interact and form an integrated system in a given learning task (Biggs, 1993). Student factors such as prior knowledge, ability, and their preferred approaches to learning and the teaching context determine an ongoing approach to a particular learning task and learning outcomes (Biggs, Kember, & Leung, 2001). Some teaching context factors such as time pressures, examination stress, and the use of inappropriate test items induce a surface approach (Ramsden, 1985), whereas interactive teaching, problem-based teaching, learner-activity, and interaction among students encourage a deep approach to learning (Biggs & Telfer, 1987).

Different aspects of studying. Students' study practices in higher education can be considered as the relationship among approaches to learning, the conceptions of learning, epistemological standards, study and learning strategies, and self-regulation (Richardson, 2005). The students' conceptions of learning and approaches to learning may be divided into two categories of surface-level reproduction and deep-level transformation of knowledge (Lonka & Lindblom-Ylanne, 1996). A college student may develop his or her epistemology from a primitive dualist conception of knowledge to a relativistic conception (Perry, 1970). Dualistic orientation students see knowledge as an unorganized set of discrete and absolute truths but relativistic orientation students see knowledge as an array of interpreted positions (Lonka & Lindblom-Ylanne, 1996). A student may employ different study and learning strategies of rehearsal, elaboration, or organization. Including with self-regulation, the relationship among these aspects of learning can be shown as Figure 2.3 below (Lonka & Lindblom-Ylanne, 1996).

Aspects of study	Superficial learning	Deep-level learning
Approach	Surface	Deep
Study and Learning strategies	Rehearsal Knowledge telling Reproduction	Elaborative, Organizational Knowledge transforming Transformation
Regulation	Teacher-regulated learning	Self-regulated learning
Epistemological standards	Knowledge criteria	Comprehension or Application criteria
Conceptions of learning and epistemology	Non-intentional Passive epistemology Dualist Intake knowledge	Intentional Active epistemology Relativist Construction of knowledge

(p.10)

Figure 2.3. Relationship among different aspects of studying

Lindblom-Ylanne and Lonka (1999) studied four clusters of advanced medical students on the relationship between their study practices and study success. The findings revealed that a meaning-oriented and self-regulated group of students used the most elaborated study practices and had constructivist conceptions of learning; while a reproduction-oriented and teacher-regulated group tended to lack regulation, used a surface approach and believed learning was about intake of knowledge. Olkinuora and Salonen (cited in Murtonen, (2001) found that students' situational orientation may also influence students' learning. The students who are not task-oriented but social-oriented or self-defensive oriented may draw their attention away from the cognitive tasks. The inappropriate conceptions of learning and unsuitable situational orientations impact negatively on learning (Murtonen, 2001).

Ward and Bodner (1993) argued that people lose their desire to learn with task orientation when they come to higher education probably because of the effects of earlier educational experiences. They advise that the best way to help students shift toward a task orientation is to decrease competition and social comparison. They also suggest three changes to assessment practice: first, quit the normative grading system and grade on an absolute scale; second, stress participation and self-improvement; and third, assessment of student performance should focus on the students' ability to justify and explain what they know rather than recall what they know.

Teachers' approaches to teaching. Biggs (1989) describes approaches to teaching in a way that is similar to the approaches to learning, i.e., they also have components of intention or motive and strategy. Teachers' approaches to teaching are influence by their perceptions of teaching and the teaching environment (Richardson, 2005), and influence students' approaches to learning significantly (Trigwell, Prosser, & Waterhouse, 1999).

Trigwell, Prosser and Taylor (1994) explained that teachers' intentions range from transmitting the content of the subject to students, to helping students to change their conceptions of the content; and, strategies range from teacher-focused to student-focused. Trigwell and Prosser (1996) describe teachers' approaches to teaching in five categories (p. 80):

1. Teacher-focused strategy with the intention of transmitting information to students.
2. Teacher-focused strategy with the intention that students acquire the concepts of the discipline.
3. A student-teacher interaction strategy with the intention that students acquire the concepts of the discipline.
4. A student-focused strategy aimed at students developing their concepts.
5. A student-focused strategy aimed at students changing their concepts.

From these five categories, it can be seen that there are two extreme families of learning theories; teacher-based and student-based theories. These families of theories view the failures in education differently. Teacher-based theories view failures in education to be caused by ineffective teaching, whereas student-based theories recognize the importance of student characteristics in learning (Biggs, 1994b).

Motivation

Motivation is defined as a dynamic internal process that energizes and directs actions and action tendencies (Ferguson, 2000). The sources of motivation can be both generated from the past events or antecedent conditions and the future goals of each individual. Motivation is a construct (Ferguson, 2000), it refers to an internal event that is not directly observable, but related theoretically and empirically to observable external events.

In the past, learning was mainly seen as a matter of cognitive development with motivation having little influence. Particularly in physics education, the role of motivation had not been studied until the middle of the 1980s (Fischer & Horstendahl, 1997). Knowing about the influence of motivation on learning may lead to new insights in the design of classroom settings. Motivational orientation is considered to be an important factor in determining students’ academic success. Likewise, the cognitive development of the learner can also change motivational orientation (Dev, 1997).

Motivation may be intrinsic or extrinsic (Pintrich & Schrauben, 1992). Intrinsic motivation is a kind of motivation that stems from internal incentives provided by internal outcomes. It could be defined as the desire to engage in an activity and participate in a task (Deci, Vallerand, & Pelletier, 1991). When people are intrinsically motivated they do not need rewards or punishment because the activity itself is rewarding. In contrast, extrinsic motivation is created by external factors like rewards and punishment. Extrinsically motivated people are not really interested in the activity for its own sake, but they care about what they will gain from the activity (Woolfolk, 2001).

The ability to persist with the task, the amount of time spent with the task, the innate curiosity to learn, the feeling of self-efficacy, and the desire to select an activity are all indicators of high intrinsic motivation (Deci & Ryan, 1985). However, the amount of interest produced by the task itself also plays an important role in the motivational orientation of the student. An assigned task that arouses interest and curiosity is more likely to motivate than a task with no interest.

Teachers may use extrinsic motivators in the form of rewards or the avoidance of punishment to bring about desired behaviour. Researchers have found that extrinsic motivation can interfere with intrinsic motivation (Dev, 1997). Deci and Ryan (1985) found that students might perceive that teachers use rewards or punishment to control their behaviour. Extrinsic motivation may negatively influence the motivational orientation of students and can have detrimental effects on intrinsic motivation (Deci & Ryan, 1985).

Cameron and Pierce (1994) studied the effects of rewards and reinforcement. They found that under some circumstances verbal praise can increase intrinsic motivation, however, expected tangible rewards can have a detrimental effect on the learner's intrinsic motivation.

Student motivation can be reduced if the learning tasks do not correspond to students' ability and skill level (Schunk, 1990). On the other hand, if the designed task is matched to the student's ability and skill level, students are likely to be intrinsically motivated and stimulated to attain mastery (Dev, 1997). To enhance intrinsic motivation teachers should replace threatening or intimidating situations and tasks by eliminating or minimizing external pressures and developing intrinsically interesting activities (Dev, 1997).

Dev (1997) suggested that teachers should involve students in the learning process by allowing them to feel that they are in control of their learning. Teachers should also respond positively to the questions posed by students, praise them in some occasions, promote mastery learning, challenge and stimulate with appropriate activities, and make evaluations based on the task and not on a comparison with the other students.

Teachers' Beliefs about Teaching and Learning Science

To understand why people organize and run their everyday-life circumstances as they do there is a need to pay much more attention to their model of beliefs, the goals they pursue, and the interpretations of their circumstances. There is no doubt about the important influences beliefs have on people's behaviour and decision-making.

The Structure of Belief Systems

Beliefs are the mental constructs that represent the codification of individuals' experiences and understandings (Schoenfeld, 1997). People's beliefs are the most important influence on their decision-making throughout their lives (Bandura, 1986). Theorists agree that beliefs are created through a process of enculturation and social construction (Pajares, 1992). In the field of education, the beliefs that teachers hold certainly affect their behaviour in the classroom. An understanding of belief structures of teachers is needed to improve their teaching practices and teacher education (Ashton, 1990; Ashton & Webb, 1986; Buchmann, 1984; Clark, 1988; Pintrich, 1990).

There was a prediction more than 20 years ago that the study of beliefs would become an important for improving teacher effectiveness (Fenstermacher, 1979). Pintrich (1990) suggested that beliefs would finally prove the most valuable psychological constructs to teacher education. A large number of studies have been conducted in the last 20 years on general beliefs and teachers' beliefs, especially in the mathematics-related fields (Aguirre & Speer, 1996; Borko & Putnam, 1996; Calderhead, 1996; Cohen, 1990; Ernest, 1989; Pajares, 1992; Schoenfeld, 1985; Strauss & Shilony, 1994; Thompson, 1992).

Nespor (1987) referred to Abelson's (1979) work on the difference between belief systems and knowledge systems and described that four features characteristic of beliefs; existential presumption, alternativity, affective and evaluative loading, and episodic structure which serve to distinguish beliefs from knowledge. Nespor (1987) explained that existential presumptions are the incontrovertible personal truths everybody holds about the existence or nonexistence of entities. These entities, in the classroom, tend to be seen as unchangeable and as beyond the teacher's control and influence. For example, a teacher may believe that some students fail because they are too lazy and they will never change. Alternativity refers to conceptualizations of ideal situations differing from the present realities. Nespor (1987) referred to an example of an English teacher who drew a fantasized ideal of teaching from a model she had dreamed since she was a young student.

Nespor (1987) argued that beliefs system have stronger affective and evaluative components than knowledge systems. Knowledge of a domain can be distinguished from feelings about that domain. In the classroom, the combination of affect and evaluation can thus be important regulators of the amount of energy that teachers will expend on an activity and how they expend it. Ernest (1989) also suggested that knowledge is the cognition outcome of thought and beliefs are the affective outcome, but he acknowledged that beliefs also possess a slender but significant cognitive component.

Abelson (1979) advocated that knowledge system information is stored in semantic network whereas beliefs are composed of episodically stored material drawn from personal experience or cultural sources of knowledge transmission. Many teachers found that critical episodes or experiences they had prior to their teaching career have significant influences to their present practices (Nespor, 1987). Calderhead and Robson (1991) reported that pre-service teachers held impressive images of teaching from their student experiences. Calderhead and Robson (1991) argued that these images play an important role in determining how teachers translate and utilize their knowledge, and how they determine the practices they use as teachers. Teacher's practice is influenced by their beliefs about education, schooling, teaching, learning and students.

Beliefs about Teaching and Learning Science

It has been realised for some time that teachers' beliefs play a very important role in shaping their classroom activities and teaching practices (Clark & Peterson, 1986). All teachers hold various kinds of beliefs. They always have beliefs about themselves such as they are good or bad in a specific discipline, about the nature of discipline they teach, about the nature of intellectual ability, about students as each individual and group, about their classroom and school environment, and more. These beliefs shape what teachers perceive in any set of circumstances, what they consider to be possible or appropriate in those circumstances, the goals they might establish in those circumstances, and knowledge they might bring to bear in them (Schoenfeld, 1997). Research has shown that the implementations of innovations in classroom are often resisted by the nature of teachers' beliefs (Munby, 1982; Nespor, 1987; Nisbett & Ross, 1980). Schoenfeld (1997) argued that there is a major difference between teachers' professed beliefs and their real beliefs. Cohen (1990) indicated that a teacher could believe that he or she is teaching in the spirit of reform while employing teaching methods that are contrary to the reform efforts.

Teachers' beliefs can be classified into expressed, entrenched and manifested beliefs (Keys, 2003). Entrenched and manifested beliefs are the beliefs that strongly influenced teachers' practice whereas expressed beliefs are espoused and rarely appear in practice (Keys, 2003). Teachers may change their expressed beliefs to entrenched beliefs by participating in professional development programs (Sheffield, 2004).

The following types of beliefs affect activities in classrooms and need to be examined in a model of teaching and teacher professional learning:

- beliefs about the nature of subject matter (in general and with regard to the specific topic being taught);
- beliefs about the nature of the learning process (both cognitive and affective);
- beliefs about the nature of the teaching process and the role of various kinds of instructions;
- beliefs about particular students and classes of students

(Schoenfeld, 1997, p. 23)

Bryan (1998) classified teachers' beliefs about science teaching and learning into six categories, which include beliefs about:

- the value of science and science teaching;
- the nature of scientific knowledge and goals of science instruction;
- control in the science classroom;
- how students learn science;
- the students' role; and
- the teachers' role.

The beliefs about the value of science and science teaching, the nature of science and the goals of science teaching, and about control in the science classroom are more central than the others; they are fundamental beliefs. These beliefs are also more difficult to change than the others (Rokeach, 1968).

Beliefs about the value of science and science teaching. Teachers who hold the beliefs that science is valuable and should be taught in school tend to focus their energy and devote their time to improve and engage in their science teaching practices (Bryan, 1998). Such beliefs are not held by all science teachers. Several studies with primary school teachers found that a number of teachers have negative attitudes to science and science teaching (Pratt, 1981; Tilgner, 1990; Wallace & Louden, 1992). These teachers dislike science and do not feel prepared to teach science (Bryan, 1998).

Beliefs about nature of scientific knowledge and goals of teaching science. Many science teachers believe that knowledge in science consists of truths, and the goal of their instruction is for student to learn these truths (Bryan, 1998). Carr, Barker, Bell, Biddulph, Jones, Kirkwood, Pearson and Symington (1994) argued that many teachers hold the beliefs that:

- science knowledge is unproblematic
- science provides right answers
- truths in science are discovered by observing and experimenting
- choices between correct and incorrect interpretations of the world are based on commonsense responses to objective data.

(p. 147)

The traditional objectivist view of science is conceived as a means of revealing the laws of nature (Milne & Taylor, 1996; Roth & Roychuodhury, 1994). Teachers who have an objectivist view of science believe that scientific inquiry is free of human values. These teachers are likely to highlight the collection and analysis of data that confirm existing theory.

By contrast, Chen, Taylor, and Aldridge (n.d.) explained that teachers who hold postmodern view of science believe that scientific knowledge is constructed socially in scientific communities. Human values shape the scientific inquiry, and scientific observations are unable to stand free of theoretical ideas. The perceived utility and value in serving society’s goals is the ultimate test of scientific knowledge.

Beliefs about control in the science classroom. Another fundamental belief is that science teachers must maintain control in their classroom. Bryan (1998) identified three types of belief about control; beliefs about control of students’ social behaviour, of procedures in science, and of students’ learning. Most teachers believe that classroom management and discipline are important to minimize safety risks. Beliefs about control over ones procedures of science teaching include ordering and sequence of events and keeping steps in an activity. Teachers also hold beliefs about control of students' learning, for example, many teachers believe that they need to ensure students discover the right answer through their activities in the science classroom (Bryan, 1998).

Beliefs about how student learn science, students' role, and teachers' role. Teachers who hold beliefs about transmitting information from teacher to learner are likely to adopt surface approach to teaching and learning (Marton & Saljo, 1976). Some of these teachers believe that knowledge can be transferred from the teacher to the students by lecturing, telling and showing the right answer, while students' role is listening, recalling and emulating.

Teachers who have transformative or constructivist beliefs about teaching and learning are different. Their instructional practices not only focus on students' engagement in activities, but they also attend to students' ideas, predictions, reasoning processes and explanations (Bryan, 1998).

Gunstone, Brass and Fensham (1994) studied the views that teachers of senior high school and first year university physics in one state of Australia hold about quality learning of physics. In this study, high school teachers held beliefs that students construct their own understanding and are responsible for their learning. Their beliefs about the nature of physics and the purpose of education focus on seeing the significance of physics for understanding the world around them more than a preparation for further study in universities. These beliefs draw high school teachers to place high value on students designing and undertaking experiments, and their pedagogies would tend to foster these students' behaviour.

The university physics teachers in this study (Gunstone, Brass, & Fensham, 1994) believed that physics is a highly logical structure, based on a set of uniformly applicable generalizations. The application to understand the world is obvious and powerful. Instructional practices of the university physics teachers are reliant on the laying out the structure of the discipline, and preparing students for research in physics. By these beliefs, laboratory work is considered to have little value and the linkage between physics and real world has no cognitive value for these teachers (Gunstone & White, 1998).

The difference between beliefs of the two groups of physics teachers above is that high school teachers held a central belief about student learning whereas the university teachers' central belief is about the nature of physics. These beliefs dominate their pedagogies and purpose of education (Gunstone & White, 1998).

The beliefs of students about learning and teaching are also significant factors for teachers, and will strongly influence what teachers can do. Bakopanos (1989) tried to encourage reflective thinking in a class and found that many students were unhappy about this approach because it was at odds with their beliefs. Gunstone and White (1998) implied that when students' beliefs are at odds with the beliefs of teachers, what teachers could easily achieve will be limited, even though the teachers' beliefs were informed and profound and the students' beliefs were narrow and inadequate. Gunstone and White (1998) assert that it is necessary to consider approaches to changing ideas and beliefs about teaching and learning.

Science Classroom Environment

Students spend at least 12 years in school by the time they finish upper secondary education. At approximately 35 hours per week and 36 weeks a year, students have to spend more than 15,000 hours at school (Rutter, Maughan, Mortimer, Ouston, & Smith, 1979). They learn not only cognitive aspects but also affective and social experiences from their school and classroom environments. Human behaviour is significantly influenced by both environment and personal characteristics (Fraser, 1986).

Classroom environment can be assessed in terms of physical and psychosocial components (Gilbert, Dunn, Mellard, & Lancaster, n.d.). Physical environment of a classroom includes many aspects such as lighting, visual environment, seating, shape and size of the room, location of the instructor, acoustics and noises, temperature, doorways and others aspects. Psychosocial environment may involve students' interest, teacher support, fairness and clarity of rules and tasks in the classroom (Rivera & Ganaden, 2001).

Walberg developed the Learning Environment Inventory (LEI) in the study of Harvard Project Physics (Anderson & Walberg, 1968), and Moos (1979) developed the Classroom Environment Scale (CES) to investigate the relationship between student satisfaction with classroom climate and learning. Walberg and Moos are respected as the pioneers on the perceptions of classroom environment (Fraser, 1986). The influence of classroom environment on the process of education has received a great deal of attention from educational researchers during the last three decades (Fraser, 1998).

There are many instruments for assessing classroom environment. These include: Learning Environment Inventory (LEI), Classroom Environment Scale (CES), Individualised Classroom Environment Questionnaire (ICEQ), My Class Inventory (MCI), College and University Classroom Environment Inventory (CUCEI), Questionnaire on Teaching Interaction (QTI), Science Laboratory Environment Inventory (SLEI), Constructivist Learning Environment Survey (CLES), and What Is Happening In This Classroom (WIHIC). Each instrument is suitable for different levels of education and comprise various scales (Fraser, 1998).

Research indicates that the differences between perceptions of teachers and students are always mismatched and teachers' perceptions of classroom environment are likely to be more positive than those of students (Fraser, 1998). Data from these instruments has been used by teachers to improve the psychosocial environments of their classrooms.

Chapter Summary

Physics instructors and students whose teaching and learning is based on traditional didactic pedagogy treat knowledge as though it is intact and transferable. Teaching strategies are normally teacher-centered whereas students prefer to employ surface approaches to studying for memorization of factual knowledge rather than deep approaches for conceptual understanding. Consequently, the traditional assessment is generally summative and focuses on students' mastery of factual content. Traditional physics pedagogy fails to take account of learners' prior knowledge, engage students in deep learning, challenge prior alternative conceptions, and fails to use assessment for formative purposes.

Contemporary constructivist learning theory (e.g., Osborne & Wittrock, 1985) is based on the belief that it is the learner who constructs his/her own understandings by making sense of natural phenomena through using existing knowledge to interpret new experiences and either extend existing conceptual understandings or restructure existing conceptions. Social constructivists (e.g., Driver et al., 1994) argue that learners construct science knowledge not only by empirical study of natural phenomena but also through social interactions with others, and it is through dialogue that conceptual understandings are co-constructed. Active, self-directed learning also requires the learner to be metacognitively self-aware in regulating their learning (Schoenfeld, 1987).

Motivation is another psychological aspect that energizes and drives people's performances. Students who have intrinsic motivation basically learn better than those who have extrinsic motivation (Deci & Ryan, 1985). Whether students employ surface or deep approaches to learning depends on whether they have a performance or learning goal orientation (Biggs, 1987; Dweck & Elliot, 1983), and those with intrinsic motivation are more likely to adopt deep approaches to learning.

Beliefs are mental constructs that play a very important role in shaping each individual's performances. Teachers' beliefs and students' beliefs are therefore very important factors that influence teaching and learning practices. Science teachers' hold beliefs about the value of science and science teaching, the nature of scientific knowledge and goals for teaching science, control in the science classroom, how students learn science, students' role, and teachers' role. Teachers' beliefs may be entrenched or manifested beliefs that strongly influence their practice, or expressed beliefs that rarely appear in practice (Keys, 2003).

Classroom environment is another aspect that influences the quality and effectiveness of students' learning (Fraser, 1986). Both the psychosocial and the physical aspects of classroom environment influence students' opportunity for learning and ultimately their attitudes to physics and physics achievement.

This research study is guided by the conceptual framework derived from the literature reviewed in this chapter and illustrated in Figure 2.4. It is argued that physics teaching and learning should be informed by modern learning theory; instructors' beliefs about teaching and learning strongly influence their physics teaching pedagogy, while students' beliefs, goals and motivations influence their approach to learning. The instructor's pedagogy and the students' approaches to learning impact on classroom environment and opportunity for learning, which in turn influence students' attitudes towards physics and physics achievement.

Conceptual Framework

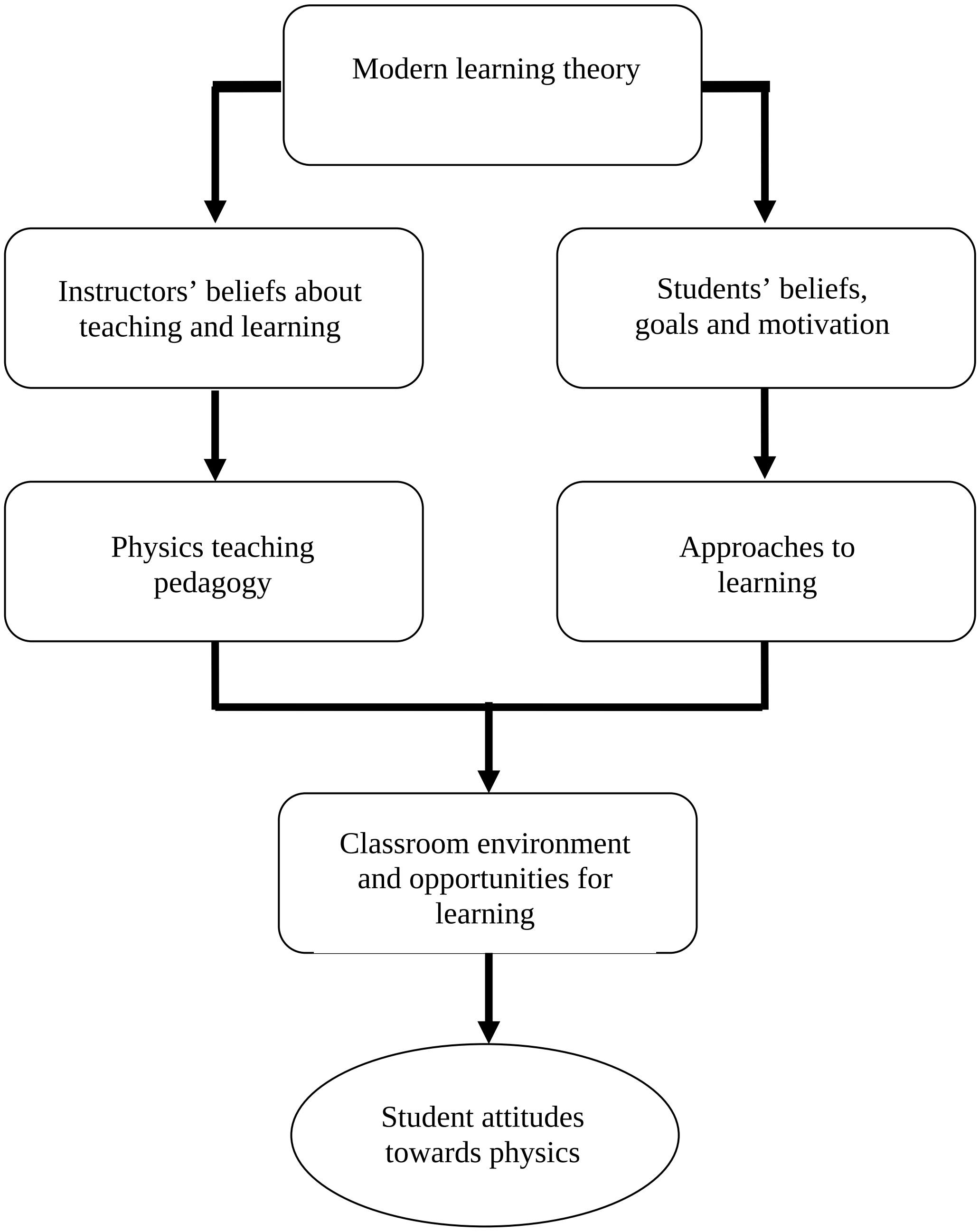


Figure 2.4. Conceptual framework

CHAPTER 3: RESEARCH METHODS

Introduction

Chapter 1 set the context for this study by providing background information about the teaching and learning of physics in Thailand that lead to the problem statement and the significance of study. Research questions and a conceptual framework have been established corresponding to the research problem. Chapter 2 developed the conceptual framework drawing on the research literature. This chapter outlines the research design, participants, instruments used for collecting data, data analysis, plan and timeline of the study.

Research Design

The purpose of this study is to investigate: (a) physics instructors' beliefs about teaching and learning and the effect these have on their teaching behaviours; (b) students' beliefs about teaching and learning, goals and motivation for studying physics and the effect these have on students' learning behaviours; and (c) the influence of (a) and (b) on classroom climate, opportunities for learning and students' attitudes to physics.

This research requires the satisfaction of all three common research purposes; exploration, description and explanation (Babbie, 1992). Surveys, interviews, observations and document analysis are the major techniques used in this study. The study uses mixed methods, that is, both quantitative and qualitative approaches.

Surveys are useful and efficient for collecting data from a large population, and also an excellent means for measuring attitudes and orientation. As Krathwohl (1993) stated "surveys are halfway house on the qualitative-quantitative continuum" (p. 360), if surveys are made by interview or open-ended questionnaires they will be qualitative or made by closed or multiple choice questions they will be quantitative. Survey research collects data from a sample, records and analyses the responses, and generalised to its population (Krathwohl, 1993).

Questionnaires are commonly used to collect data in survey research (Babbie, 1992). Each item must be relevant to the aims and objectives of the research, written in a simple and clear sentence, not more than one question in an item, and must not have any bias.

An interview is an alternative method of collecting survey data. Interviewing is typically conducted in a face-to-face encounter between interviewer and interviewee, but a telephone interview could be done as well (Babbie, 1992). Generally, there are two types of interview, structured and unstructured interviews. A structured interview consists of a set of questions to be asked in an orderly sequence. When the researcher has developed a clear idea of the area of interest, a structured interview is a very useful method. If the area of research is only generally specified, the unstructured interview could be more useful to adopt (Reaves, 1992).

Observation is a method of collecting data by a person – an observer, or by the other means of making an audio or video recording of the phenomenon of interest. The advantage of observation is that it records actual behaviour of the people in the situation, which may differ from their answers to questionnaires or interviews. Observation therefore can be used to check the validity of subjects' responses. However, the people who are aware that they are being observed tend to behave differently from how they do in an ordinary situation (Krathwohl, 1993).

In particular, classroom observation is a collaborative process of both the observer and the people being observed. Collaboration between the researcher, and the teacher and students in the class before, during and after observation can help all participants be at ease and gain the most benefit from the experience.

The analysis of important documents such as syllabus statements, teaching programs, students' notebooks and examination papers can provide invaluable information about current policies, intended and implemented curricula.

The research methods have been used to provide complementary information from different sources so that triangulation of data will provide greater confidence in the research findings.

The research design is illustrated in Figure 3.1 below.

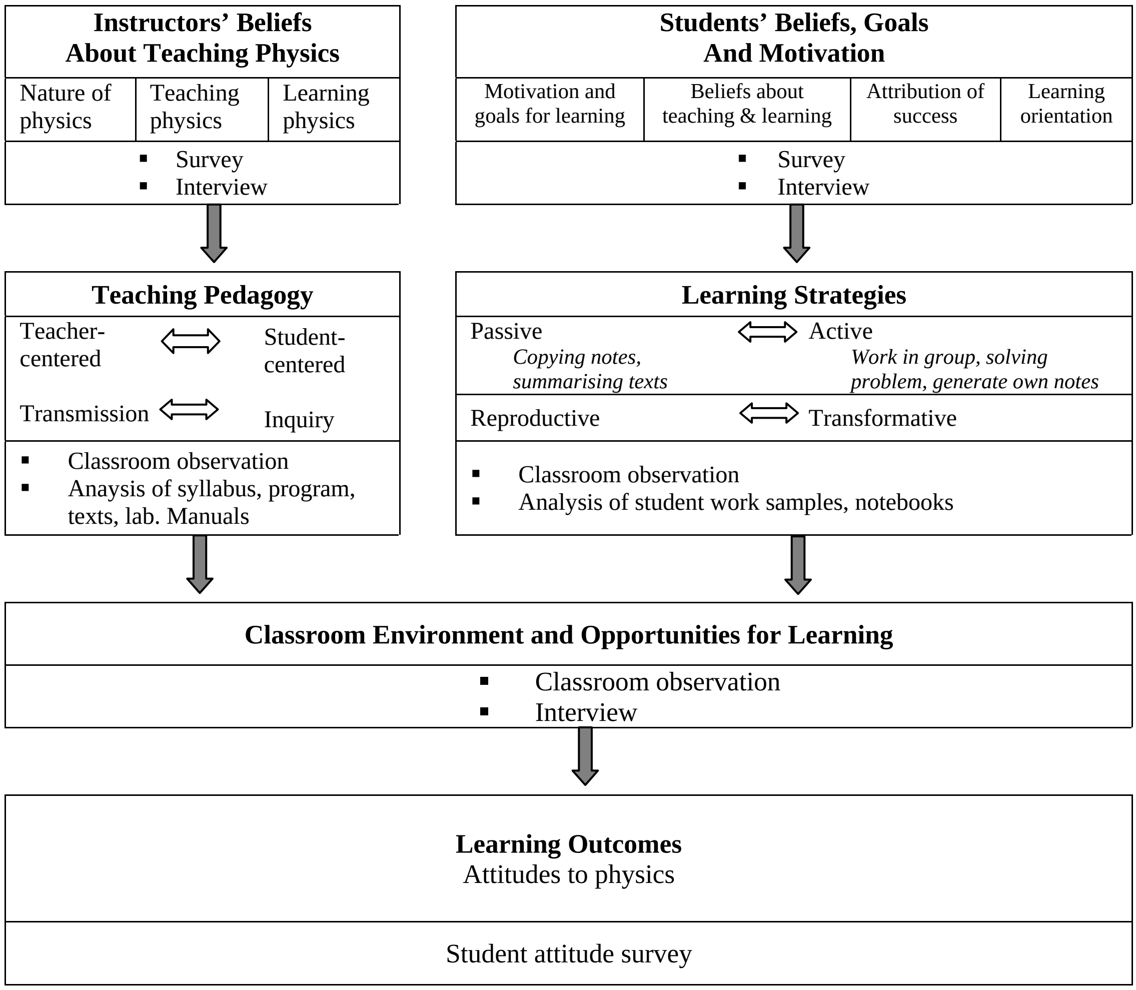


Figure 3.1. Research design

Research Participants

There are currently 41 Rajabhat universities in Thailand, however, at the time this research was conducted there were only 36. There were at least two physics instructors who teach the introductory physics courses in each Rajabhat. Thus, 72 persons is the minimum number of the introductory physics instructors in the 36 Rajabhats. The number of students who enrol in the introductory physics courses in these Rajabhats in each semester should not be less than 3600 (approximately at least 100 students per Rajabhat). This research chose all of the introductory physics instructors to participate in the survey of their beliefs about teaching and learning physics, and selected by convenience sampling about 140 students from two Rajabhat universities in the southern part of Thailand to survey their beliefs, goals and motivation.

Four classes of introductory physics taught by different instructors from two Rajabhat Universities in southern Thailand were selected by convenience sampling. The four instructors and about 20 students from these classes participated in case studies. These students and instructors were interviewed at the beginning of the semester after the administration of the first student questionnaire.

These introductory physics classes were observed to investigate the actual teaching and learning strategies, classroom environment and opportunities for learning. The four instructors and 20 students who were the participants in the first interview participated again in the second interview after classroom observations later in the semester.

At the end of the semester, the same groups of 140 students who completed the first questionnaire participated again in a second student questionnaire.

Document analysis provided additional information about teaching and learning. The available documents comprised syllabus, program, texts, laboratory manuals, assignments, test and exams, and student work samples. Some of these documents from the selected classes were analysed.

Research Instruments and Data Collection

Questionnaires

Three questionnaires were constructed and used in this research. The first was administered to the instructors of introductory physics in 36 Rajabhat universities all over Thailand. The instructor questionnaire (Appendix C) explored the instructors' beliefs about the purposes of teaching physics, effective teaching and learning strategies, and assessment in physics. Two student questionnaires were also developed. The first student questionnaire (Appendix D) probed students' goals and motivations for studying physics, students' beliefs about teaching and learning of physics, and their attribution of success. The second student questionnaire (Appendix H) probed students' attitudes towards physics and elicited their ideas about improving physics teaching and learning.

The construction of these questionnaires started from an analysis of research variables, and then developed items relating to these variables. The questionnaires were carefully translated into Thai language by the Researcher before being administered in a pilot study, which was used to develop the final form of the instruments.

Interviews

Structured interviews were conducted twice in this research. The first interviews took place with four instructors (Appendix E) and 20 students (Appendix F) after the first student survey and the instructor questionnaire and before the classroom observation, in order to corroborate and elaborate data obtained from survey questionnaires of the both groups of participants. The focus of the interviews was similar to the survey questionnaires but elicited more in-depth information from the respondents. The second interviews took place after the classrooms had been observed, with the four instructors and 20 students from the observed classes. The aim of the second interview was to confirm interpretations made about classroom observations. The interviews were audio recorded for transcription and analysis.

Classroom Observations

Before the observation of each class, the Researcher met with the class instructor to clarify the purpose of the observations and the role of the observer. The classroom observation focused on three areas; instructor's teaching pedagogy, students' learning strategies, and some aspects of classroom environment and the opportunities for learning. Each class was observed once or twice. The observation recording forms (Appendix G) were carefully designed to cover all important features of the observation.

Document Analysis

Instructional documents such as the syllabus, texts, plan, program, manuals, and some other documents were analysed to provide information about instructional intentions and approaches. Student work samples such as notebooks, laboratory reports, and assignment reports were also analysed to provide information about learning strategies.

Data Analysis

Questionnaires

Responses to the open questions of questionnaires were all given by respondents in Thai and carefully translated to English by the Researcher. These answers were coded into categories for each question. Responses to closed questions were also coded. A coding manual (Appendix I) was developed to guide the coding process and to ensure consistent categorisation of responses. Codes were recorded in Excel spreadsheets and were then imported into the SPSS program for analysis.

The data were then analysed using SPSS to generate descriptive statistics such as frequency distributions and percentages to summarise the frequency of responses in categories of instructors' beliefs, and students' beliefs, goals and motivations, and their attitudes towards the unit and to physics.

Interviews

The recorded data from interview were first transcribed into a verbatim manuscript. All data in the form of interview transcripts, classroom observations and document analysis were carefully read and read again to develop an understanding of the case. Once this had been done, the key themes were identified from the interviews and these were recorded with illustrative quotes where appropriate.

Classroom Observation

From each observed class, the data from observational forms were grouped and summarised according to the strategies of teaching and learning. Some features of classroom environment and opportunities for learning were also considered. Data were then summarized as a narrative description.

Document Analysis

Instructor's teaching materials such as texts, laboratory manuals, syllabi, assignments and tests were examined to identify data that could help explain the instructor's teaching practice and the students' approach to learning. Written records were made of the main features of the documents and from these some themes emerged which were clarified through relating the features from the documents with data from classroom observations and interviews.

Triangulation and Synthesis of Data

Data from the various sources were analysed, reduced, summarised and presented in separate results chapters. Interpretation of these data led to the development of assertions in each of these chapters. In the general discussion chapter data from the various sources and assertions are compared to corroborate findings and these are synthesised into general assertions which were used to answer the research questions.

The Structure of Data Analysis

Basic data were analysed by methods described above and the results were presented in Chapters 4 - 7. Chapter 4 focused on the analysis of data to describe instructors' opinion about teaching and learning physics in Thai Rajabhat universities. Chapter 5 presented the analysis of the first student questionnaire to explain students' opinion about teaching and learning physics. Chapter 6 reported case studies from the analysis of data collected through interviews, classroom observation, and document analysis. Chapter 7 presented the analysis of data from the second student questionnaire which examined students' opinion at the end of the semester about studying physics. The results of data analysis were summarised as the assertions in each Chapter.

These assertions were discussed to develop general assertions in Chapter 8. The general assertions were determined into five themes which were concluded to be the answers of the research questions in Chapter 9.

Research Plan

The research was conducted in second semester of the Thai educational year of 2002, and is described in six phases below.

Phase	Methods	Subjects	Amount	Location	Instruments
1 (1st-3rd week of Nov.02)	Survey	▪ Introductory physics instructors ▪ Introductory physics students	72 140	All Rajabhats Southern Rajabhats	Questionnaire Questionnaire
2 (4th week of Nov.02 - 1st week of Dec.02)	First Interview	▪ Introductory physics instructors ▪ Introductory physics students	4 20	Southern Rajabhats Southern Rajabhats	Interviewing forms Interviewing Forms
3 (2nd-3rd week of Dec.02 and 2nd-3rd week of Jan.03)	Classroom observation	Introductory physics classes	4	Southern Rajabhats	Observational forms

4 (4th week of Jan.03 - 1st week of Feb.03)	Second Interview	▪ Introductory physics instructors ▪ Introductory physics students	4 20	Southern Rajabhats Southern Rajabhats	Interviewing forms Interviewing Forms
5 (4th week of Jan.03 - 1st week of Feb.03)	Second student survey	▪ Introductory physics students	140	Southern Rajabhats	Questionnaire
6 (2nd week of Feb.03 - 4th week of Mar.03)	Document analysis	▪ Teaching materials ▪ Student working samples	At the 4 case study sites	Southern Rajabhats	

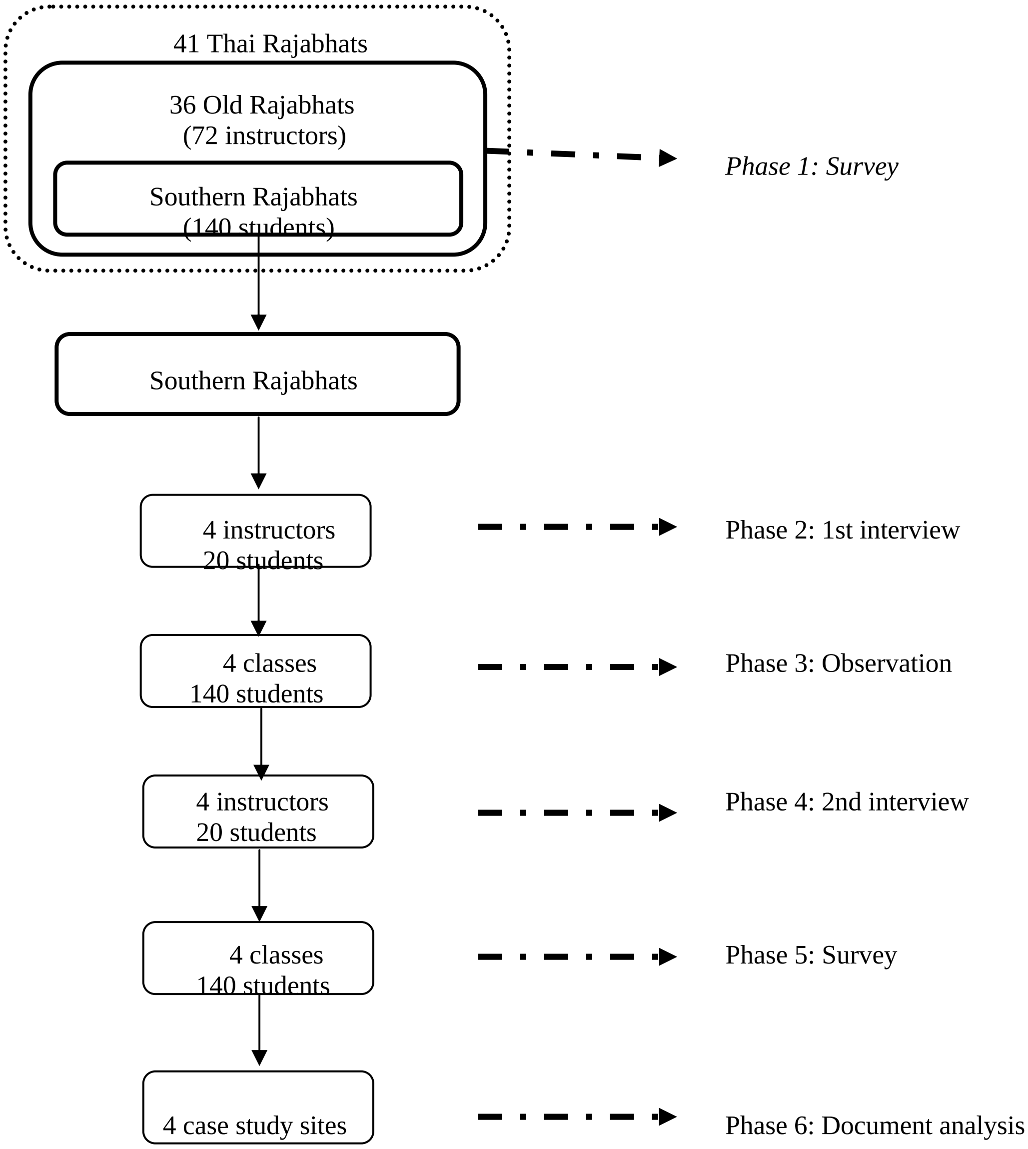


Figure 3.2. The research plan

Timeline

The educational year for Rajabhat universities in Thailand is formally divided into two semesters, 18 weeks for each semester. The first semester is between the beginning of June and the middle of October. The second semester is from the beginning of November to the middle of March. This research collected data in the second semester in the educational year of 2002; between November 2002 and March 2003.

Activity	**Nov.2002**				**Dec.2002**				**Jan.2003**				**Feb.2003**				**Mar.2003**			
	Week																			
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Survey	■	■	■																	
Interview				■	■	■					■	■	■							
Observation							■	■	■	■										
Second student survey												■	■	■						
Document Analysis														■	■	■	■	■	■	■
Data Analysis		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

Figure 3.3. The timeline of the research

CHAPTER 4: THE INSTRUCTORS QUESTIONNAIRE

Introduction

This Chapter presents and discusses the results from the instructors' questionnaire. The first section presents demographic data about Rajabhats and instructors who participated in the survey. The second section describes the instructors' opinions about the purposes of teaching physics and what students should learn in physics. The third part shows the percentages of time devoted to various teaching strategies in actual and ideal teaching, opinions about effective physics teaching and factors that limit the quality and effectiveness of physics teaching. The fourth section is about instructors' opinions and beliefs about effective learning strategies, students' motivation and limiting factors. The fifth section considers instructors' methods of assessment in physics. The sixth section considers instructors' suggestions for improving physics teaching and learning in Rajabhat institutes. The last section summarises the assertions from all previous sections of this Chapter.

Demographic Data

The survey questionnaire was sent to 36 Rajabhat universities located in all regions of Thailand during November and December 2002. Completed questionnaires were received from 89 physics instructors at 32 Rajabhats. Responses were therefore received from more than 80% of all Rajabhat universities in Thailand.

At the beginning of the questionnaire, the instructors provided information about their qualifications, major fields of study, and teaching experiences as shown below in Tables 4.1, 4.2, 4.3 respectively.

Table 4.1. Qualifications of the physics instructors (n = 87)

Qualification	Count	Percent of respondents
B.Sc.	12	13.8
B.Ed.	17	19.5
Diploma	2	2.3
M.Sc.	48	55.2
M.Ed.	17	19.5
Ph.D.	4	4.6
Total	100	114.9

The 87 instructors reported a total of 100 qualifications as some reported both a bachelor degree and a postgraduate qualification. More than a half of the instructors have a master degree in science (55%) and about 80% have a higher degree, either an M.Ed., M.Sc. or Ph.D.

Table 4.2. Major field of study (n = 87)

Major	Count	Percent
Physics	74	85.1
Education	10	11.5
Others	3	3.4
Total	87	100.0

Table 4.2 shows that 85% of the instructors have a major in physics. Some of the other instructors who reported a major in another field of study, may have a physics background at the undergraduate level but have a major in different fields in their higher degree (e.g. M.Ed.). Hence, at least 85% of the instructors who teach introductory physics in Thai Rajabhats have sufficient background in physics.

Table 4.3. Teaching experience (n = 85)

Years of teaching experience	Count	Percent
< 5 yrs	35	41.2
6-10 yrs	17	20.0
11-15 yrs	3	3.5
16-20 yrs	1	1.2

Years of teaching experience	Count	Percent
>20 yrs	29	34.1
Total	85	100.0

Table 4.3 shows that the distribution of teaching experience amongst the physics instructors is bimodal, that is there are many relatively inexperienced instructors (0 – 10 years), and many highly experienced instructors (> 20 years), yet few in the range 10 – 20 years.

Analysis of demographic data reveals that more than half of the instructors have a master degree in science and are well qualified to teach at introductory physics level, however, there are some instructors whose major is in education or some other field. The majority of instructors (59%) have at least five years experience, which includes a group of instructors (34%) who have more than 20 years of experience.

Assertion 4.1

The majority of instructors is well qualified in physics and has at least five years of teaching experience.

The Purposes of Teaching Physics

Survey questions probed instructors' beliefs about the purpose of teaching physics. An open-ended question and six Likert rating scale items addressed this issue. Table 4.4 summarises instructors' responses to the open-ended question.

Table 4.4. Instructors' responses to the question: What should students learn about the nature of physics? (n = 88)

Responses	Count	Percent of respondents
Understandings		
Principles, laws and concepts in physics	42	47.7
Physical phenomena	34	38.6
Interactions among matter	10	11.4

Responses	Count	Percent of respondents
Applications		
Application of physics	20	22.7
Relevance to real life	13	14.8
Skills and processes		
Mathematical skills	7	8.0
Scientific process	7	8.0
Skills in doing experiments	4	4.5
Other		
History of physics	2	2.3
Quantities in physics	2	2.3
Total	141	160.3

Again, many instructors gave more than one response. Responses to this question were initially coded into 10 categories, which were then clustered into four groups. Most respondents indicated that students should learn the concepts in physics, principles, laws, physical phenomena, and interactions among matter. As some instructors wrote that;

> “(Students should learn) facts and other kinds of physics knowledge such as principles, laws and theories which are related to their daily life experiences.” (Instructor no.29; 28 years of teaching experience)
>
> And,
>
> “(Students should learn) three aspects in physics, which are the results of interaction between matter and energy, theories or laws that related to the interaction, and how to apply these laws or theories to explain the natural phenomena.” (Instructor no. 32; 32 years of teaching experience)

The next most frequent group of responses related to applications of physics and relevance to real life. A relatively small number of respondents mentioned skills and process of science and mathematics.

Opinions about what students should learn in physics were surveyed again in Part B of this questionnaire, using six Likert rating scale items. Instructors’ responses to these questions are presented in Table 4.5.

Table 4.5. Instructors' responses to the Likert rating scale items about what students should learn in physics

Item no.	Strongly disagree	Disagree	Not disagree or agree	Agree	Strongly agree
From your teaching, you anticipate the students will …					
(1) memorise the facts of physics that you teach.	0	5.6	18.0	51.7	24.7
(2) make sense of the physics contents and the relationships between concepts so they understand them.	0	4.5	5.6	37.1	52.8
(3) construct their own meaning for the concepts you teach.	0	1.1	14.6	38.2	46.1
(4) be able to appy their physics concepts to explain the world around them in their everyday experiences.	0	3.4	10.2	27.3	59.1
(5) learn skills of planning experiments.	0	4.5	13.6	34.1	47.7
(6) learn skills of doing experiments.	1.1	0	11.4	38.6	48.9

Most of the instructors agreed or strongly agreed with each item. That is, the instructors expected students to memorise (1st item), understand (2nd and 3rd items), apply (4th item) and learn skills (5th and 6th items) in physics. The percentage of respondents who agreed and strongly agreed with the memorization item (76%) is less than for the understanding and applying items (90%, 84%, and 86% respectively) and also for the skills items (82% and 87%).

Taken together, the data from Tables 4.4 and 4.5 suggest that instructors believe that the main purpose of physics teaching is the development of knowledge of physics concepts, and more instructors hope students will understand the physics rather than memorise it.

Assertion 4.2

The majority of instructors believe that the main purpose of physics teaching is that students should learn the facts, laws and principles of physics. More instructors agreed or strongly agreed with the statement that students should understand the concepts, than with the statement that students should memorise the facts of physics.

Effective Strategies for Physics Teaching

The instructors were surveyed to determine the percentage of teaching time devoted to various teaching strategies under actual and ideal teaching circumstances. These data are presented in Table 4.6.

Table 4.6. Percentages of time devoted to various teaching strategies in ideal and actual circumstances (n = 88)

Teaching strategies	Ideal circumstances		Actual circumstances	
	Mean	Std. Dev	Mean	Std. Dev
Explaining physics	22.45	14.93	36.64	18.28
Questioning and discussing	16.90	11.47	13.61	10.39
Giving notes	5.79	7.78	8.38	8.64
Showing video	10.74	6.89	6.09	6.18
Demonstration	11.34	7.58	9.73	8.36
Individual work	16.12	8.16	12.50	7.90
Small group work	16.94	9.20	13.62	9.50

The responses for each strategy varied considerably so that the standard deviation figures are quite large. In the actual circumstances, the most frequently used strategy is explaining physics (37%). Under ideal circumstances, instructors believe that explaining physics would decline markedly from 37% to 22%. Given the large standard deviations, the other changes were very small: giving notes would decline from 8% to 6%, questioning and discussion would increase from 14% to 17%, and showing videos would increase from 6% to 11%.

Assertion 4.3

As expected, the physics instructors actually spend more time explaining than on any other strategy. Under ideal circumstances they would reduce the amount of time explaining and increase the amount of time devoted to student-centered strategies such as questioning and discussing, individual and group work.

The instructors were also asked about the characteristics of effective physics teaching. The categories of responses are shown in Table 4.7.

Table 4.7. Instructors' responses to the question: What are the characteristics of effective physics teaching? (n = 87)

Responses	Count	Percent of respondents
Clear explanation	37	42.5
Doing experiments	37	42.5
Problem solving and inquiry	16	18.4
Student centered	14	16.1
Doing exercises	9	10.3
Educational innovation (media)	9	10.3
Group discussion	7	8.0
Encouraging students	6	6.9
Critical thinking	4	4.6
Cooperative atmosphere	3	3.4
Good attitudes towards physics	3	3.4
Good evaluation	2	2.3
Scientific method	2	2.3
Using various methods	2	2.3
Enjoy lessons	1	1.1
Total	152	174.7

The most frequently mentioned characteristics of effective physics teaching were 'clear explanation' (42.5%) which may reflect beliefs about knowledge transmission; and 'doing experiments' (42.5%) which may reflect beliefs about physics being an experimental science. Some of the responses in Table 4.7 such as problem solving and inquiry, student-centered, doing exercises, group discussion, and critical thinking would be expected to be related to beliefs about a student-centered pedagogy that employs inquiry strategies. Even though the instructors may hold beliefs about the effectiveness of student-centered pedagogy they may actually employ teacher-centered strategies in their teaching (Cohen, 1990).

The instructors were asked about their roles in effective physics teaching. Their suggestions are summarised in Table 4.8.

Table 4.8. Instructors' responses to the question: What are the important roles of the instructors in effective teaching? (n = 88)

Responses	Count	Percent of respondents
Encourage and promote students' learning	43	48.9
Manage suitable learning activities	26	29.5
Transmit physics knowledge	26	29.5
Help, advise or coach students	20	22.7
Being a good evaluator	4	4.5
Total	119	135.2

Although about 30% of instructors believed that effective teaching involves transmitting physics knowledge a large number of responses reflected beliefs about effective teachers being facilitators or managers of learning activities (encourage and promote 49%; manage learning 30%; help, advise or coach 23%).

Some respondents mentioned many roles that covered both student-centered and teacher-centered strategies. This ambiguity may arise from their prior experiences of studying and teaching, and new trends from the contemporary theories of teaching and learning. This may reflect the inconsistency between instructors' professed beliefs and their entrenched beliefs (Schoenfeld, 1997).

Many items asked instructors to respond to statements about physics teaching strategies using an agreement scale that ranged from 'strongly disagree' to 'strongly agree'. The results are summarised in Table 4.9.

Table 4.9. Instructors' responses (percentage agreement) to the rating scale items about physics teaching

Item no.	Strongly disagree	Disagree	Not disagree or agree	Agree	Strongly agree
Your approach to teaching physics is to …					
(7) transmit knowledge to students.	0	5.6	23.6	47.2	23.6
(8) help students search for knowledge.	0	2.2	9.0	40.4	48.3
(9) help students to solve problems.	1.1	7.9	28.1	46.1	16.9
(10) work with students in the construction of knowledge.	0	4.5	10.1	43.8	41.6
(11) be the manager of activities in the classroom.	2.2	5.6	24.7	36.0	31.5
In your class …					
(12) you have time to help each student with his/her learning.	3.4	21.3	19.1	39.3	16.9
(13) you are able to create student interest.	0	0	26.1	56.8	17.0
(14) it must be quiet with little discussion for effective learning.	9.0	30.3	32.6	18.0	10.1
(15) you use many different teaching strategies to meet the needs of different learning styles.	0	2.2	15.7	49.4	32.6
(16) you have to rush through the course as there is so much content to cover.	5.7	26.1	36.4	23.9	8.0
(17) you have little freedom to teach the way you like as you have to follow the syllabus.	9.0	23.6	38.2	23.6	5.6
(18) you ask the students many questions to engage them in their learning.	0	8.0	28.7	43.7	19.5

Five items (7-11) asked instructors about their approach to physics teaching. More than 60% of instructors agreed or strongly agreed with each of these items. The

7th item represented a teacher-centered strategy while the 8th – 11th items represented student-centered strategies. The results from this part of the questionnaire therefore reflected the combination of instructors' beliefs about knowledge transmission and helping students construct knowledge.

More than 60% of instructors agreed or strongly agreed with the 13th, 15th, and 18th items about creating student interest, using different teaching strategies and asking many questions which all related to student-centered teaching.

Items 14 (it must be quiet for effective learning) and 16 (have to rush through the content) in Table 4.9 are consistent with a teacher-centered knowledge transmission pedagogy. Responses to these items were more ambivalent, with the most frequent response being neither agree nor disagree. Instructors responded similarly to Item 17 which suggested they had some limitations on the way they could teach.

Assertion 4.4

Instructors hold a range of beliefs about their roles in effective teaching. Their roles included transmitting knowledge and also being facilitators of learning.

Instructors were asked an open-ended question about the factors that limit the quality and effectiveness of their physics teaching. Their responses are summarised in Table 4.10.

Table 4.10. Instructors' responses to the question: What is the main factor that limits the quality and effectiveness of your physics teaching? (n = 87)

Responses	Count	Percent of respondents
Students have low ability and background knowledge	41	47.1
Shortage of laboratory and educational equipment	30	34.5
Overload tasks and responsibilities of instructors	21	24.1
Students have poor attitudes towards physics	20	22.9
Lack of support from the administration	12	13.8
Insufficient time to complete physics lessons	9	10.3
Lack of texts and learning materials	8	9.2

Responses	Count	Percent of respondents
Using ineffective teaching strategies	4	4.6
Too many students in a class	2	2.3
Total	147	169.0

Factors that are considered to limit the quality and effectiveness of physics teaching mainly arose from students' ability and prior knowledge (47%), and attitudes (23%). The shortage of equipment (34%) and learning materials (9%), given the large number of students in a class (2%) were also frequently mentioned by the instructors. Instructors also stated that their workload (24%), lack of support from administration (14%) and limited class time (10%) limited the quality of their teaching. Only 5% of respondents indicated that their ineffective teaching strategies limited the quality of their teaching.

Assertion 4.5

The students' poor background knowledge, ability and attitudes, and the lack of equipment and support from the administration mostly limit the quality and effectiveness of teaching physics in Rajabhats. The constraints of curriculum, time and teaching pedagogy were not identified as significant problems for instructors in teaching physics.

The data on instructors' beliefs about effective teaching (Tables 4.9 and 4.10) indicate a mix of views that range from transmitting knowledge to facilitating students' learning. Previous research has revealed that teachers will express one set of beliefs about what they believe teaching should be like and actually hold other beliefs that determine their actual teaching practice (Keys, 2003; Sheffield, 2004). The mix of beliefs elicited in the questionnaire may represent a diversity of beliefs amongst the instructors or a mix of espoused beliefs and entrenched beliefs.

Assertion 4.6

Instructors may hold ambivalent beliefs about teacher-centered and student-centered pedagogy which may reflect espoused beliefs about ideal teaching practice and entrenched beliefs that drive their actual teaching practice.

Effective Strategies for Physics Learning

The instructors were asked three questions in Part A of the questionnaire about effective learning strategies, motivation and limitations for physics learning. Instructors' opinions about effective learning strategies are summarised in Table 4.11.

Table 4.11. Instructors' responses to the question: What are the most effective strategies for learning physics? (n = 87)

Responses	Count	Percent of respondents
Hands-on activities or laboratory approaches: Active learning	58	65.9
Problem solving and inquiry methods	26	29.5
Reading and listening	17	19.3
Using various strategies	9	10.2
Doing exercises	7	8.0
Questioning and discussing	7	8.0
Analytical activities	1	1.1
Total	125	142.1

The most common responses related to hands-on activities (66%), and problem solving and inquiry methods (30%). Active listening and reading, writing, discussing, and engaging in the higher-order thinking are active learning strategies (Bonwell & Eison, 1991) and when using these students are more likely to employ deep approaches to learning.

Assertion 4.7

Instructors believed that the most effective strategies for learning physics are active learning or student-centered strategies.

Another question asked instructors about students' motivation to study physics. Table 4.12 shows the responses to this question.

Table 4.12. Instructors' responses to the question: What is the motivation for students to study physics? (n = 87)

Responses	Count	Percent of respondents
Intellectual challenge of the subject	28	32.2
Good teaching and the successes in studying	24	27.6
Enhanced employment prospects	24	27.6
Application of physics to real situations	18	20.7
Awareness to the importance of physics	6	6.9
The successes of famous physicists	2	2.3
No motivation in physics	5	5.7
Total	107	123.0

The most frequent response (32%) indicated that instructors believe that the intellectual challenge of physics is the main motivation for students to study the subject. A high percentage of instructors implied that good teaching and student success in studying physics (28%) were motivating factors. Responses about enhanced employment prospects (28%) probably relate to the shortage of physics teachers in Thailand. Although it was an infrequent response (6%) some instructors said there was no motivation for studying physics. The students are often required to enrol in physics courses rather than selecting the courses freely by themselves. Enrolment may fall if students were free to choose.

Assertion 4.8

Instructors reported that the main motivations for students to study physics could be the intellectual challenge of the subject, good teaching, enhanced employment prospects and application to real situations.

Instructors were also asked about factors that limit students' success in gaining good grades in physics. Responses to this question are summarised in Table 4.13.

Table 4.13. Instructors' responses to the question: What factors limit students' success in getting good grades in physics? (n = 87)

Responses	Count	Percent of respondents
Low background knowledge of physics and mathematics	38	43.7
Ineffective teaching strategies	24	27.6
Poor attitudes towards physics, less effort and attention	23	26.4
Too much difficult contents in a short period	10	11.6
Lack of encouragement and motivation	9	10.3
Low IQ and ability	7	8.0
Lack of laboratory equipment and texts	4	4.6
Ineffective and rote learning strategies	3	3.4
Inappropriate assessment	1	1.1
Total	119	136.9

The most frequent response from instructors (44%) was that students' background knowledge in physics and mathematics is a significant factor that limits their success in getting good grades. About one quarter of respondents indicated that ineffective teaching strategies using in physics classes (28%) and the poor attitudes towards physics of students (26%) limited students' success.

There are similarities between these results about factors limiting learning (Table 4.13) and factors limiting teaching (Table 4.10) in that instructors believe that both teaching and learning are limited by students' background knowledge and attitudes, and poor teaching strategies. It is noticeable that lack of equipment is seen as a greater impediment to good teaching than to learning.

Assertion 4.9

Instructors reported that success in getting good grades in physics is limited mainly by low background knowledge in physics and mathematics, inappropriate teaching strategies and having poor attitudes towards physics.

The 19th – 23rd rating scale items were also used to investigate the instructors' opinions about students' approaches to learning. Results from these items are shown in Table 4.14.

Table 4.14. Instructors' responses to rating scale items about student approaches to learning

Item no.	Strongly disagree	Disagree	Not disagree or agree	Agree	Strongly agree
In your class …					
(19) students make-up their own notes from your lectures and the text.	4.5	14.6	27.0	40.4	13.5
(20) students copy the notes that you give them in lectures.	5.6	25.8	36.0	27.0	5.6
(21) students must follow the instructions you give them for experiments so that they are successful.	2.3	23.9	28.4	36.4	9.1
(22) students are able to plan some of their own experiments.	1.1	10.2	14.8	51.1	22.7
(23) students have sufficient mathematical skills and knowledge to be successful with physics.	6.7	7.9	20.2	34.8	30.3

A larger percentage of instructors agreed or strongly agreed that students make their own notes in lectures (54%) than copy notes provided by the instructors (33%). Similarly, a larger proportion of responses agreed or strongly agreed that students plan some experiments (74%) rather than follow experiment instructions provided by the instructors (46%). The instructors' reports about students making their own notes and planning their own experiments (Items 19 and 22) appear to be inconsistent with typical practice. It is common in Thai Rajabhats for students to copy notes provided by the instructor and to follow instruction for experiments rather than planning their own. Further data regarding these practices are reported in the case studies in later chapters. The instructors' responses may reflect ideological beliefs about what should happen in their classes rather than what actually happen. Responses to the last item indicate that the majority of respondents (65%) agreed or strongly agreed that students have sufficient mathematical skills and knowledge to be successful in physics. It should be noted that instructors' responses to other items (Table 4.13) indicate that lack of mathematical skills limits students' success in physics. Instructors may be responding to Item 23 thinking that students 'should' have these skills.

Assessment in Physics

Assessment is a very important process in teaching and learning. So this questionnaire posed instructors two questions about assessment in physics. The first question asked about the purposes of assessment and the second sought information about the methods that instructors use in assessment.

Table 4.15. Instructors' responses to the question: What is the main purpose of assessment in physics? (n = 88)

Responses	Count	Percent of respondents
To measure students' ability to understand and apply physics knowledge	50	56.8
To measure students' development and achievement	20	22.7
To measure practical skills in laboratory work	13	14.8
To measure the ability of solving problem	5	5.7
To evaluate and categorise students	4	4.5
To improve teaching and learning strategies	7	8.0
Total	99	112.5

The overwhelming majority of responses (92/99) related to summative assessment of achievement and in particular understanding of physics knowledge (50/99). Only seven responses recognized the formative role of assessment in improving teaching and learning.

Responses to the question about the methods of assessment in physics are reported in the Table 4.16.

Table 4.16. Instructors' responses to the question: How do you assess your students in physics? (n = 88)

Responses	Count	Percent of respondents
Methods of assessment		
Pencil-and-paper tests	55	62.5
Practical work assessment	30	34.1
Assignment assessment	17	19.3
Observation assessment	17	19.3
Oral enquiry assessment	13	14.8
Continuous assessment	6	6.8
Various unspecified methods	20	22.7
Assessment framework		
Criterion referenced	5	5.7
Norm referenced	3	3.4
Total	166	188.6

Most responses described methods of collecting evidence of achievement, however, a few reported the evaluation framework (criterion or norm-referenced) used to report achievement. The most common methods of assessing students were tests (63%) and practical work assessments (34%).

Assertion 4.10

The purpose of assessment was focused on summative rather than formative assessment, and instructors preferred methods of assessment were tests and reports of practical work.

Improvement of Physics Teaching and Learning

A question was asked about the way that physics teaching and learning in Thai Rajabhats could be improved. The results are shown as in the following table.

Table 4.17. Instructors' responses to the question: How could physics teaching and learning be improved in Rajabhat institutes? (n = 88)

Responses	Count	Percent of respondents
Resources and support		
Provide sufficient materials, staff and budgets	30	34.1
Provide more texts and other information resources	13	14.8
Improve administrative systems	2	2.3
Decrease instructors' workload	2	2.3
Teaching methods		
Improve teaching and learning strategies, focus on laboratory approaches	26	29.5
Use student-centered strategies	8	9.1
Stress on affective domain	6	6.8
Improve assessment procedures	4	4.5
Curriculum		
Curriculum development	23	26.1
Decrease some details in physics contents	1	1.1
Instructors		
Professional development for instructors	14	15.9
Hard working both in teaching and studying	3	3.4
Quality assurance in teaching and learning	2	2.3
Focus on research work	2	2.3
Cooperative working among physics instructors	1	1.1
Students		
Select smart students to study physics	4	4.5
Total	141	160.2

Instructors' suggestions for improving teaching and learning of physics were in five categories; resources, teaching, curriculum, instructors and students. The most common suggestions were: provision of sufficient materials, staff and budgets (34%) and texts (15%); improve teaching strategies, particularly laboratory work (30%); curriculum development (26%); and, professional development for instructors (16%).

Assertion 4.11

Instructors suggested that physics teaching in Thai Rajabhats could be improved by providing sufficient resources and support, improving teaching strategies and curriculum, and professional development for instructors.

The last part of the questionnaire (Part C) provided free space for respondents to give any kinds of comments. Forty-two of the 89 instructors (47%) responded to this part. Most of comments (81%) related to teaching and learning physics in Thai Rajabhats. All of these responses can be divided into three groups; the problems of teaching and learning, how to improve teaching and learning, and other comments that are not relevant to teaching and learning. The categories of responses with counts and percentages are shown in the Table 4.18.

Table 4.18. Final comments (n = 42)

Responses	Count	Percent of respondents
Problems with teaching and learning		
Students have low competence (intelligence) to learn	9	21.4
Shortage of laboratory equipment and technician support	5	11.9
Irrelevant physics lessons to real-life situations	3	7.1
Students have not enough prior knowledge and experiences	3	7.1
Instructors' beliefs about tenable physics knowledge	2	4.8
Non-sophisticated instructors	2	4.8
Out of date curriculum	2	4.8
Overload tasks and responsibilities of instructors	2	4.8
Lack of support from the administration	1	2.4
Lack of sufficient budget	1	2.4
Students have bad attitudes towards physics	1	2.4
How to improve physics teaching and learning		
Continuously improve teaching strategies	12	28.6
Improve physics curriculum	7	16.7
Motivate talented students to study physics	7	16.7
Do more academic research and publications	5	11.9
Provide sufficient time for student learning	3	7.1
Assessment system improvement	3	7.1

Responses	Count	Percent of respondents
Begin physics lessons at the early ages of students	3	7.1
Provide suitable texts and materials	3	7.1
Focus on student understanding rather than memorising	3	7.1
Increase the number of instructors and technical staffs	1	2.4
Raise the value of physics profession	1	2.4
Secondary school education quality improvement	1	2.4
Others		
Irrelevant comments to teaching and learning physics	8	19.0
Total	88	209.5

Many responses repeated opinions expressed earlier in the questionnaire. The two most common responses were that students had limited ability to study physics (9) and there is a need to improve teaching strategies (12).

Chapter Summary

The responses from completed questionnaires indicate that most physics instructors in Thai Rajabhats are well qualified for teaching introductory physics. The majority of these instructors have more than five years teaching experience.

Most of the instructors believed that students should understand principles, laws and concepts in physics and they spend more class time explaining physics than other teaching strategies such as practical work. Instructors indicated that they wish to decrease the amount of time explaining and increase the time devoted to the student-centred strategies.

Instructors' believe that 'clear explanations' and 'doing experiments' are the characteristics of effective teaching. Although they suggested that an important role in effective teaching is to be facilitators or managers of learning activities, they still hold beliefs about transmitting knowledge.

Instructors reported that the significant factors that limit the quality and effectiveness of physics teaching are: students' poor background knowledge, ability and attitudes to the subject; and the lack of equipment and learning materials and administration support. Curriculum, time and teaching strategies are not perceived to be important limitations to physics teaching in Rajabhats.

Instructors' opinions about effective learning strategies relied on student-centred or active learning such as hands-on activities, problem solving and inquiry, in which students would be expected to employ deep rather than surface approaches to learning. Respondents believed that the main motivations for students to study physics are intellectual challenge of the subject, good teaching and successes in studying, enhanced employment prospects and application to real life. Instructors also reported that students are limited in getting good grades by their low background knowledge, particularly in mathematics and physics; ineffective teaching strategies and by their poor attitudes to physics.

Most instructors reported that the purpose of assessment to the summative assessment of achievement, especially to measure students' understanding in physics. A small number of respondents indicated that formative assessment, which aimed to improve the teaching and learning strategies was a purpose of their assessment. Instructors mainly use tests and reports of practical work to assess students' achievement.

Some suggestions are proposed to improve physics teaching and learning in Thai Rajabhats. These suggestions included providing more resources and support, improving teaching and learning strategies, curriculum development, professional development for instructors and motivating smart students to study physics.

These main findings have been summarised as assertions. The assertions are listed below.

4.1 The majority of instructors is well qualified in physics and has at least five years of teaching experience.

4.2 The majority of instructors believe that the main purpose of physics teaching is that students should learn the facts, laws and principles of physics. More instructors agreed or strongly agreed with the statement that students should understand the concepts, than with the statement that students should memorise the facts of physics.

4.3 As expected, the physics instructors actually spend more time explaining than on any other strategy. Under ideal circumstances they would reduce the amount of time explaining and increase the amount of time devoted to student-centered strategies such as questioning and discussing, individual and group work.

4.4 Instructors hold a range of beliefs about their roles in effective teaching. Their roles included transmitting knowledge and also being facilitators of learning.

4.5 The students' poor background knowledge, ability and attitudes, and the lack of equipment and support from the administration mostly limit the quality and effectiveness of teaching physics in Rajabhats. The constraints of curriculum, time and teaching pedagogy were not identified as significant problems for instructors in teaching physics.

4.6 Instructors may hold ambivalent beliefs about teacher-centered and student-centered pedagogy which may reflect espoused beliefs about ideal teaching practice and entrenched beliefs that drive their actual teaching practice.

4.7 Instructors believed that the most effective strategies for learning physics are active learning or student-centered strategies.

4.8 Instructors reported that the main motivations for students to study physics could be the intellectual challenge of the subject, good teaching, enhanced employment prospects and application to real situations.

4.9 Instructors reported that success in getting good grades in physics is limited mainly by low background knowledge in physics and mathematics, inappropriate teaching strategies and having poor attitudes towards physics.

4.10 The purpose of assessment was focused on summative rather than formative assessment, and instructors preferred methods of assessment were tests and reports of practical work.

4.11 Instructors suggested that physics teaching in Thai Rajabhats could be improved by providing sufficient resources and support, improving teaching strategies and curriculum, and professional development for instructors.

CHAPTER 5: THE FIRST STUDENT QUESTIONNAIRE

Introduction

This Chapter presents an analysis of the data from the first student questionnaire. This Chapter comprises eight sections. The first section presents the demographic data about the students who participated in the survey. The second section describes students' goals and motivation in studying physics. The third section reports the students' responses their beliefs about teaching physics. The fourth section presents students' beliefs about learning physics. The fifth section presents data about students' actual and ideal learning strategies. The sixth section describes students' attribution of success in studying physics and the seventh section reports some other comments about teaching and learning physics. The last section presents a summary of discussion and assertions gathered from all previous sections of the Chapter.

Demographic Data

The first student questionnaire was administrated to first year students in two Rajabhat universities in the South of Thailand at the beginning of second semester in the academic year 2002. The students were all enrolled in introductory physics courses in that semester. These students were from three programs of Science (66.4%) and two programs of Education (33.6%). The details are shown as Table 5.1.

Table 5.1. Program of study and Rajabhat (n = 140)

Program	Rajabhat	Count	Percent
Public Healthcare	1	35	25.0
Food Science	2	31	22.1
Environmental Science	2	27	19.3

Program	Rajabhat	Count	Percent
General Science Education	2	34	24.3
Physics Education	2	13	9.3
Total		140	100.0

Students' Goals and Motivation for Studying Physics

The questionnaire began by asking students some open-ended questions to elicit their opinions about their goals and motivation for studying physics. Responses to these questions are shown in Tables 5.2.1, 5.2.2, 5.3, 5.4, 5.5 and 5.6.

Table 5.2.1. Students' response to the question: Do you want to study physics? (n = 139)

Responses	Count	Percent of respondents
No	36	25.9
Yes	103	74.1
Total	139	100.0

Table 5.2.2. Students' reasons for their answers in Table 5.2.1 (n = 140)

Responses	Count	Percent of respondents
Yes: It can apply to real life, create technology	51	36.4
Yes: It is an interesting and challenging subject	34	24.3
Yes: It is important to my career	30	21.4
Yes: I want to be a smart person	8	5.7
No : Physics is difficult	22	15.7
No : It is not relevant to real life	12	8.6
No : I don't like mathematics and physics	9	6.4
No : I have a poor background in physics and mathematics	2	1.4
Total	168	119.9

Note. The 140 students gave a total of 168 reasons, i.e. some students gave more than one reason.

Table 5.3. Students' response to the question: What do you want to get from physics? (n = 140)

Responses	Count	Percent of respondents
Understanding and knowledge in physics	75	53.6
Ability in applying knowledge to real life	43	30.7
Skills of solving problems and mathematics	15	10.7
Good teachers and good teaching	15	10.7
Fun and enjoyable lessons, not serious classes	10	7.1
To pass an examination and get good grades	8	5.7
Content of physics that related to real life	5	3.6
Nothing from physics	1	0.7
Total	172	122.8

Table 5.4. Students' response to the question: Why do you agree or disagree with the statement "it is very important to please your physics instructor and your parents, so you must work hard."? (n = 138)

Responses	Count	Percent of respondents
Agree : To satisfy their aspirations	47	34.1
Agree : To make them happy and proud of me	44	31.9
Agree : To show gratitude to my parents	12	8.7
Agree : It must be only this way	11	8
Agree : Responses not relevant	13	9.4
Disagree: I must control myself, nobody else	16	11.6
Disagree: Responses not relevant	3	2.2
Total	146	105.9

Note. 87% of respondents agree.

Table 5.5. Students' response to the question: Why do you agree or disagree with the statement "it is very shameful to be a poor student in the class so I must work hard."? (n = 137)

Responses	Count	Percent of respondents
Agree : People are able to succeed by themselves from their hard working	33	24.1
Agree : Being a poor student is a disadvantage	27	19.7

Responses	Count	Percent of respondents
Agree : It is unacceptable to other people	19	13.9
Agree : Nobody wants to be the weakest person in the class	9	6.6
Agree : Poor students get low grades and fail	9	6.6
Agree : It may affect my career in the future	4	2.9
Agree : Parents are ashamed of having weak children	2	1.5
Disagree: Individuals are always different	15	10.9
Disagree: Embarrassment motivates students	11	8
Disagree: You can be better in another way	9	6.6
Disagree: Being a poor student discourages people	3	2.2
Disagree: This is a difficult subject	1	0.7
Total	142	103.7

Note. 73% of respondents agree.

Table 5.6. Students' responses about goals and motivation in studying physics

Item no.	Strongly disagree	Disagree	Not disagree or agree	Agree	Strongly agree
1. I don't want to study physics because it is not relevant to real life	20.7	44.3	23.6	11.4	0
2. I want to study physics because it helps me to understand the world	0	6.4	21.4	55.7	16.4
3. I have been required to study physics by other people	31.4	42.1	15.7	10	0.7
4. Studying physics will help me with my career	2.9	13.7	11.5	58.3	13.7
6. Passing exam is my biggest concern about studying physics	1.4	7.1	13.6	46.4	31.4
9. I just want to get a good grade and I am not interested in understanding physics ideas	31.2	51.4	10.1	5.8	1.4
34. The main purpose of laboratory work is to verify physics concepts and laws	0.7	15.8	20.9	51.1	11.5
35. Physics is very important for the development of technology	0	0.7	8.6	50.7	40

About one quarter of the students did not want to study physics (Table 5.2.1) because it lacks relevance and is difficult (16% of respondents), and some students (11%) indicated they were required by others to study physics (Item 3, Table 5.6). Results in Tables 5.2.1, 5.2.2 and 5.3 show that the majority of students want to study physics (74%) because physics is important in the real world (36%), it is interesting and challenging subject (24%) and to enhance career prospects (21%). These data are consistent with students' responses to Items 1, 2, 4 and 35 in Table 5.6. For example, 72% agreed or strongly agreed with statements about physics helping to understand the world (Item 2) and physics helping with my career (Item 4). Ninety-one percent agreed or strongly agreed that physics is very important for the development of technology (Item 35). When asked about what they wanted to get out of studying physics (Table 5.3), they wished to understand and know more about physics (54%), and be able to apply physics to real life (31%) which are consistent with their responses to Item 9 in Table 5.6. Most of respondents, however, agreed or strongly agreed with Item 6 and were concerned about passing the examination (78%).

Most students agreed with the statements "it is very important to please your physics instructor and your parents, so you must work hard", and "it is very shameful to be a poor student in the class so I must work hard" (83% and 75% respectively). Students were therefore motivated to study hard so that they are successful to please others and avoid being shamed by poor grades.

Assertion 5.1

Students wanted to study physics for understanding and to be able to apply physics to real life. Some students considered physics to be an interesting and challenging subject while others recognized that physics is very important to the development of technology. Many students indicated that they were motivated to study hard because they would succeed to please others and avoid the shame of poor grades.

Students' Beliefs about Teaching Physics

When students were asked about characteristics of good physics teaching, they replied to this question with various opinions. Responses included both teacher-centered and student-centered strategies. The majority of respondents believed that characteristics of good physics teaching include the teacher-centered strategy of clear explanation of concepts (54%). Some responses implied student-centered strategies such as hands-on activities (22%), solving problem (15%), attend to individual students' needs (14%) and student participation in lessons (9%). Many students (24%) proposed that lessons should be enjoyable and fun. Details are shown in Table 5.7.

Table 5.7. Students' responses to the question: What are the characteristics of good physics teaching? (n = 139)

Responses	Count	Percent of respondents
Explain clearly for the students' understanding	75	53.6
Make physics lessons to be enjoyable and fun	33	23.6
Hands-on activities and sudent-centered	31	22.1
Emphasis on solving problems with maths	21	15
Begin from fundamental to advanced in slow steps	21	15
Attend to students' individaul needs	19	13.6
Student participation in lessons	13	9.3
Use appropriate media and materials	4	2.9
Relate to real situations	2	1.4
Total	219	156.5

Eight rating scale items were used to probe students' opinions about physics teaching in Part B of the questionnaire. The responses are shown in terms of agreement percentages in Table 5.8.

Table 5.8. Students' opinions (agreement percentages) about teaching physics

Item no.	Strongly disagree	Disagree	Not disagree or agree	Agree	Strongly agree
10, Lecturing and giving notes are the most important activities in the physics class	5	25	15	40.7	14.3
11. Physics instruction must relate to everyday experiences so we can see how it affects us in our daily lives	0	6.5	22.3	52.5	18.7
15. The instructor should listen to the class opinions	0	1.4	11.5	51.1	36
16. The instructor should explain each topic in detail	0.7	0.7	4.3	41.4	52.9
17. The physics lessons should be enjoyable	0	2.2	10.1	39.9	47.8
18. The instructor should let us work on problems and exercises in small groups to help us learn physics	0	2.9	10.1	59	28.1
19. I need to learn by myself with the guidance from the instructor	3.6	15.8	23.7	44.6	12.2
20. My understanding in physics mainly depends on how well I am taught by my instructor	1.4	19.3	22.9	39.3	17.1

Interestingly, the strongest agreement (94% agreed or strongly agreed) was for Item 16 about the instructor explaining each topic in detail, and 55% of students agreed or strongly agreed about the importance of lecturing and giving notes (Item 10). High portions of students also agreed or strongly agreed that physics lessons should be enjoyable (88%) and must be related to real life (71%), instructors should listen to the class opinions and provide a chance of working in small groups (87%). Fewer numbers of respondents agreed or strongly agreed to learning by themselves (57%).

The data reported in Tables 5.7 and 5.8 indicate that students recognise the importance of both teacher-centered strategies (e.g. clear explanation) and student-centered strategies (e.g. small group work).

Assertion 5.2

Students believed that both teacher-centered and student-centered strategies are important for good physics teaching. They wished instructors would explain clearly, provide enjoyable lessons, listen to students' opinions and allow students to work in a small group.

Students' Beliefs about Learning Physics

In Part A of the questionnaire, the students were asked an open-ended question about effective learning strategies in physics. Their responses are summarised in Table 5.9.

Table 5.9. Students' responses to the question: What study strategies should students use to learn physics effectively? (n = 136)

Responses	Count	Percent of respondents
Pay attention in classes for understanding the lessons	61	44.8
Doing exercises and homework	37	27.2
Doing laboratory work	33	24.3
Review lessons after classes	23	16.9
Questioning and discussing	22	16.2
Reading texts and manuals	17	12.5
Taking and copying notes	8	5.9
Working in groups	6	4.4
Memorize formulae and theory	6	4.4
Not relevant answer	6	4.4
Total	219	161.0

The most frequent responses about effective physics learning were paying attention in the class (45%) and doing exercises and homework (27%). There are two different types of introductory physics courses in Thai Rajabhats; one type combines both lecture and laboratory classes in a course, and another type has separate lecture and laboratory courses so that students may enrol in only the lecture course. Responses that indicated doing laboratory work helped in learning physics (24%) were probably from students who were enrolled in laboratory courses at that time. Two categories of responses (review lessons after classes; questioning and discussing) indicated that some students recognised the importance of active learning strategies.

Several agreement scale items in Part B of the questionnaire.were used to elecit students' opinions about learning strategies. The percentages of agreement are shown in Table 5.10.

Table 5.10. Students' opinions about learning strategies

Item no.	Strongly disagree	Disagree	Not disagree or agree	Agree	Strongly agree
5. I must remember as many facts and laws as possible in physics	6.5	25.2	18	39.6	10.8
7. It is important that I try to make sense of physics concepts and really understand them	0	3.6	20	52.9	23.6
8. Discussing physics ideas with other students does not help me understand them	17.1	52.1	12.9	15.7	2.1
12. I need some opportunities to discuss physics ideas with my classmates to help me understand physics	0	1.4	12.9	62.9	22.9
14. Experiments help me to understand physics	0.7	8.6	10.8	59.7	20.1
21. In a lecture session, I take notes by writing down exactly what the instructor says and what he writes on the board	1.4	19.3	19.3	51.4	8.6
22. I prefer to practice with the exercises that are similar to the examples given by the instructor	2.1	13.6	18.6	54.3	11.4
23. I use my own words to summarise concepts from texts and lectures in physics	0.7	8.6	30.7	52.9	7.1
25. If I remember more facts and laws, I will get higher scores and grades in physics	5.7	27.9	21.4	35	10

Item no.	Strongly disagree	Disagree	Not disagree or agree	Agree	Strongly agree
29. To get good grades in physics you must understand the ideas, remembering the facts is not enough	0.7	0	1.4	47.1	50.7
30. I must be an obedient student in the class	12.9	32.1	40.7	12.9	1.4
31. I always have some questions to ask or discuss with the instructor	2.9	15	52.9	23.6	5.7

A large majority of students agreed or strongly agreed that to get good grades in physics you must understand the ideas (98%, Item 29) and it is important to try and make sense of physics (77%, Item 7). Smaller percentages of students agreed or strongly agreed with the need to remember facts and laws to get high grades (45%, Item 25; 50%, Item 5). Eighty-six percent agreed or strongly agreed that it is important to discuss physics ideas with classmates to help understand physics (Item 12). There were, however, responses that indicated some students used more passive learning strategies. Many students reported that they take verbatim notes (60%), preferred to practice exercises that are similar to the examples given in class (66%), and only 29% always had questions for the instructor.

Assertion 5.3

Students preferred to understand rather than memorise facts and laws in physics, recognised the importance of discussing ideas with peers to understand physics. However, some used more passive learning strategies.

Students' Beliefs about Learning Activities

Table 5.11 below shows the average percentages of time students actually spend on various activities each week in physics compared with the average percentages of their ideal learning circumstances.

Table 5.11. Students' responses to the request: Complete the table below to show the percentage of time you typically spend in class on various learning activities each week in physics, and the percentages for ideal teaching and learning circumstances. (n = 140)

Learning Circumstances	Actual circumstances		Ideal circumstances	
	Mean	Sd.Deviation	Mean	Sd.Deviation
Listening to the instructor's lecture	21.8	10.7	19.0	8.9
Taking and copying notes	16.7	8.1	14.2	6.5
Questioning and discussing	7.5	4.5	10.6	5.8
Doing laboratory work	15.4	7.4	15.7	7.8
Reading texts and manuals	11.2	6.0	12.5	6.0
Doing exercises and homework	11.9	5.4	12.6	5.4
Working in group	11.4	5.9	10.8	5.0
Other activities	5.8	4.9	6.6	5.2

Given the size of the standard deviations the differences between actual and ideal time allocations are quite small. Students actually spend most of their classtime listening to the lecture and taking notes (38%) and they wish to decrease this amount of time to 33%. Questioning and discussing is only the activity on which students clearly prefer to spend more time (8% to 11%). Times for doing laboratory work are the same amounts in both actual and ideal circumstances (15%) which is not surprising given that only 24% of students believed that laboratory work helps them learn physics (Table 5.9).

Assertion 5.4

Students spent most class time listening to lectures and taking notes. There would only be small changes to the actual times under their preferred ideal circumstances. Listening to lectures and taking notes would decrease while questioning and discussing would increase.

Students' Attribution of the Success of Learning

Four open-ended questions were used to survey students' opinions about students' attribution of success in learning physics. The responses are shown in Tables 5.12.1, 5.12.2, 5.13.1, 5.13.2, 5.14.1, 5.14.2 and 5.15.

Table 5.12.1. Students' responses to the question: Do you agree that physics is a subject only for the clever people? (n = 140)

Responses	Count	Percent of respondents
No	122	87.1
Yes	18	12.9
Total	140	100.0

Table 5.12.2. Students' reasons for the answers in Table 5.12.1 (n = 139)

Responses	Count	Percent of respondents
No : Effort and hard working help people to learn	74	53.2
No : You can learn if you interested and enjoy physics	40	28.8
No : Good teachers and teaching help us to learn	13	9.4
No : Physics is a subject for every one	12	8.6
Yes: Clever people are able to learn quickly	10	7.2
Yes: Physics is a difficult subject	8	5.8
Total	157	113.0

Table 5.13.1. Students' responses to the question: Do you believe that if you work hard you can get good grades in physics? (n = 140)

Responses	Count	Percent of respondents
No	9	6.4
Yes	131	93.6
Total	140	100.0

Table 5.13.2. Students' reasons for the answers in Table 5.13.1 (n = 140)

Responses	Count	Percent of respondents
Yes: Success is always a result of hard work	44	31.4
Yes: Working hard helps you to understand physics	42	30
Yes: I just think it should be better if I work hard	19	13.6
Yes: You will be able to do exercises and tests	18	12.9
Yes: Working hard helps you to be smarter	12	8.6
Yes: You can memorize better by working hard	6	4.3
No : Working hard doesn't mean you understand it	10	7.1
No : Useless if you are very weak in mathematics	2	1.4
Total	153	109.3

Table 5.14.1. Students' responses to the question: What is more important for getting good grades in physics? (n = 139)

Responses	Count	Percent of respondents
Ability	9	6.4
Effort	131	93.6
Total	140	100.0

Table 5.14.2. Students' reasons for the answers in Table 5.14.1 (n = 137)

Responses	Count	Percent of respondents
Effort : Success is a result of enough effort	49	35.8
Effort : Effort raises your ability and understanding	28	20.4
Effort : Ability only is not enough for success	16	11.7
Effort : You can pass exams by your effort	10	7.3
Effort : You may get some rewards from your effort	3	2.2
Ability: Without ability, effort is useless	6	4.4
Ability: People succeed in studying with their ability	4	2.9
Ability: Ability helps people to understand easily	3	2.2

Responses	Count	Percent of respondents
Ability: Ability is an innate characteristic	2	1.5
Effort and ability are equally important	7	5.1
Not relevant answer/ I just think like that	13	9.5
Total	141	103.0

The data in Tables 5.12, 5.13 and 5.14 clearly indicate that almost all students (87 – 93%) believed that effort is far more important than ability for success in physics. They argued that effort and hard working help people to learn (53%), and you can learn if you are interested and enjoy physics (29%). Only 13% believed that physics is only for clever people.

Four agreement scale items were also used to probe students' attribution of success in physics. Details are shown in Table 5.15.

Table 5.15. Students' opinions about attribution of success of learning

Item no.	Strongly disagree	Disagree	Not disagree or agree	Agree	Strongly agree
24. Physics is a subject only for smart people	40	36.4	12.9	7.1	3.6
26. If I work hard I will get good grades in physics	1.4	1.4	7.1	60	30
27. If you are not a clever student you will not get good grades in physics	27.1	45	14.3	10	3.6
28. Success in studying physics depends more on effort than ability	1.4	2.9	5.7	47.9	42.1

Responses to these items strongly confirm the previous results. The majority of respondents strongly disagreed or disagreed that physics is only for a smart people (77%), and if you are not a clever student you will not get good grades in physics (72%). Ninety percent agreed or strongly agreed that success in physics depends more on effort than ability.

Assertion 5.5

Students believed that people can learn and succeed in physics by their effort and hard working rather than ability.

Most students agreed that physics is a difficult subject. They reported various factors that make physics difficult. Details are shown in Table 5.16.

Table 5.16. Students' responses to the question: Many students say that physics is a difficult subject. What is it that makes physics difficult to learn and get good grade? (n = 137)

Responses	Count	Percent of respondents
Lots of difficult mathematics	56	40.9
Abstract and complicated contents	37	27
Teaching and assessment strategies	30	21.9
Less effort and attention, laziness and worrying	21	15.3
Having bad attitudes to the subject	16	11.7
Students have insufficient ability to learn	8	5.8
Irrelevant to real life, doesn't make sense	4	2.9
I don't think so	4	2.9
Not familiar with laboratory equipment	1	0.7
Not relevant answer	1	0.7
Total	178	129.8

Responses to this question show that the difficulties of physics arise from three main aspects. The most frequently mentioned of these relates to the nature of physics due to difficult mathematics (41%) and abstract contents (27%). Students also recognised that difficulties were experienced when learners made less effort, or attention, had less ability or poor attitudes to the subject (27%). Respondents also indicated difficulties arise from teaching and assessment strategies (22%).

Students' opinions about factors that make physics difficult were rechecked with three agreement scale items. Percentages of agreement are shown in Table 5.17.

Table 5.17. Students' opinions about factors that make physics difficult to learn

Item no.	Strongly disagree	Disagree	Not disagree or agree	Agree	Strongly agree
13. Laboratory work in physics is difficult for me	2.1	32.9	30	33.6	1.4
32. Mathematics is the main difficulty with learning physics, not physics itself	3.6	30.7	20.7	37.1	7.9
33. I prefer to do multiple-choice tests than other types of tests	1.4	20.1	41.7	28.1	8.6

Students held ambivalent beliefs about the difficulty of laboratory work. More students agreed than disagreed that mathematics is the main difficulty in studying physics. More students preferred multiple choice tests than preferred other types of tests.

Assertion 5.6

Students believed that physics is a difficult subject. The difficulties in physics may arise from mathematics, its abstract contents and teaching and assessment strategies.

Other Comments

At the final part of the questionnaire students were allowed to give any comments about physics. Responses were mainly related to teaching and learning physics, and often repeated previously reported opinions. These comments are summarized in Table 5.18.

Table 5.18. Final comments (n = 49)

Responses	Count	Percent of respondents
Arouse the class with enjoyable lessons, not too strict	12	24.5
Clear explanations help students to understand physics	9	18.4
Please improve your approaches to teaching	9	18.4
Teachers must be friendly and helpful to students	6	12.2
Teachers must understand each individual student	6	12.2

Responses	Count	Percent of respondents
Physics must be relevant to real life and my career	5	10.2
Physics is not too difficult if you pay enough attention	7	14.3
You can learn physics if you understand it	4	8.2
Success in physics is the result of good teaching	4	8.2
If we are good in mathematics we will be good in physics	3	6.1
To understand physics needs your effort and patience	2	4.1
Physics is difficult, I don't want to study it	2	4.1
We learn better by hands-on activities with appropriate help	2	4.1
Many students never succeed in physics	1	2
Physics lessons should be started at the early ages	1	2
Lecture should be followed with exercises and labs	2	4.1
Teachers always pay their attention only on teaching	2	4.1
Total	77	157.2

Many comments appealed for the improvement of teaching strategies, such as provide enjoyable and interesting lessons, explain clearly, be friendly and aware of individual differences among students.

Chapter Summary

Completed questionnaires were received from 140 students at two Rajabhats in the South of Thailand. These students were from two groups who study Science Education and three groups who study Science and Technology.

The students indicated that they were willing to study physics because the subject is very important for technology development and understanding the real world, and for their careers in the future. The main goals of studying are to understand physics and the ability in applying physics to real life. The majority of students agreed that they must work hard to please their instructors and parents, and avoid being poor students, but they did not agree that they have been required to study by other persons.

The students believed that the characteristics of good physics teaching are both teacher-centered strategies such as explaining each topic in details and giving notes, and student-centered strategies such as hands-on activities, solving problems and student participation.

Higher percentages of respondents suggested paying attention to the classes as an effective learning strategy in physics. Although some student-centered learning strategies such as doing exercises, homework and laboratory work were also proposed in their suggestions, the overall responses showed that students tended to be passive rather than active learners.

Students spend most class time listening to lectures and writing notes. Students would prefer to spend less time listening to the lecture and taking notes, and spend more time questioning, discussing, reading and doing exercises.

They did not agree that physics is a subject only for clever people. In their opinions, people could learn physics by their effort and hard working. Furthermore, to get good grades in physics they suggested that understanding is more important than memorising facts and laws of the subject.

Students believed that physics is a difficult subject. The significant factors that make physics difficult are from using difficult mathematics and the abstract and complicated contents in physics.

The assertions developed in this Chapter are summarised below.

5.1 Students wanted to study physics for understanding and to be able to apply physics to real life. Some students considered physics to be an interesting and challenging subject while others recognized that physics is very important to the development of technology. Many students indicated that they were motivated to study hard because they would succeed to please others and avoid the shame of poor grades.

5.2 Students believed that both teacher-centered and student-centered strategies are important for good physics teaching. They wished instructors would explain clearly, provide enjoyable lessons, listen to students' opinions and allow students to work in a small group.

5.3 Students preferred to understand rather than memorise facts and laws in physics, recognised the importance of discussing ideas with peers to understand physics. However, some used more passive learning strategies.

5.4 Students spent most class time listening to lectures and taking notes. There would only be small changes to the actual times under their preferred ideal circumstances. Listening to lectures and taking notes would decrease while questioning and discussing would increase.

5.5 Students believed that people can learn and succeed in physics by their effort and hard working rather than ability.

5.6 Students believed that physics is a difficult subject. The difficulties in physics may arise from mathematics, its abstract contents and teaching and assessment strategies.

CHAPTER 6: CASE STUDIES

Introduction

This Chapter presents case studies which were compiled from studies of teaching and learning introductory physics courses in two selected Rajabhat universities. The participants were four groups of instructors and students.

Data were collected through interviews with instructors and students, classroom observations, and document analysis. Interviews were conducted twice for each group at the beginning and the end of the semester. All interviews were conducted in the Thai language. Classroom observations were made once or twice for each group during the semester.

Pseudonyms

To retain anonymity of participants, pseudonyms are used in reporting the case studies. The following pseudonyms were used:

Case Study A: Instructor was Anek. The students were Sanan, Sanit, Sunee and Supa.

Case Study B: Instructor was Arun. The students were Nida, Nataya, Naree and Nisa.

Case Study C: Instructor was Aree. The students were Ratana, Ranee, Bunga, Banyen, Benja, and Bulan.

Case Study D: Instructor was Ampa. The students were Thida, Tiwa, Thani, Tewi and Tanya.

Background of Selected Rajabhats

The two selected Rajabhats are located in the South of Thailand. Students in each Rajabhat were mostly from the Southern provinces. Each Rajabhat has its own separate Science Center. Both Rajabhats had insufficient laboratory equipment and facilities for teaching introductory physics courses effectively.

There were seven instructors at one Rajabhat and eight at the other. Introductory physics is a compulsory course for all Science and Science Education programs in every Thai Rajabhat. These courses are always taught by younger instructors rather than by more experienced instructors. There are three types of introductory physics courses in Thai Rajabhats; lecture courses, laboratory courses, and lecture combined with laboratory courses.

Two of the case studies focused on lecture combined with laboratory courses, the other two were from classes that studied two separated courses of lecture and laboratory in that semester. Three of case studies were conducted at one Rajabhat and one at another Rajabhat. The instructors were about 27 years old and the students about 19 years old.

Case Study A

This case study focused on a class that studied a lecture combined with laboratory course of introductory physics in a Science program. The study involved two interviews with the instructor and with the students and two lecture classroom observations.

The Instructor: Anek

Background

Anek was first asked to outline his educational background and teaching experiences. He explained that he did not do very well in physics when he was a secondary school student. He went to study Computer Science in a University for one year but he finally found that physics was more attractive to him. He changed to study physics and did quite well with it on his four-year course. He said he likes to study physics because of its interesting contents and because his physics teacher at secondary school always provided fascinating lessons.

> "I didn't really prefer to be a teacher when I came to start working here but only to get some experiences in teaching. After one semester of teaching, however, I found that this career is impressive to me. I'm very proud in providing knowledge to my students. I am very happy to be a teacher." (Interview; 9/12/2002)

Nature of physics

When Anek was asked about what he hoped his students would learn about the nature of physics, he replied that:

> "There are three important things. Firstly, they must learn physics content that is relevant to everyday life; secondly, they should learn physics for application; and thirdly, they should know the influence of physics to create innovation for use in our lives." (Interview; 9/12/2002)

Teaching physics

When asked about how to teach physics better, Anek explained that:

> "First of all, we have to understand individual differences because students are from different backgrounds. In the class we should explain only some important topics, ask some questions, and demonstrate with appropriate media for better understanding and to motivate students. The lecture should be followed by labs." (Interview; 9/12/2002)

Anek emphasized that these strategies would be effective because instructors could prepare suitable lessons for each group of students and a good lesson plan could motivate and make sense to students.

For Anek, the teaching strategies he uses most often are explaining and giving notes, he rarely uses demonstrations, and includes about six or seven experiments in each course. The reason he uses explanation as a main strategy is the inadequacy of equipment and materials to use for demonstrations. Experiments are used to teach students how to use equipment and analyse experimental data.

Learning physics

In his opinion, Anek proposed that students would succeed in physics by:

> "…(1) having positive attitudes to study physics, (2) reading the text before classes, (3) asking questions or discussing in the class, (4) listening carefully and taking notes, and (5) reviewing the lessons after classes." (Interview; 9/12/2002)

He confirmed these strategies will help students to have a "clear understanding and remembering".

Anek explained that many students find physics a difficult subject for three reasons.

> "First, they don't understand the real meaning of physics and they can't recognize its relevance to their real life. Second, physics is always described by difficult mathematics. Third, students were told by others that physics is difficult, and unfortunately they believe it." (Interview; 9/12/2002)

Anek explained that many students do not like physics because "they hold the belief about physics as a difficult subject" and "the lack of motivation in studying physics". He mentioned that it is very difficult to find a job for anyone who finishes the Bachelor degree in physics.

Second interview

The second interview with Anek took place at the end of the semester. He was asked about his teaching throughout the course.

Anek explained that:

> "I spent most of time with giving lectures. I tried to motivate students with questions but there was no response from them, so I didn't know whether they understood the lessons or not. The students never asked me any questions either. .. We also have not enough demonstration equipment, and therefore lectures became a significant strategy." (Interview; 3/03/2003)

When asked about limitations to the quality and effectiveness of his teaching, Anek replied that:

> "There are three factors; (1) students pay less attention, (2) I can't explain clearly because I don't know which points that students need, and (3) lack of a particular text for this course." (Interview; 3/03/2003)

Anek said he was not really satisfied with the students' learning in that semester. He estimated that only about one third of students were successful. He suggested that students could improve their learning by reading texts before and doing exercises after classes.

To improve his teaching, Anek wished to give more demonstrations and laboratory work for his classes, and explain lessons more clearly.

Anek proposed that teaching physics in Thai Rajabhats would be improved by; (1) using more experimental work to verify physics, (2) addressing the problem of students not giving the correct conclusion for experimental reports, and (3) experiment manuals should not describe all procedures in detail, so as to leave some decision for students to make.

The Students

First interview

Physics experiences

The four students in this case study described their experiences in physics at their secondary schools.

Sanan said that studying physics was too serious. Physics teaching was similar to other subjects, that is, his teacher mainly gave the explanation for each topic, began each lesson by describing scientists' work to motivate students. Sanan listened to the explanations and copied notes; he occasionally used his own words to take notes. There were rarely physics experiments. Students could ask questions about any points they did not understand and Sanan preferred to ask the teacher in the class.

Supa studied with only one teacher for all three years of the physics course at her secondary school. Her teacher used various kinds of media including sometimes the Internet and remote lessons via satellite. The most frequent teaching strategies were explaining and giving notes which were followed by exercises and homework. The teacher gave extra classes on Sunday for some difficult topics. Supa's learning strategies were listening and copying notes, and occasionally going to a tutor.

Sanit explained that his physics teacher at secondary school was a humorous person who always told funny stories to students for relaxation. There were demonstrations sometimes, but rarely did experiments because of the lack of equipment. The main strategies of teaching were giving explanations and notes. Sanit studied by listening and copying notes but he didn't understand some topics because he always lost his concentration in the lessons.

Sunee studied with many physics teachers at her upper secondary school. She said each teacher employed a slightly different teaching style but most of them emphasised explanation of physics problems, calculations and seldom provided laboratory work. Hence, Sunee studied physics by practicing with exercises and rarely doing experiments.

When they were requested to identify the meaning of physics, they replied differently that;

> "Physics is everything closely related to us but it is imperceptible." (Sanan, interview; 16/12/02)

> "Physics is a subject about calculation using mathematical formula and related laws." (Supa, interview; 16/12/02)

> "Physics is a subject that is not relevant to daily life for most people, it may be needed only by some people." (Sanit, interview; 16/12/02)

> "Physics is a subject about causes and effects related to phenomena around us in terms of numbers." (Sunee, interview; 16/12/02)

Beliefs about teaching and learning physics

All students in this case study agreed that physics should be taught. Sanan explained that it would help people to have a better life; however, it is not necessary to learn deeply in every topic. Supa indicated that physics is related to other subjects and it would be useful for students in the future. Sanit and Sunee commented that physics should be taught only to some people who need physics for their careers.

Sanan and Sanit proposed that physics lessons should be enjoyable and meaningful. Sanan hoped to do more exercises and experiments to help them understand the subject while Sanit wished to work in a small group. Supa expected that working in small groups would help students learn. Both Supa and Sunee indicated that teachers should explain lessons clearly by using various kinds of educational media to help students' understand.

In that semester, these students planned to read more from texts. Sanan, Supa and Snit expected to be attentive to the classes. Sanan and Sunee said they would ask the instructor or friends to explain any points they did not understand. Sanit wished to take notes carefully while Sunee wished to practice with exercises.

Goals and motivation

Supa and Sunee were interested in studying some physics topics whereas Sanan and Sanit were not at all interested. If they were free to choose the subjects to study, they would not choose physics. To pass the examination was their goal for studying physics.

Attribution of success

Among their classmates, these students expected Kung (pseudonym) would be successful in physics. Sanan, Supa and Sanit explained that Kung was the smartest student in the class, but Sunee said Kung liked to study this subject and worked harder than the other students. All of them agreed that hard working students could get good grades also.

Learning orientation

The most satisfactory result in studying physics for this group of students was meaningful understanding. They argued that they could get good grades, please their parents or the instructor, and to be successful in other aspects by learning for meaningful understanding.

Second interview

The second interviews with these students took place at the end of the semester. The beginning conversation was about actual learning strategies they used most often in physics and how they could improve.

Sanan said that he often took notes during the lectures and reviewed them after classes. He indicated that he could understand physics better by using these strategies and his learning could be improved by more readings.

Supa said that;

> "I took notes and tried to understand every topic in the lectures. Before the examination I liked to discuss or explain the contents to a group of my friends" ….. "taking notes using my own words helps me to understand better" (Interview; 26/03/2003)

Supa said that she could improve her approaches to learning by sitting in the front row near to the instructor, which would force her to concentrate on the lessons, taking notes as she couldn't chat with friends; and discussing more with her peers.

Sanit took notes in some difficult parts and read texts after the classes, which helped him to understand and memorise the lessons. He said that he should take notes in more detail and discuss with peers or ask the instructor about the difficult topics, which would improve his learning.

For Sunee, she explained that;

> "I took notes during the lectures. Requested some friends to explain the lessons before having a test or exam; this helped me to understand better

> because I could ask them any kind of question in detail”. (Interview; 26/03/2003)

When Sunee was asked about any changes she would like to make to her learning strategies, she replied that she would not be too shy in asking questions or discussing the lessons with the instructor.

The students were asked about the factors that limited their success in learning physics. Sanan referred to the sweltering weather in the afternoon classes (that made him sleepy), complicated topics, and the lack of attention. The limitations of learning for Supa were due to some complicated and boring topics; few discussions and few students asked questions; and sometimes she paid less attention. Sanit referred to the difficulties of the subject and the lack of attention. Shyness, laziness and also the lack of attention to the lessons were the main factors that limited Sunee’s success.

All of them were satisfied with the instructor’s teaching in that semester, but they made some suggestions for improvement. Sanan preferred the instructor to explain some topics in more detail while taking some less important topics out of the course (e.g. nuclear physics). Supa wished to have more opportunity to work in a small group and laboratory. Sanit preferred to have some tutorial sessions and required the instructor to reduce the complexity of the mathematics. Sunee wished to study physics with more examples that were similar to the tests and less difficult mathematics.

The last question was about the causes of their success in learning. Sanan, Supa and Sanit expected that they would be successful from their hard working. On the other hand, Sunee expected that she would not be successful because she read less and never asked any questions in the class; however, she also wished to pass the examination.

Classroom Observations

The first observation of this class was made in the middle of the semester. It was a 100 minute lecture session in a sweltering afternoon with the lesson about electricity (1:15 – 3:05 pm.). There were about 35 students in the class.

After a few words of greeting, the instructor began to explain the lesson using overhead transparencies and wrote on the board about electrical potential and potential differences while students listened quietly and copied notes. The same activities had continued for about 35 minutes when some students began to feel sleepy and lost their concentration. There was a question from the instructor and some groups of students answered at around 45 – 50 minutes into the lecture. After that there was a break for 10 minutes.

The lesson continued again for about 15 minutes with example calculations shown on the projection screen. The instructor explained how to calculate step by step while students copied notes. There were some questions about the calculation from the instructor during this stage, which students answered.

When the instructor began to explain new topics about resistivity and resistances, some students in the back rows lost interest in the lesson while the others listened and copied notes. The instructor gave a question about this topic to the class and some students responded.

In the last 10 minutes of the lesson, the instructor began a new topic about electrical power. He explained the content using the overhead projector and the students listened and copied notes again.

The second classroom observation was made at the last lecture session before the final examination. The class was taught about nuclear physics, which was the last topic of the course, and it took about 50 minutes to finish. The class was in the afternoon of the summer season.

The instructor employed the usual teaching strategies; explained the content using transparency projection and wrote sometimes on the board. Students also listened and copied notes. These circumstances were interrupted by a question about the atomic bomb from a student and the instructor replied for five minutes. The same strategies of teaching and learning continued after that for about 20 minutes to finish the lesson.

Some students asked about the final examination before the session finished. The instructor explained some details and then reminded students to review all lessons for the examination.

Document Analysis

The syllabus of this course contained objectives, course description, texts and learning documents, guidelines for teaching, learning and assessment. The objectives for learning were to gain more understanding in basic knowledge of physics for further studies of related subjects, be able to explain or apply concepts to daily life situations, and be able to manipulate some physics apparatus. The assessment included 60% for assignments and 40% for the final examination. Assignments were given in forms of laboratory reports or exercises. Tests were usually used to measure the students' ability in physics problem solving.

For texts and learning documents, the instructor introduced some physics books to students as the main and subordinate texts for this course. These books are mostly written in Thai and commonly could be found in the library of that Rajabhat University. Each book generally covers most topics of the course. In practice, students preferred to read the notes they copied or took from lectures, or other provided documents rather than these texts.

The students could take notes in any form they liked. Different styles of notebooks belonged to individual students. Many students in the class intensively copied notes about every detail from the lectures into their notebooks while others took fewer notes. Every student copied the calculation examples. Very few students used their own words in their notebooks; they copied notes verbatim from the overhead projector.

The instructor did not provide any worksheets. It was found in the students' notebooks that all examples worked by the instructor were always followed by more or less similar exercises completed by students.

Case Study B

This case study focused on a class in a Science Education program that studied both lecture and laboratory courses of introductory physics in that semester. The study involved two sets of interviews and one laboratory classroom observation.

The Instructor: Arun

Background

At the first interview, Arun explained that he did quite well in physics when he was a secondary school student and he completed a B.Sc in Physics from a university in Thailand.

> "The first two years in the University, I was not satisfied with the teaching. The turning point appeared in the third year; I had a chance to do my own project in physics, it was a practical work to solve a very useful problem."
>
> And
>
> "Actually, I preferred to be a researcher when I finished the Bachelor degree, but finally I became a teacher. I am very happy in teaching when there are good responses from my students". (Interview; 13/12/2002)

Nature of Physics

Arun said he hopes that students in secondary school should have fundamental knowledge in physics in terms of definitions, laws and theories to be able to apply in real situations. He said that Rajabhat students should really understand physics and be active learners.

Teaching physics

In Arun's opinion, the laboratory approach is the most effective strategy for teaching physics. "Doing experiments is the most significant aspect of physics that all physicists used to seek physics knowledge," said Arun.

When asking about his main teaching strategies, Arun replied that he uses lecturing most often. He gave some reasons for doing that; lack of time to cover the syllabus, students do not have adequate science investigative skills and are not active learners, and the lack of suitable texts and enough laboratory equipment.

Learning physics

Arun proposed that students should learn by themselves with the guidance from instructors, they should discuss with others for more understanding and concentrate doing experiments. He mentioned that these strategies would help students to find their own weakness and strength, and be able to create new ideas. Learning does not happen to anyone only by knowledge transmission, he asserted.

Arun described that many students find physics difficult because they cannot separate mathematics from physics. Mathematics is always difficult for most students, thus physics is also difficult.

When asked why many students not like physics, Arun explained that:

> "They don't know how to apply physics knowledge to their real lives. Another important reason is that there is too much emphasis on theoretical contents, with the lack of interpretation and relevance to real life or integrated lessons". (Interview; 13/12/2002)

Second interview

Arun explained that he spent about 50% of class time with lecturing, another 50% he assigned students to research and present some topics to the class. He said that some parts of the contents need to be explained but some others should be the students' responsibility to learn. Transmitting knowledge by lectures may be boring to students and this method could not provide every detail of the course.

Arun referred to four factors that limited the quality and effectiveness of his teaching in that semester; students had low background knowledge, instructor might use inappropriate teaching strategies, unsuitable classroom conditions and learning materials, and lack of class time.

Arun said he was not satisfied with his teaching because most students still got poor grades. He proposed that students should study actively, concentrate in the lessons and not to be shy in asking questions or discussing difficulties with the instructor.

To improve his teaching, Arun explained that there are four aspects of teaching which he would like to change. These included providing basic background knowledge to all students before starting the course, encouraging students to study, preparing a suitable classroom climate, and teaching in large group for general topics and in small groups for the deep details.

Arun proposed that physics teaching in Rajabhats could be improved by increasing the number of physics instructors, including more student projects in physics, and promoting collaboration with physics teachers in secondary schools.

The Students

First interview

Physics experiences

At her secondary school, Nida explained that the physics teacher tried to explain the content using the text, and then gave examples and exercises to students. Nida studied by paying attention to the lessons and practicing with exercises or asking some questions.

Nataya explained that her secondary school did not have a qualified physics teacher, laboratory equipment or rooms. That was different from chemistry and biology in which students had some chance of doing experiments. Physics teaching was boring; students copied notes from the board. Nataya said she has very poor attitudes towards the physics teacher since then. She tried to learn this subject by reading texts and manuals.

Naree described her physics experiences at secondary school.

> "Worthless! My teacher did not graduate in physics. He grabbed physics papers from the Internet or somewhere and gave them to us to read; couldn't answer or explain our questions. We the students were not satisfied with his teaching although we got good grades in the subject." (Interview; 12/12/2002)

Naree said she tried to read and practice with exercises from physics books. Sometimes she and her friends went to ask other teachers about physics. These were the strategies she used in studying physics at the secondary school.

Nisa complained that her physics teacher at secondary school employed only "talk and chalk" strategy for teaching, without any attention to students in the class. Nisa and her friends had to study in a small group by themselves in order to help each other practice with exercises.

These students described physics as:

> "Physics is a very difficult and imperceptible science." (Nida, interview; 12/12/02)

> "It is a subject that consists of theories and experiments to verify, a boring subject that needs to memorise and review at all times." (Nataya, interview; 12/12/02)

> "Physics is a subject that is full of numbers and formula, using mathematics to find the answers." (Naree, interview; 12/12/02)

> "Physics is a very complicated subject, imperceptible and unable to imagine." (Nisa, interview; 12/12/02)

Beliefs about teaching and learning physics

All of the students in this case study agreed that physics should be taught to students because it is useful and some students need to learn the subject. They proposed that teaching physics should be fun and enjoyable with more opportunities for discussion and doing experiments, clear explanation and sufficient learning materials. In that semester they planned to study physics by paying more attention in the classes, reading texts, reviewing lessons after classes, and discussing topics with friends.

Goals and motivation

Nida said that she was actually interested in studying physics because it is useful, but the teaching and learning processes were always boring and she would fail the subject. She therefore did not want to choose physics as a subject to study. Similarly, Naree and Nisa did not want to study physics because it is difficult for them. For Nataya, however, she might choose to study physics with a good teacher.

Nida and Nisa wished to get good grades and a good understanding of physics that semester. Nataya wanted to gain more understanding while Naree just hoped to pass the examination.

Attribution of success

These students expected four of their friends; Nim, Nong, Noi and Nid (pseudonyms) would be successful in physics because they had a persistent character and were able students. They agreed that hard working students could get good grades also, which might be better than the clever students who worked less hard.

Learning orientation

Meaningful understanding was the most satisfactory result for all of the students in this case study. All of them confirmed that because they were studying in the Science Education programs so they needed to understand physics meaningfully, which would help them to be the good science teachers in the future. Nataya explained that;

"If I don't understand it clearly I would teach physics in the similar ways to my school teacher." (Interview; 12/12/2002)

Second interview

The common learning strategies which these students used most often were listening to the lectures and reading texts or lecture notes. Some of them employed strategies of discussing physics topics with friends, doing exercises, taking notes or searching from the Internet. They indicated that to improve their learning they needed to do more reading, review the fundamental knowledge, having good attitudes towards physics and be more self-confident in studying physics.

The teaching strategies also contributed to limiting students' success in learning physics. The other limitations were lack of background knowledge and effort, poor attitudes towards the subject and strict regulations in the class; the laboratory classes were strongly teacher directed.

The students complained that the strict regulations made it difficult for them to enjoy physics. They suggested that the instructor should be friendlier with students. Lectures should be enjoyable with clear explanation, more opportunities for discussion, and sufficient learning materials. They also wished this course was more related to real life and have less complicated details.

All of them expected that they would not be successful in learning because of their poor attitudes towards the subject and the instructor's teaching, their laziness, the lack of attention, and poor background knowledge.

Classroom Observations

The observations of this class were made in the middle of the semester. It was a laboratory session for 150 minutes from 1:00 – 3:30 in the afternoon. Students were in groups of two or three working in two rooms. There were six groups doing mechanics experiments in the observed room.

There was a laboratory assistant to help the class in preparing and setting out apparatus for the experiments. Electrical plugs were available at each table for electric devices. Some of the experimental apparatus such as the linear air track, rotation apparatus, and moment of inertia apparatus had been set on the tables already. Other kinds of equipment were arranged orderly on the table.

This laboratory course was linked to the physics lecture course that the students were enrolled in for that semester. Theories in the lectures then were expected to be verified by experiments. Each group of students, however, needed to do different experiments because there was insufficient apparatus for the whole class to do the same experiment at the same time. The six experiments in that class were one dimensional motion, free fall, circular motion, springs and vibration, projectile motion, and moment of inertia.

The instructor began with a short introduction to some of the apparatus to be used in the experiments and how to do each experiment following the procedure in the laboratory manual. Students studied the manuals and set up equipment while the instructor went to advise each group for about 20 minutes. After that, each group began to do their own experiment and some students discussed the experiment within their group, some of them also spoke with the instructor.

The students continued doing their experiments for about 40 minutes before most groups started to analyse experimental data. During the data analysis, the instructor went to talk with some groups. The members in each group started writing individual reports and most students finished by 2:45 pm, i.e. before the end of the session at 3.30 pm.

Document Analysis

There were four kinds of documents for this physics course that were analysed. These included textbooks, notebooks, laboratory manuals, and worksheets and reports.

The instructor introduced some books as the texts for this course, both in Thai and English. He assigned the students to research some topics from these books and make presentations to the class, however, students preferred to read Thai books rather than English versions since the contents are the same.

Students' notebooks contained notes given by the instructor. Most students copied every detail in their notebooks and rarely used their own words. Very few students practiced further exercises in their notebooks.

The instructor provided students with laboratory manuals for all experiments. The manual provided objectives, related theories, lists of equipment, and the experimental procedure for each experiment and how to analyse the data. The manual normally included a diagram or picture of the equipment set up.

Students were required to complete worksheets and experimental reports. The students had to do exercises on worksheets and write individual experimental reports. Both of these would be handed to the instructor on time.

Case Study C

This case study focused on a class with students from Science and Science Education programs that studied both lecture and laboratory courses of introductory physics in that semester. The study involved two sets of interviews and two lecture classroom observations.

The Instructor: Aree

Background

Aree explained that she had preferred to study physics since she was a secondary school student, because she realised that physics does not need much rote learning and she also liked mathematics. She studied physics at a Thai university and finally finished the Master degree in Applied Physics. Aree was a part time teacher while she was studying the Master degree and she decided to be a teacher at that time. She said that she always enjoyed teaching and was happy with the achievement of her students.

Nature of physics

Aree said that she hoped her students would understand all aspects of physics she taught, such as the principles and concepts or other contextual knowledge in physics.

Teaching physics

In her opinion, the most effective strategies for teaching physics are the combination of lecture and laboratory. Aree explained that these strategies could help student to understand physics. She employed these teaching strategies most often because she decided that these are the best strategies.

Learning physics

Aree suggested that students would be successful in physics if they pay enough attention to the lessons, do exercises by themselves and participate in group work. She explained that these strategies would help students to understand and memorise the lessons.

Aree explained that many students find physics difficult because the subject needs to be analysed rather than memorised, and involves a lot of mathematics. Many students do not like physics because they had bad experiences of physics at secondary schools. Physics pedagogy is a significant factor that makes physics a boring subject.

Second interview

When asking about her teaching strategies in that semester, Aree said that she spent about 60% of class time with lecture and 40% with the corresponding laboratory.

> “These are the typical strategies using in physics classes, which are very good strategies because experiments would verify and repeat the contents, and help students to understand lessons firmly” (Interview; 28/02/2003)

Aree referred to the poor background knowledge and inactive learning habits of students as the main factors that limited the quality and effectiveness of her teaching. She also argued that there is not a single teaching strategy which could satisfy all students.

Aree concluded that she was not satisfied with the students’ learning in that semester. She suggested that students could learn better if they were prepared with fundamental knowledge before studying this course, ask some questions and be active during the course. To improve her teaching, she required more class time with less students in the class, tutorial sessions and more learning materials.

Aree proposed that physics teaching could be improved in Rajabhats, by; (1) being strict in student admission to ensure they have the background knowledge needed to study physics, (2) providing fundamental courses for students with poor background knowledge, (3) evaluating instructors' teaching regularly, (4) increasing budget for laboratory equipment, (5) developing learning materials, (6) increasing the number of teaching staff, and (7) improving classroom facilities and equipment.

The Students

First interview

Physics experiences

Ratana explained that the physics teacher at her secondary school liked to explain how the content related to real situations before giving examples and exercises, and preferred students to participate in discussion. Ratana studied by practicing various types of exercises. If she had any questions she never hesitated to ask the teacher. Ratana said that this teaching approach encouraged her to continue further study in physics.

At Ranee's secondary school, physics teaching was based on the explanation of examples, and giving exercises and homework. Ranee said that she listened carefully to the explanation, practiced with exercises and homework, or asked questions in the class sometimes.

Banyen explained that her teacher gave the explanation of contents after students' reading or doing exercises. There were some tutorial classes on Wednesday afternoon at her secondary school for students who wanted to study further in universities. Banyen and her friends preferred to read and discuss the lessons in a small group.

Benja said that it is difficult to understand physics from the explanation. Her physics teacher tried to employ student-centered strategies by assigning students to read some books in the library. The most common teaching and learning strategies were, however, based on explaining and practicing with exercises.

Physics teaching at Bunga's secondary school was based on physics problems and very few experiments. Her teacher preferred students to practice with exercises.

Bunga studied physics by practicing with exercises and discussing physics topics with her friends.

Bulan's physics lessons began with reading texts followed by the teacher explaining the content, giving an example calculation, and finished by giving exercises and homework. Bulan said that she was satisfied with this teaching but she did not like the subject.

Each student described physics as follows:

> "Physics is different from mathematics, it is about situations in our daily lives while mathematics is about numbers, and however, numbers are significant in physics. In summary, physics is the study of all occurrences in the world." (Ratana, interview; 11/12/2002)

> "Physics is a study of phenomena with mathematics." (Ranee, interview; 11/12/2002)

> "Physics is a subject related to scientists' work." (Banyen, interview; 14/12/02)

> "Physics is a complicated subject, difficult to understand and imperceptible." (Benja, interview; 14/12/02)

> "Physics is a subject about guessing, we have never known whether it is true." (Bunga, interview; 14/12/02)

> "Physics is a subject about many theories which are imperceptible." (Bulan, interview; 14/12/02)

Beliefs about teaching and learning physics

All of the students in this case study agreed that physics should be taught to students because it is useful in explaining natural phenomena and has useful applications. They proposed that teaching physics should be clear with explanations and experiments. The lessons should be enjoyable and fun, notes should be written on the board or overhead projector, and they should have more opportunities for discussion.

In that semester, Ratana, Banyen, Benja and Bunga planned to read texts especially before going to the classes. Most of them wished to discuss difficult topics with friends or ask the instructor when they have any questions. Ratana, Ranee and Bulan intended to review the lessons by practicing with exercises. Ratana and Bulan said they need to pay more attention in the classes.

Goals and motivation

Ratana and Ranee said that if they were free to choose the subjects they would study, they would choose physics, but Banyen, Benja and Bunga said they would not, while Bulan preferred to choose physics if it is a laboratory course.

The goals for studying physics for Ratana, Banyen and Benja were to get good grades and more understanding. Bunga expected to pass the examination and would not be a poor student in the class, whereas Bulan said that she wished only to pass the examination.

Attribution of success

Among their classmates, Ratana expected Dusit and Decha (pseudonyms) would be successful in physics because they were the smart students in the class, but Ranee said that Ratana would be the most successful because she is hard working. Banyen, Benja, Bunga and Bulan expected Wipa (pseudonym) would be successful in physics among their classmates because she was a persevering student.

All of them agreed that hard working students could get good grades also, and probably be better than the clever students who didn't work hard.

Learning orientation

All students in this case study confirmed that the most satisfactory result in studying physics for them was meaningful understanding.

> "Good understanding helps people to work effectively," said Ratana. (Interview; 11/12/2002)

Second interview

In that semester these students employed various learning strategies. Ratana paid attention to the lessons regularly, practiced with exercises and asked the instructor questions about difficult topics. Ranee listened to the lectures, took notes in detail, practiced with exercises and read texts. Both Ratana and Ranee wished to be more attentive to improve their grades and understanding. Banyen, Benja and Bulan copied notes, reviewed after classes and sometimes asked friends or the instructor to explain the lessons. Bunga said that she employed rote learning strategies by copying and reading notes. Banyen and Benja wished to work harder and discuss difficult topics with the instructor. Bunga expected to be more attentive and have good attitudes towards the subject whereas Bulan also wished to pay more attention, work harder, and practice with more exercises.

They referred mainly to the lack of attention as the limitation of their success in physics. The other factors included topics that were difficult and boring, laziness, the lack of opportunity to ask questions, cultural beliefs about not being distinguished from other students, procrastination, disturbances in the classes (e.g. noises), teaching strategies and poor attitudes towards the subject.

Some of them said that they were not satisfied with the instructor's teaching. They firmly proposed that the instructor should teach in a more interesting way with clear explanations and give more detail in doing experiments. They also wished the instructor would provide more opportunities for asking questions, learning materials, and a better conclusion at the end of each topic. This physics course should have less complicated mathematics and more class time.

Ratana, Banyen Bulan confirmed that success in studying physics was a result of paying attention to the lessons. Banyen explained that;

> "I attended to the classes regularly during this semester and did my mid-term tests really good but I was not ready with the final test. I read other subjects such as Economics more than physics at the final examination."
> (Interview; 01/03/2003)

Ranee and Benja referred to hard working for their success in physics that was similar to Bunga who said that her success was a result from doing the experiments by herself.

Classroom Observations

This class was observed twice, at the beginning and the end of the semester. Both observations were lecture sessions.

The first observation was in the morning from 9:10 to 10:50 am. The instructor began with the explanation of an exercise on the board for about 10 minutes. Students listened and copied notes quietly. A student at the front row asked a few questions, which the instructor explained and followed with some discussion with that student for a while.

The instructor started her lecture about Gauss's law at 9:35 am. She explained the contents while she wrote notes on the board and asked a few questions to the class. The students listened and copied notes, only a few students responded to the questions. The lecture went on in the same manner until 10:25 am. when there was a break for 10 minutes.

The lesson continued after the break with the instructor showing how to do a physics problem and then giving exercises. Students still listened and copied notes quietly until the end of the lecture at 10:50 am.

The second observation was in the afternoon from 3:35 to 5:10 pm. The instructor began with talking about students' notebooks and exercise books for 10 minutes. She gave a lecture about magnetic field from 3:45 to 4:05 pm. During her lecture students listened and copied notes as usual. This topic ended with an example written on the board.

The lecture continued about the force on a current-carrying conductor in a magnetic field from 4:10 to 4:50 pm. The procedure of teaching was in the same style but there were some noises from students talking while most of them listened and copied notes. The class finished with giving a few examples and giving exercises for the students to complete after the class.

In summary, both observed classes were large groups with about 45 students. The instructor played the most important role in the classes. She spent about 70 – 80% of class time explaining while students listened and copied notes at the same time. Only a few students at the front rows participated with the instructor in discussion whereas most students were passive learners.

Document Analysis

Two important documents for this class were notebooks and exercise books. The instructor required students to take notes carefully and these were handed to her after the final examination for marking. The students had to do exercises regularly and the exercise books would be checked occasionally.

The instructor introduced some textbooks to students but they rarely used these books in the class. The students preferred to copy and review the notes given by the instructor.

Laboratory manuals were available to students. These manuals were the same as those in the Case Study B. Each student had to write a report for the experiments and hand these to the instructor on time.

Case Study D

This case study was conducted with a class of introductory physics for students in Science programs. The course was a lecture combined with laboratory physics. The case study was based on two sets of interviews and one laboratory classroom observation.

The instructor: Ampa

Background

Ampa intended to be a teacher since she studied at secondary school. After completing a B.Ed. in physics she was employed as a science teacher at a vocational college for one year. Ampa resigned that job when she won a scholarship from the Office of Rajabhat Institute Council (ORIC), Ministry of Education; to study the Master degree in Biophysics. Ampa has been a physics instructor at one of Thai Rajabhats since she finished the M.Sc. in that field.

Nature of physics

Ampa said that she wished her students to understand and be able to apply physics in real situations.

> "Learning physics is not only for the ability of doing calculation in physics exercises or transmitting knowledge to other people but students would be able to apply whatever they learned to their real lives." (Interview; 25/12/2002)

Teaching physics

Ampa believed that laboratory approaches are the most effective strategies in teaching physics. She mentioned that students could understand physics and its relations to natural phenomena by doing experiments.

Ampa said that she spends about 60% of class time with lecture and giving exercises, and about 40% with laboratory. She explained that she needs more time to explain lessons because most students have poor background knowledge.

Learning physics

Ampa suggested that practicing with exercises and analysing experimental data is the most effective learning strategy in physics. She confirmed that this strategy could help students to learn physics by themselves.

Ampa explained that many students find physics difficult because the subject uses a lot of complicated mathematics, which is unavoidable. In her opinion, physics could be imperceptible and difficult if students have no opportunity in doing experiments. Consequently, many students do not like to study physics and think it is a useless subject.

Second interview

Ampa explained that she employed laboratory approaches most often in that semester because these approaches could help students to learn by themselves and understand physics. The main limiting factor to the quality and effectiveness of her teaching was the poor background knowledge of her students. Ampa said that she was satisfied with the students' learning; however, she wished them to be clever in solving physics problems.

Ampa said that she could improve her teaching if she has some more time to prepare better instruction and demonstrations To improve physics teaching in Thai Rajabhats, Ampa proposed that; (1) laboratory approaches to teaching be promoted, (2) decrease teaching loads, and (3) motivate talented students to study physics.

The Students

First interview

Physics experiences

Thida explained that at her secondary school there was a lack of laboratory equipment so physics teaching was based on giving explanations and writing notes on the board. She listened to the explanations, copied notes and reviewed them after classes, and tried to memorise the formulae and details. She preferred to ask the teacher questions when she didn't understand.

Tiwa's secondary school did not have a qualified physics teacher or laboratory equipment. Physics teaching was therefore based on explaining the contents of the textbook. Tiwa tried to pay attention in the classes, practice with exercises and discuss difficult topics with her friends.

Teaching physics at Thani and Tewi's secondary schools was similar to Tiwa's experience. Teachers described the content in the texts and gave exercises, but rarely did experiments. Thani said that he studied by copying notes and reviewing them after classes. Tewi explained that she tried to listen in the classes but it was very difficult to understand, so she turned to practicing with exercises in a small group of her friends which helped her to understand better.

Tanya was lucky because she studied with a good teacher and did experiments at her secondary school. She enjoyed physics although she never liked mathematics. Tanya copied notes in detail with neat writing and always asked lots of questions until she understood the concepts.

When they were requested to identify the meaning of physics, they replied that;

> "Physics is a subject about the mechanism of working systems in both living and non-living things." (Thida, interview; 23/12/2002)

> "Physics is a study about the motion of objects and things around us, besides living things and chemical elements." (Thani, interview; 23/12/2002)

> "Physics is a subject dealing with our daily-life experiences." (Tanya, interview; 23/12/2002)

> "It is a science about the nature and technology of all surroundings, but people do not know exactly about its meaning. Physics is involving with numbers, which helps people to be more successful in developing technology." (Tiwa, interview; 23/12/2002)

> "Physics is a subject about everything in nature. Most people are not interested in physics but if they know more it would be advantageous to their lives." (Tewi, interview; 23/12/2002)

Beliefs about teaching and learning physics

These students believed that physics should be taught to students because it is important to the development of technology and our lives. They proposed that physics in both secondary schools and Rajabhats should be taught with a combination of lecture and laboratory, and students should spend more time in doing experiments than theoretical explanations.

In that semester, all of these students planned to study physics by being attentive to the classes. Thida said that she would take notes carefully in her own words. Tiwa wished to review lessons regularly after classes. Thani expected that he would copy notes in detail, review at home and discuss them with friends. Tewi expected to read texts as much as possible and ask the instructor whenever she finds a problem. Tanya vowed that she would to work hard and read texts before going to the class.

Goals and motivation

Most of these students recognised the importance of physics for their careers so they would choose to study physics. Only Thani argued that physics is too difficult because it contains so many formulas, thus he would not choose physics as a subject to study.

Thida, Thani and Tanya said that their goal of studying physics in that semester was to get good grade. Thida commented further that she expected to get at least B+, and also have better attitudes towards physics.

The goals of studying physics for Tiwa in that semester were to learn how to use physics instruments, solve physics problems, analyse data and make conclusions from physics experiments. Similar to Tewi, her goals were to understand the basic concepts in physics, and be able to apply physics in real life.

Attribution of success

When they were asked about whom among their classmates would be successful in physics, these students had different opinions. Thida and Tewi expected Supa (pseudonym) to do well. Thida argued that Supa was an attentive student and could understand lessons more than the others in the class while Tewi noted that Supa was a clever student. Tiwa expected Siree (pseudonym) to do well because she was a persistent student. Thani said Saree (pseudonym) would get good grades since she employed better learning strategies than the others. In Tanya's opinion, Sopee and Somporn (pseudonyms) would be successful in physics because they were the most persevering students in the class. All of them agreed that hard working students could get good grades in physics.

Learning orientation

The most satisfactory result in studying physics for Thida, Tiwa, Tewi and Tanya was meaningful understanding; but differently for Thani, he wished to get good grades.

Second interview

The actual learning strategies that Thida, Tiwa and Thani used most often in that semester were taking or copying notes and reviewing them after classes. Thida and Thani also preferred to ask the instructor questions or discuss physics with friends. They confirmed that these strategies helped them study physics. Thida expected she could improve her learning strategies by working harder and concentrating on lectures. Tiwa wished to take notes on the important issues and read more texts.

Tewi and Tanya said that they employed the learning activities given by the instructor in the classes. Tanya said that she was always actively engaged with activities but she hoped to improve her learning by discussing physics with her classmates. Tewi said that she likes mathematics so she did not have many problems in physics; however, she should read more texts for better learning.

They commented mostly on inappropriate teaching strategies and the lack of learning materials such as texts and laboratory equipment as the factors that limited their success in learning physics. The other factors were classroom environment, subject difficulties, less attention and participation, and the problems from their time management.

Generally, the students were quite satisfied with the instructor's teaching. Some aspects of the teaching strategies that they proposed to change were to decrease some theoretical content and increase experimental work, the instructor should explain lessons in more detail after giving notes, each topic should be summarised and followed by a test, and providing more opportunities for discussion or working in groups. They also suggested that some of the complicated formulas which are difficult to remember should be omitted from the course.

Success in learning physics for this group of students, was due to hard working and being in a good group for laboratory sessions.

Classroom Observation

The classroom observation was made in the morning from 8:35 – 10:15 am. It was a laboratory session, in which the students worked in groups of four or five. There were almost 40 students in the class.

One laboratory assistant was attending to help the class in preparing and setting out laboratory equipment. There were eight different experiments in the class. Apparatus for the aerodynamics, standing wave and surface tension experiments had been set up on the bench, but most of the electrical apparatus such as electrical wires and multi-meters needed to be gathered from the laboratory store.

The instructor started the lesson in the first 10 minutes by repeating some conditions and regulations that students must follow during the experiments, and introduced some apparatus. Then the students were separated in eight groups to set up their own experiments.

In the next 10 minutes, students talked in their groups while doing the experiment, however, it was noticeable that some students did not fully participate with the activities in their groups. Meanwhile, the instructor went around the class to talk to or advise students.

At about 9:00 am, while the instructor was talking seriously with one group, some groups seemed to start to analyse data. The instructor then turned to explain to the whole class, for nearly 10 minutes, about the problems of collecting data she found from that group. Four groups of students continued their experiments after that, the members in these groups worked cooperatively.

At 9:20 am, there were only two groups still doing the experiments. Most students analysed data on their individual worksheets. Ten minutes later, many students discussed their results in small groups. Some groups went back to repeat the experiments to check their data.

At 9:40 am, the instructor explained loudly to the whole class about how to analyse the data. Some students did not pay attention to that explanation but went on with working in their worksheets.

Between 9:40 and 10:00 am, one group repeated their experiment again. Most students were writing reports while some other students talked in small groups.

At about 10:10 am, all students stopped working and left the classroom.

Document Analysis

Only laboratory manuals and experimental reports were analyed in this case study. The laboratory manuals were available to all students. Each experiment had its manual which contained the objectives for the experiment, related theories, experimental equipment, a diagram showing the experimental set up, the procedure for doing the experiment and for analysing data. Students were required to do the experiments following these manuals.

Worksheets for completing the experimental reports came along with the manuals. Students filled in the blanks with the collected data. After that they worked with the data by calculation or plotting graphs; writing the result, discussion and conclusion.

Analysis of Case Studies

Introduction

The four cases were based on introductory physics classes in two Rajabhats. The members in each case were an instructor and four to six first year students. The case studies were compiled from interviews, classroom observations and document analysis.

At the first interview, the instructors discussed their beliefs about what students should learn in physics, effective teaching and learning strategies in physics, and students' difficulties with physics. In the second interview, they described their teaching and identified factors that limited the effectiveness of their teaching. Finally, they proposed how physics teaching could be improved.

At the beginning of the semester, the students were asked about their experiences of physics as school students. They described their strategies for learning physics, their goals and motivation, attribution of success, and their learning orientation.

At the end of the semester, these students were asked again about their actual study strategies, what changes they expected to make with their study strategies, the instructor's teaching, and their success in learning physics.

Classroom observations for each case study were made to corroborate claims about teaching and learning strategies and to observe classroom facilities and resources. Document analysis provided further insights into the teaching and learning of physics.

The case studies are analysed and assertions developed in relation to beliefs, and teaching and learning strategies.

Instructors' Beliefs

Beliefs about the purposes of studying physics

Most instructors in the case studies had similar views about what they hoped their students would learn about the nature of physics. The answers tended to focus on the applications of physics to everyday life and to technology, rather than on physics as a discipline of science which generates new knowledge.

Assertion 6.1

The instructors believed that students should learn about the relevance of physics to technology, and be able to apply physics knowledge in real life situations.

Beliefs about effective teaching and learning strategies

The instructors identified what they believed were the most effective physics teaching strategies and the strategies they use most often in physics. Although they believed a combination of lecture and laboratory approaches was most effective, they used mainly lectures. This may be related to limited resources needed for laboratory work. The instructors also identified strategies that they believed were effective for learning physics. They believed that students should be attentive and engaged in learning.

Assertion 6.2

The instructors considered that both lecture and laboratory are effective teaching strategies in physics. Although they believed that laboratory approaches were very effective, most of them spent more class time in lectures than laboratory work.

Assertion 6.3

The instructors indicated that students should learn physics by being attentive to the classes, doing experiments and exercises, working in groups, reading texts before classes and reviewing notes after classes.

Beliefs about the difficulties of learning physics

All of the instructors believed that the mathematical nature of physics is the main cause of difficulties in learning physics.

Assertion 6.4

The instructors believed that students find physics difficult because mathematics is used in the subject. They also referred to the students' ability, poor background knowledge, negative attitudes towards the subject, and inappropriate learning strategies as the factors that make physics difficult to learn.

Beliefs about factors limiting the quality and effectiveness of physics teaching

When reflecting on their teaching in that semester, the instructors identified the factors and conditions that limited the quality and effectiveness of their teaching, which are summarised in the following assertion.

Assertion 6.5

Almost all instructors indicated that the low ability of students, the lack of attention and responses from students, ineffective teaching strategies, unsuitable classroom environment, the lack of learning materials, and insufficient class time were the factors that limited the quality and effectiveness of their teaching.

Beliefs about improving physics teaching

The instructors made various suggestions about how to improve physics teaching. Their suggestions are summarised in the assertion below.

Assertion 6.6

Suggestions for improving physics teaching included providing demonstrations and tutorial sessions for students, increasing class time, decreasing the number of students in the class, providing more learning materials and improving the classroom environment.

When asked to imagine the scenario of having the authority to make any changes to improve physics teaching in Rajabhats, the instructors focused on issues of resourcing, however, they did also make suggestions about differentiating instruction for students with different background in physics, and professional development for instructors.

Assertion 6.7

Teaching physics in Rajabhats could be improved by promoting laboratory approaches, only admitting talented students to physics courses, increasing the number of physics instructors and decreasing teaching loads, increasing budgets and providing more learning materials, providing fundamental courses to students with weak background knowledge, and improving instructors' teaching ability and classroom environment.

Students' Beliefs

Beliefs about the nature of physics

The students described their understanding of the nature of physics using their own words. Many students said that physics was difficult, complicated and imperceptible in abstract. They also indicated the reasons why physics should be taught to students.

Assertion 6.8

Students believed that physics is a study of natural phenomena in terms of quantities which is difficult, complicated and imperceptible with many theories and experiments. It should be taught to students because it is useful to our lives and important to technology development.

Beliefs about teaching physics

Most students had negative experiences of physics from their experiences at secondary school and some were taught physics by teachers who were not specialists in the subject. Many students had little experimental work in secondary physics due to the lack of laboratories and equipment in their schools.

Assertion 6.9

From the experience of physics in secondary school, students believed that physics teaching is not interesting; it is normally done by giving explanations and notes, exercises and homework, and rarely doing experiments or discussion.

In contrast to these teacher-centered and didactic teaching methods experienced at school, the students proposed a range of more student-centered strategies that would be more effective for teaching physics.

Assertion 6.10

Students proposed that physics teaching should be enjoyable, meaningful and attractive, and involve a combination of theoretical and laboratory sessions that emphasised student practical work. There should be clear explanation using appropriate media, giving notes, practicing with exercises and homework, discussion and working in small groups.

Beliefs about studying physics

The learning strategies used by the students at secondary school were related to the didactic and teacher-centered form of instruction. Students were fairly passive learners.

Assertion 6.11

Students study physics by listening to the explanations, copying notes, reading texts, practicing with exercises, and sometimes asking teachers questions or discussing ideas with peers.

The students were asked about their plans for studying physics in that semester. Their responses indicated they intended to be more active in their learning than they were at school.

Assertion 6.12

Students expected that to be effective in studying physics they would need to be attentive to the classes, read texts and review lessons, discuss difficult ideas with the instructor or peers, take or copy notes, and practise with exercises.

Goals, Motivation, Attribution of Success, and Learning Orientation

Goals and motivation

As expected, physics is not a motivating subject for most students even though they realised the importance of physics to their lives and for the development of technology. It seems that students believed that only some special groups of people need to do physics, but themselves, they are just required to pass the examination.

Assertion 6.13

Except the students from Science Education programs, most students did not prefer to study physics if they were free to choose the subjects to study. Most students indicated that their goals for studying physics were to pass the examination and understand physics. Some indicated that they wished to get good grades, be able to apply physics to their lives and have good attitudes towards physics

Attribution of success

The students expected clever students would be successful in physics if they worked hard, however, they also accepted that any hard working students could get good grades also.

Assertion 6.14

Most students agreed that talented and hard working students would be successful and get good grades in physics.

Learning orientation

Almost all of the students who participated in the case studies wished to understand physics. They argued that studying for meaningful understanding would help them get good grades and please their parents and instructors.

Assertion 6.15

Most students accepted that meaningful understanding was the most satisfactory result for studying physics.

Classroom Observation

Classroom environment

Lecture and laboratory classes were observed. The lecture classes were quiet with about 35 – 45 students. The weather was hot and humid if the classes were in the afternoon. Overhead projectors, microphone and chalkboards were available for lecturing and giving notes.

The laboratory classes were clean and orderly. Each group of students consisted of at least three and not more than five members worked quietly with laboratory equipment. Due to the insufficiency of physics equipment, it is impossible for all students in a laboratory class to do the same experiment at the same time. A rotational laboratory design was arranged for the class. This resulted in poor integration of theory and practical work.

Assertion 6.16

Due to limitations with equipment a rotational laboratory design was used which resulted in poor intergration of theory and practical components of the course.

Instructor's activities

In the lecture sessions, the instructors played the dominant role in the classes; they spent about 70 - 80% of class time with explaining, giving notes and working through examples of physics problems on the board or overhead projector. There were very few other activities such as questioning, discussion or supervising students.

In the laboratory classes, the instructors spent about 10 - 25% of class time describing experiments to the whole class and about 20% discussing or supervising in small groups.

Assertion 6.17

The instructors spent the majority of class time explaining the content of the lecture. Given the relatively small lecture class sizes the sessions had very limited interaction between the instructor and students. In laboratory sessions about one quarter of the session was consumed by the instructor's explanations.

Students' activities

Students' actual studying activities were consistent with their beliefs about effective learning; they were mostly passive learners. They spent about 70 - 80% of class time listening and copying notes in the lecture sessions. Many students copied notes verbatim from the overhead projector. Only a few students at the front row of the classes participated in any discussion with the instructors.

Assertion 6.18

Students were passive learners. Most lecture class time was spent listening, copying notes verbatim and very few students asked the instructor any questions.

In laboratory sessions, students spent about 10 - 25% of class time listening to the instructor's explanation, 10% in discussion within their groups, 35 - 50% in doing experiments, and 30 - 45% analysing data and writing the experimental reports. Students followed the detailed instructions in the laboratory manual to complete laboratory exercises and then used structured worksheets for completing reports of their laboratory work.

Assertion 6.19

Students completed structured laboratory exercises by passively following prescribed laboratory procedures.

Document Analysis

Most textbooks were in the Thai language but were rarely used by students. Students' notebooks generally contained copied examples and notes from the lectures. Laboratory manuals contained objectives, brief statements of related theories, and detailed procedures for doing the experiments. Experimental reports were completed on worksheets and students were required to present to the instructor at the end of each laboratory session. Notebooks might also be checked by the instructor for the lecture classes.

Details in the syllabus varied between the different Rajabhats and introductory physics courses, however, all included a course description, objectives, texts, assessment, and teaching and learning guidelines.

The general objectives of studying introductory physics courses included in the syllabus statements were; to understand fundamental physics concepts, to gain more basic knowledge for further study, to be able to apply knowledge to real situations, and to manipulate physics apparatus.

The assessment in introductory physics consists of assignments and tests. About 60% of marks are awarded during the semester for reports, exercises and mid-term tests, the remaining marks are for the final examination. Paper-and-pencil tests in physics usually comprise routine problem solving exercises.

Assertion 6.20

Analysis of syllabus documents, student notebooks, laboratory reports and assessment materials indicate that physics is taught, learned and assessed in ways that are consistent with a knowledge transmission pedagogy.

CHAPTER 7: THE SECOND STUDENT QUESTIONNAIRE

Introduction

The student opinion questionnaire was administrated to students in two Rajabhats in the South of Thailand at the end of the second semester in February, 2003. This Chapter presents an analysis of the data from the questionnaires. The Chapter comprises nine sections. The first section presents the demographic data about the students who participated to the survey. The second section describes students' general opinions about physics. The third section summarises students' attitudes towards physics. The fourth section reports students' opinions about physics compared with other subjects. The fifth section describes students' intensions regarding further study of physics. The sixth section reports students' opinions about aspects of physics. The seventh section reports students' opinions about how to improve physics. The eighth section summarises students' other comments and the last section presents the summary of discussion and assertions gathered from all previous sections of the Chapter.

Demographic Data

The students who participated to this questionnaire were from the same groups of students who completed the first questionnaire previously reported in Chapter 5. The number of respondents changed from 140 students for the first questionnaire to 147 students for this questionnaire (from 85% to 89% of the population respectively). The results of both questionnaires are therefore representative of the population of students studying introductory physics at these two Rajabhats. Details are shown in Table 7.1.

Table 7.1. Program of study and Rajabhat (n = 147)

Program	Rajabhat	Count	Percent
Public Healthcare	1	32	21.8

Program	Rajabhat	Count	Percent
Food Science	2	35	23.8
Environmental Science	2	32	21.8
General Science Education	2	34	23.1
Physics Education	2	14	9.5
Total		147	100.0

These students had been studying introductory physics courses through the semester and were waiting for the final examination when the questionnaire was administrated. Students' responses were expected to reflect their experiences of studying the subject throughout the semester.

General Opinions about Physics

Part A of the questionnaire comprised 17 agreement scale items. These items surveyed students' general opinions about the nature of physics and studying physics. The percentages of agreement are shown in Table 7.2.

Table 7.2. Students' responses to the question: What do you think about physics? (n = 147)

Item no.	Percent of respondents				
	Strongly disagree	Disagree	Not disagree or agree	Agree	Strongly agree
1. Physics is interesting	2	9.5	40.8	41.5	6.1
2. Physics is enjoyable and fun	3.4	30.6	47.6	17.7	0.7
3. Physics is useful	0	5.4	12.2	63.9	18.4
4. Physics is difficult	1.4	4.1	8.2	41.1	45.2
5. Physics is complicated	0.7	6.2	9.6	45.9	37.7
6. Physics is tedious and boring	1.4	17.7	45.6	27.9	7.5
7. Physics is irrelevant to real life	11.8	47.2	22.9	16	2.1
8. Good teaching never happens in physics classes	5.4	40.8	38.1	13.6	2

Item no.	Percent of respondents				
	Strongly disagree	Disagree	Not disagree or agree	Agree	Strongly agree
9. I need to learn more physics	2.1	6.8	18.5	51.4	21.2
10. The way to get good grades is memorise the facts	3.4	17.8	15.8	47.9	15.1
11.The way to get good grades is to understand and be able to apply the ideas	1.4	3.4	8.2	52.4	34.7
12. Doing experiments helps me learn physics	0.7	8.2	17	54.4	19.7
13. Solving physics problems helps me learn physics	0.7	5.4	30.6	55.1	8.2
14. Physics helps you understand the world and make decisions in your life	1.4	13.1	42.1	37.9	5.5
15. You need to study hard to get good grades in physics	0.7	4.8	11	56.6	26.9
16. You need to be clever to get good grades in physics	6.9	27.6	30.3	29	6.2
17. You need to be good at maths to get good grades in physics	2.8	15.9	20	51.7	9.7

A large majority agreed or strongly agreed that physics is difficult (86%) and complicated (84%). A large majority also agreed or strongly agreed that physics is useful (82%), however, only 43% agreed or strongly agreed that physics helps you understand the world and make decisions in your life. The moderately high level of agreement (73%) with Item 9: *I need to learn more physics* may indicate that the usefulness of physics (Item 3) relates to further study or their career. More students agreed or strongly agreed that physics is tedious and boring (35%) than agreed or strongly agreed that physics is enjoyable and fun (18%).

In terms of studying physics, most students agreed or strongly agreed that the ways to get good grades in physics are to understand and be able to apply the ideas (87%), memorise facts (63%) and be good at mathematics (61%). More students agreed or strongly agreed that you have to study hard (83%) than be clever (35%) to get good grades. Seventy-four percent agreed or strongly agreed that doing experiments helps them learn physics, and 63% agreed or strongly agreed that solving physics problems helps them to learn.

Assertion 7.1

Most students agree that physics is a difficult and complicated subject; however, they recognised that physics is useful.

Assertion 7.2

Students believe that trying to understand and apply the ideas, memorise facts, working hard, being good at mathematics but not necessarily being clever are needed to get good grades in physics.

Assertion 7.3

Students believe that doing experiments and solving physics problems help them to learn physics.

Attitudes towards Physics

The first seven items in Part A of the questionnaire are related to students' attitudes towards physics. Items 1 to 3 are positive, whereas Items 4 to 7 are negative statements. With transformation of the negative statements by reversing the scoring and adding up the scores for all seven items, the total score provides a measure of students' attitude towards physics.

Responses for the items were scored as follow: 1 = strongly disagree (very negative attitude), 2 = disagree (negative attitude), 3 = not agree or disagree (neutral), 4 = agree (positive attitude), and 5 = strongly agree (very positive attitude) hence, the total values of these responses over the seven items will be in the following ranges: 7 to 10 = very negative attitude; 11 to 17 = negative attitude; 18 to 24 = neutral; 25 to 31 = positive attitude; and, 32 to 35 = very positive attitude.

Using the procedures described above, students' attitudes towards physics were classified. The student' attitudes towards physics for each program of study are shown in Table 7.3.

Table 7.3. Attitudes towards physics (n = 147)

Program of Study	Number of students				Total
	Very negative attitudes	Negative attitudes	Neutral	Positive attitudes	
Public Healthcare	0	4	22	6	32
Food Science	2	12	20	1	35
Environmental Science	0	9	23	0	32
General Sciences Education	0	4	28	2	34
Physics Education	0	0	7	7	14
Total	2	29	100	16	147
Percent of respondents	1.4	19.7	68.0	10.9	100.0

The majority of respondents had neutral attitudes towards physics (68%). About one fifth of students (31/147) had very negative and negative attitudes. Only 11% of students had positive attitudes towards physics and none had very positive attitudes. It should be noted that fewer students in science education programs (8%; 4/48) had negative attitudes towards physics than students in other programs (27%; 27/99).

Assertion 7.4

Most students have neutral attitudes towards physics. Lower proportion of students in science education programs has negative attitudes towards physics.

How Does Physics Compare With Other Subjects?

Students were asked to compare physics with nine other subjects. Students' responses are summarised in Table 7.4.

Table 7.4. Students' responses to the question: How does physics compare with other subjects? (n = 127)

Responses	Count	Percent of respondents
1 = The least popular subject	18	14.2
2	15	11.8

Responses	Count	Percent of respondents
3	30	23.6
4	18	14.2
5	15	11.8
6	9	7.1
7	9	7.1
8	7	5.5
9	3	2.4
10 = The most popular subject	3	2.4
Total	127	100.0

Students ranked physics from the least to the most popular; of their subjects. It should be noted that 50% of respondents evaluated physics as one of the three least popular subjects (1 to 3), whereas, only 10% indicated physics was one of the most popular subjects (8 – 10). This result indicates that for many students physics is not an enjoyable subject, a finding consistent with students' responses to Item 2 from Table 7.2.

Assertion 7.5

Half of the students consider physics to be one of the three least popular subjects they study.

Intension to Study More Physics

Students were asked whether they want to study more physics and the reasons for their answers. Responses are summarised in Tables 7.5.1 and 7.5.2.

Table 7.5.1. Students' responses to the question: Would you like to study more physics? (n = 144)

Responses	Count	Percent of respondents
No	61	42.4

Responses	Count	Percent of respondents
Yes	83	57.6
Total	144	100.0

Table 7.5.2. Students' reasons for their answers in Table 7.5.1 (n = 137)

Responses	Count	Percent of respondents
Yes: I want to learn more and do better in physics	62	45.6
Yes: Application of physics is useful	15	10.9
Yes: I can't avoid studying more physics	4	2.9
Yes: Physics is challenging	4	2.9
No : It is difficult to understand	39	28.5
No : Physics is boring	8	5.9
No : I don't like physics	7	5.1
No : I don't want to get a bad grade	5	3.6
No : Physics is not relevant to my life	4	2.9
No : No reason	1	0.7
Total	149	109.0

Note: Some students gave more than one reasons.

Taken together, the data from Tables 7.3, 7.4 and 7.5 paint a fairly negative student view of physics. Of particular concern is that the percentage of students who did not want to study physics has increased from 26% (Table 5.2.1) at the beginning of the semester to 42% (Table 7.5.1) at the end of the semester after having studied an introductory physics course.

Assertion 7.6

After studying introductory physics, the percentage of students who do not want to study physics increased from 26% to 42%.

Preferences Regarding Aspects of Physics

Two open-ended questions in Part B of the questionnaire asked students to indicate the aspects of physics that they like and dislike. Students' responses were coded into categories. The frequencies of responses in these categories are reported in Tables 7.6 and 7.7.

Table 7.6. Students' responses to the question: What do you like about physics? (n = 132)

Responses	Count	Percent of respondents
Laboratory experiments	62	47
Some theoretical contents	41	31.1
Application to real-life situations	10	7.6
Mathematical calculation	9	6.8
All aspects of physics	2	1.5
Instructors and their teachings	2	1.5
None	12	9.1
Total	138	104.6

Table 7.7. Students' responses to the question: What do you dislike about physics? (n = 127)

Responses	Count	Percent of respondents
Mathematical calculation	79	62.2
Some difficult contents	29	22.8
All aspects of physics	9	7.1
Laboratory experiments	5	3.9
Complicated lectures	3	2.4
Tests and examinations	2	1.6
None/ I don't know	3	2.4
Total	130	102.4

Students reported that the aspect of physics they like most is laboratory experiments (47%), this result is consistent with the responses to Item 12 in Table 7.2. Some students indicated that they like theoretical contents (31%). Most students disliked mathematical calculation (62%) and some difficult contents in physics (23%). In contrast, a small number of students did not like laboratory experiments (4%) and liked mathematical calculation (7%). Seven percent reported that they did not like any aspects of physics while only 2% indicated they liked all aspects of physics.

Assertion 7.7

In studying physics, students most liked to do laboratory experiments but they least liked mathematical calculations.

How to Improve Physics

Students were asked about what they would change to make physics better. Most students did not respond to this question. Only 40 students replied, and most indicated that they should pay more attention and work harder (70%), which corresponded to the responses to Item 15 in Table 7.2. It should be noted that none of the students made suggestions for improving physics teaching which may reflect cultural beliefs about teachers knowing best. Details of students' responses are shown in Table 7.8.

Table 7.8. Students' responses to the question: How would you change physics to make it better? (n = 40)

Responses	Count	Percent of respondents
Pay more attention and work harder to understand	28	70
Read and try to memorise contents	3	7.5
Study within a small group	1	2.5
No comment/It is OK/I don't know	9	22.5
Total	41	102.5

Other Comments

The last Part of questionnaire allowed students to make any other comments. These comments are concluded in Table 7.9.

Table 7.9. Students' responses to the question: Do you have any other comments about physics? (n = 112)

Responses	Count	Percent of respondents
Make lessons to be clear and easy to understand	20	17.9
Effective learning depends on good teaching strategies	20	17.9
Make lessons to be enjoyable and interesting	19	17
Provide good instructors with good teachings	12	10.7
Do not emphasise on the deep theoretical contents	11	9.8
Physics contents should be relevant to real life	11	9.8
Provide more laboratory work	10	8.9
Give more explanation in details	8	7.1
Provide basic knowledge of physics and mathematics	7	6.3
Students must pay more attention and work harder	4	3.6
More times for tutorial and practice sessions	3	2.7
Give more examples and similar exercises	3	2.7
Make conclusion at the end of each lesson	3	2.7
Physics should be elective subjects	2	1.8
Provide more intensive contents	2	1.8
No grading in physics	1	0.9
Teaching and studying strategies should be changed	1	0.9
Instructors should aware of individual differences	1	0.9
No comment	8	7.1
Total	146	130.5

These comments are mainly related to improve teaching strategies. Students still reflected the characteristics of passive learners; i.e. they preferred to have clear and easy lessons (18%), good teaching for better learning (18%), and enjoyable and interesting lessons (17%).

Assertion 7.8

Students want instructors to improve physics teaching strategies, lessons should be clear, easy, enjoyable and fun. They hope that good teaching would help them learn physics better.

Chapter Summary

The questionnaires were completed by students at the end of the semester to elicit their opinions about introductory physics when they had nearly finished studying their semester long courses.

Most students decided that although physics is a difficult and complicated, it is a useful subject. To get good grades in physics, students believed that they need understanding, hard working, memorising facts and being good in mathematics. They also believed that doing experiments and solving physics problems would help them learn physics better.

The majority of students who had studied introductory physics had neutral attitudes towards physics. When compare with other subjects, physics is one of their least popular subjects. Less students wished to study physics after they had studied an introductory physics course.

Not many students responded to the question of how to improve physics. The majority of students who responded to the question, however, proposed that they would pay more attention and work harder.

At the final Part of the questionnaire students were asked to make any other comments. Most of these comments suggested that teaching strategies should be improved.

Assertions developed in this Chapter are listed here.

7.1 Most students agree that physics is a difficult and complicated subject; however, they recognised that physics is useful.

7.2 Students believe that trying to understand and apply the ideas, memorise facts, working hard, being good at mathematics but not necessarily being clever are needed to get good grades in physics.

7.3 Students believe that doing experiments and solving physics problems help them to learn physics.

7.4 Most students have neutral attitudes towards physics. Lower proportion of students in science education programs has negative attitudes towards physics.

7.5 Half of the students consider physics to be one of the three least popular subjects they study.

7.6 After studying introductory physics, the percentage of students who do not want to study physics increased from 26% to 42%.

7.7 In studying physics, students most liked to do laboratory experiments but they least liked mathematical calculations.

7.8 Students want instructors to improve physics teaching strategies, lessons should be clear, easy, enjoyable and fun. They hope that good teaching would help them learn physics better.

CHAPTER 8: GENERAL DISCUSSION

Introduction

The effectiveness of teaching and learning physics is one of the main concerns of physics educators around the world (McDermott & Redish, 1999). There is no doubt that teachers' beliefs play an important role in influencing teaching, whereas, on the other hand, students' beliefs, goals and motivations are significant factors influencing students' learning strategies (Pintrich & Schrauben, 1992; Wigfield & Harold, 1992). Rajabhat universities (formerly, Rajabhat institutes) are the tertiary education institutes that provide both pre-service and in-service teacher education in Thailand. They have been trying to improve the quality of teaching and learning in every field of study. This investigation of instructors' beliefs and students' beliefs, goals and motivations for studying physics will provide useful direction for the improvement of teaching and learning of physics in Thai Rajabhat universities. Improved teaching and learning of physics in pre-service teacher education may also enhance physics teaching in Thai schools.

This thesis considered three populations; the physics instructors in 36 Thai Rajabhats, first year students from Rajabhats in the South of Thailand, and four case studies of instructors and students. The physics instructors completed a questionnaire at the beginning of the second semester in 2002. The first year students completed two questionnaires, one at the beginning and another at the end of the same semester. Case studies of physics teaching and learning were compiled from interviews, classroom observations and document analysis conducted during that semester.

This Chapter discusses five themes that emerged from the assertions developed from the instructor questionnaire data reported in Chapter 4, the student questionnaire data reported in Chapter 5, the case studies reported in Chapter 6, and data from the second student questionnaire reported in Chapter 7. The five themes are:

Theme one: *instructors' beliefs*, examines physics instructors' beliefs about the nature of physics; the purposes of studying physics; effective strategies for teaching and learning; factors limiting the quality of physics teaching; and, how physics teaching and learning can be improved.

Theme two: *students' beliefs, goals and motivations*, examines the beliefs of students about the nature of physics, goals and motivations for studying physics, and learning strategies in physics.

Theme three: *instructors' approaches to teaching*, considers instructors' actual teaching strategies and the extent to which they are influenced by the instructors' beliefs.

Theme four: *students' approaches to learning*, considers students' actual study strategies and the extent to which they are influenced by the students' beliefs, goals and motivation.

Theme five: *classroom environment*, *opportunities for learning and students' attitudes*; considers the combination of factors that influence classroom environment, opportunities for learning, and students' attitudes towards physics.

Theme One: Instructors' Beliefs

Beliefs are the mental constructs of each individual (Schoenfeld, 1997) that influence their decision making (Bandura, 1986). Teachers' beliefs about teaching, learning, the nature of a subject and the purposes of education are significant factors influencing the teachers' attitudes to classroom practice (Gunstone & White, 1998). It would therefore be expected that the teaching of physics instructors in Thai Rajabhats is shaped by their beliefs about the nature of physics knowledge, and physics teaching and learning.

This theme comprises three sections. The first section: instructors' beliefs about what students should learn about physics; considers instructors' beliefs about the learning outcomes that should arise from physics instruction. The second section: instructors' beliefs about teaching physics; considers instructors' views about actual and ideal (or effective) teaching practices, factors that limit the quality and effectiveness of teaching, and how to improve physics teaching. The last section: instructors' beliefs about learning physics; identifies the instructors' beliefs about effective learning strategies, factors that limit physics learning, students' motivations and assessment in physics.

Instructors' Beliefs about what Students should Learn about Physics

Instructors' responses to the questionnaire indicate that they believe that students should learn the factual knowledge of physics (Assertion 4.2). The instructors expected that students should understand and be able to apply physics rather than simply memorise the facts of the subject (Tables 4.4, 4.5). These beliefs were confirmed again by responses from the first interview with some physics instructors (Assertion 6.1) in the case studies.

Instructors believe that physics is a collection of intact knowledge in terms of facts, laws and principles. These beliefs are congruent with the argument of Carr, Barker, Bell, Biddulph, Jone, Kirkwood, Pearson and Symington (1994) that many science teachers view science knowledge as the truths discovered by scientists which are unproblematic and the right answers. Gunstone and White (1998) commented that most physics (and science) teachers develop beliefs about the nature of science through their experiences in learning the subject. Beliefs about the nature of physics knowledge held by most physics teachers in tertiary institutions are in the form of general statements to explain natural phenomena (Gunstone & White, 1998).

General Assertion 8.1

Physics instructors in Thai Rajabhats believe that students should understand and be able to apply factual knowledge of physics.

Instructors' Beliefs about Teaching Physics

Keys (2003) classifies teachers' beliefs into three types, which are, expressed, entrenched and manifested beliefs. Expressed beliefs are the set of ideal beliefs that teachers verbally express, however, they are rarely enacted in practice (Keys, 2003) such as a physics teacher who said that he strongly believed in interactive activities but he actually spent more than 90% of class time in explaining to the class (Black, 1989). Keys (2003) categorises expressed beliefs in several forms including platonic and organisational beliefs. The platonic beliefs are the expressed beliefs that teachers are unwilling to do extra work to modify their practice so that they are enacted, while they are normally willing to support the organisational beliefs promoted by their school or university. Entrenched and manifested beliefs are the set of beliefs that determine actual practice (Keys, 2003). Keys (2003) explains that when expressed beliefs become entrenched beliefs there will be changes in practice, particularly when they are involved in a professional learning program as demonstrated by Sheffield (2004). Otherwise, most teachers tend to teach in the same manner that they were taught (Barros & Elia, 1998).

Physics instructors in Thai Rajabhats reported that they actually spend a large proportion of teaching time in explaining physics content. They professed that they would like to decrease the amount of class time devoted to explanation and increase the time for some other student-centered strategies (Table 4.6; Assertion 4.3) which would represent organisational expressed beliefs (Keys, 2003).

The instructors' responses about effective teaching strategies indicated that they hold ambivalent beliefs about teacher-centered and student-centered strategies (Tables 4.7, 4.8, 4.9; Assertions 4.4, 4.6). The instructors who participated in the case studies accepted that both lecture and laboratory are effective strategies for teaching physics but they spent more class time on lecturing (Assertion 6.2). These results suggest that instructors hold entrenched beliefs of teacher-centered and transmitting knowledge strategies while they hold expressed platonic beliefs of student-centered and constructing knowledge strategies. Instructors spent most of the time in lectures explaining and giving notes. Instructors asked students few questions and so lectures were not very interactive (Assertion 6.17).

The instructors indicated that students' poor background knowledge and negative attitudes towards physics, and the lack of equipment and administrative support are the main factors limiting the quality and effectiveness in their teaching (Table 4.10; Assertion 4.5). They suggested that physics teaching in Rajabhat universities could be improved by providing more resources, and by improving the curriculum and teaching strategies through professional development for instructors (Table 4.17; Assertions 4.11, 6.7).

General Assertion 8.2

Physics instructors in Thai Rajabhat universities hold both entrenched beliefs of didactic and knowledge transmission teaching strategies and expressed platonic beliefs of student-centered, constructivist teaching strategies. They believe that the main limitations to the quality and effectiveness of their teaching are the factors associated with students and administration rather than their own teaching strategies.

Instructors' Beliefs about Learning Physics

Most responses from the instructors' questionnaire indicate that they believe active learning or student-centered approaches such as hands-on activities, problem solving and inquiry strategies to be the most effective strategies for learning physics (Table 4.11; Assertion 4.7). The instructors from the case studies gave various opinions about effective learning strategies, the most common opinions being that students should be attentive in classes, and do experiments and exercises (Assertion 6.3) while there is also strong support for student-centered strategies (Arun, First Interview; 13/12/2002) and laboratory approaches (Ampa, First Interview; 25/12/2002, Second Interview; 24/02/2003).

There is an ambivalence of beliefs about active and passive learning. The beliefs about active learning or student-centered strategies would be expressed platonic and organisational beliefs, and the beliefs about passive learning strategies would be entrenched beliefs as their teaching and learning practices relied on the instructors' explanation and students' listening. Seemingly, the instructors wish their students to employ deep approaches to learning (Biggs, 1999) whereas the instructors' pedagogy is focused on knowledge transmission which encourages surface learning.

There was a variety of opinion about the motivations for students to study physics. The most frequent responses included the intellectual challenge of the subject, good teaching, enhanced employment prospects, and application to real situations (Table 4.12; Assertion 4.8). Since motivational orientation is an important factor in determining students' success (Dev, 1997), the limited success of students in studying physics, therefore, suggests that there may be low motivation for students in studying physics. This is addressed in Theme Two. Many instructors were not satisfied with their students' learning; for example, Anek (Second interview; 3/03/2003), Arun (Second interview; 28/02/2003), and Aree (Second interview; 28/02/2003). Most of the instructors indicated that the poor background knowledge of students, especially in mathematics; rather than the approaches to learning, was the major limitation to success in studying physics (Table 4.13, 4.14; Assertions 4.9, 6.4, 6.5). It should be noted that this is the same factor that instructors cite as limiting their success in teaching.

More than a half of respondents to the instructor questionnaire reported that the important aim of assessment in physics is to measure students' success in understanding and applying physics knowledge (Table 4.15; Assertion 4.10), which revealed that they focused on summative rather than formative assessment. The methods of assessment most commonly used were pencil-and-paper tests and reports of practical work (Table 4.16; Assertion 4.10). The assessment is therefore, not focused on improving teaching and learning (Black & Wiliam, 1998).

General Assertion 8.3

The instructors espoused the belief that the most effective learning strategies in physics are active learning or student-centered strategies.

General Assertion 8.4

The instructors believe that motivations for studying physics are the intellectual challenge of the subject, good teaching, enhanced employment prospects and application to real situations; but these may not be motivational factors for students.

General Assertion 8.5

The instructors believe that the main purpose of assessment is to measure students' understanding and success in applying physics knowledge rather than to improve teaching or learning processes.

Theme Two: Student Beliefs, Goals and Motivations

Goals are the performance standards that people expect to be attained (Vandewalle, 1997). A dichotomy in goal orientation that can be used to explain the behaviours of students in learning, is performance versus learning goal orientations (Dweck & Elliot, 1983). Performance goal orientation is associated with the view that ability is a fixed and uncontrollable characteristic, which is difficult to develop (Vandewalle, 1997). On the other hand, students with a learning goal orientation, view ability as a variable and controllable characteristic of each individual, which can be developed through effort and experiences (Vandewalle, 1997).

Motivation is a process within each individual that energizes and directs a person to act and tend to perform an action (Ferguson, 2000). It could be generated from past events or the future goals of each individual (Ferguson, 2000). Motivational orientation is an important factor influencing students' success in learning (Dev, 1997).

The investigation of students' goals and motivations for learning, and their beliefs about teaching and learning provide data that can inform improvements to the teaching and learning of physics. This theme is developed in three sections. The first section: Students' goals and motivations; considers many aspects of students' opinions about their goals, motivations, and attribution of success in studying physics. The second section: Students' beliefs about teaching physics; considers the students' perspectives about teaching physics both from their experiences and their anticipation of future physics teaching. The last section: Students' beliefs about learning physics; examines the students' epistemological beliefs, beliefs about learning strategies and learning orientation.

Students' Goals and Motivations

The instructors believed that the motivations for students to study physics are the intellectual challenge of the subject, good teaching and learning success, and enhanced employment prospects (Table 4.12; Assertion 4.8). Most students who completed the first student questionnaire wanted to study physics because they recognised that physics is important in real life, technology development and their career (Tables 5.2.1, 5.2.2). They were motivated to study physics successfully because they wanted to please other people and not to be a poor student in the class (Tables 5.4, 5.5; Assertion 5.1) rather than their own interest in the subject (Assertion 6.13). The important goals of these students in studying physics are to understand and be able to apply physics knowledge, and to pass the examination (Tables 5.3, 5.6; Assertions 6.13, 6.15). They confidentially believed that people can learn, be successful, and get good grades in physics by effort and hard working (Tables 5.12.1, 5.12.2, 5.13.1, 5.13.2, 5.14.1, 5.14.2, 5.15, 7.2; Assertions 5.5, 6.14). Physics, however, is not a favorite or attractive subject for students to study (Tables 7.4, 7.5.1, 7.5.2; Assertions 7.5. 7.6).

The results described above indicate that most students hold a strong learning goal orientation (Vandewalle, 1997) and their motivations to study physics were mainly extrinsic (Woolfolk, 2001).

An important finding is that less students wished to study physics after completing an introductory physics course (Assertion 7.6). Some students in the case studies explained how their instructors' teaching reduced their motivation for studying physics (Nataya, Naree, Nisa; Second Interviews; 24/02/2003). These students explained that the instructors should be friendly, listen to students' opinions, and not discourage students. These arguments are consistent with the suggestions that teachers should respond positively to students' questions, praise them occasionally and stimulate with appropriate activities (Dev, 1997).

Pintrich and Schrauben (1992) described three general components of students' motivational beliefs which are expectancy, value, and affect; that are very important for student engagement in learning. Expectancy components are the considerations of ability to perform a task and the expectation to control success on the task. Value components include the goals for engaging a task and the beliefs about the importance and interest of a task, whereas affective components consist of students' emotional reactions (such as pride or shame) and emotional needs (self-esteem or self–worth) that arise from the involvement with a task rather than the anticipation (Pintrich & Schrauben, 1992).

Expectancy components include self-efficacy beliefs and control beliefs. Self-efficacy beliefs are individuals' beliefs about their abilities to accomplish a certain task (Bandura, 1982). Control beliefs are beliefs about ability to control the environment that may influence their performance and outcomes of their work on a task (Schunk, 1985). Three aspects of control beliefs are internal sources, external sources (or powerful others; such as parents, teachers, etc.), and unknown sources (Connell, 1985). Students with internal source beliefs tend to perform better than those who hold external source control beliefs (Pintrich & Schrauben, 1992).

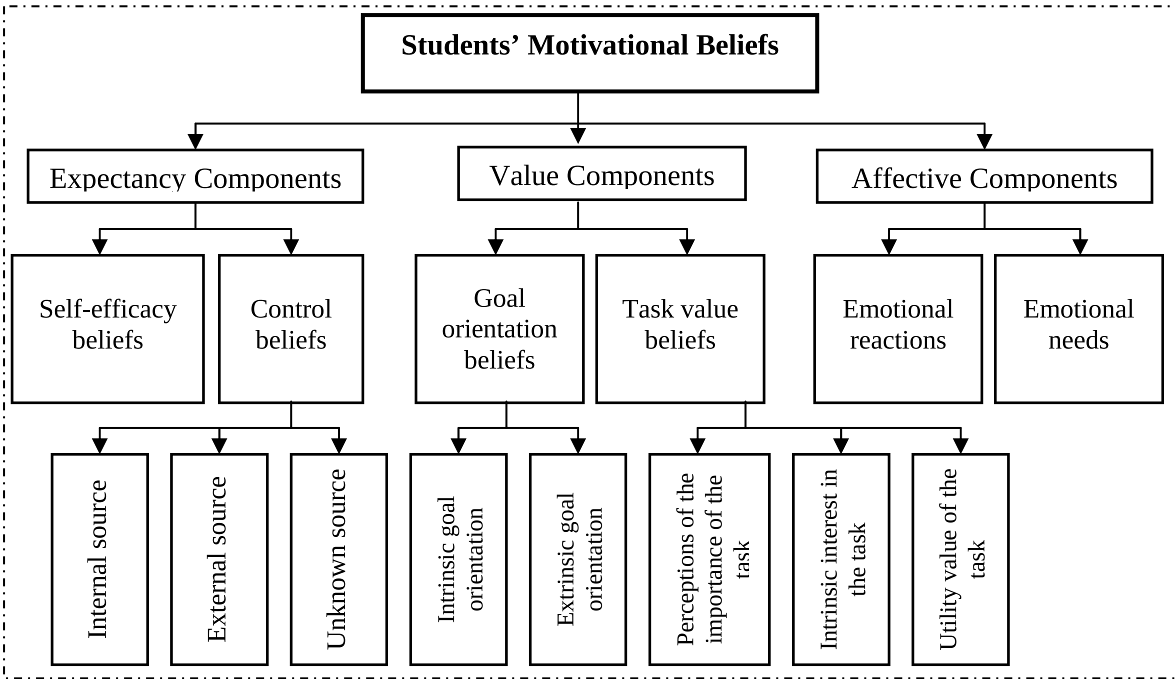


Figure 8.1. Students' motivational beliefs

Value components are concerned with the beliefs about students' reasons for doing a particular task. These components consist of goal orientation beliefs and task value beliefs. Students' goal orientation may be intrinsic (e.g., mastery, challenge, learning, and curiosity) or extrinsic (e.g. grades, rewards, and praise from others) and this will influence their performances (Pintrich & Schrauben, 1992). Task value beliefs are about the importance and interest of a task, which may influence the strength and intensity of students' performances on the task. There are three components of task value beliefs; the perceptions of the importance of the task, the intrinsic interest in the task, and the utility value of the task for future goals (Eccles, 1983).

The motivational beliefs of Rajabhat students in studying physics can be summarised using the taxonomy outlined in Figure 8.1. Since students wished to understand physics and were concerned about passing examinations (Tables 5.3 and 5.6; Assertions 5.1 and 6.13), this indicates that they hold both beliefs of intrinsic goal orientation for understanding physics and extrinsic beliefs for passing the examinations or getting good grades. Although they recognized the importance of physics, the students are not interested in studying physics (Assertions 5.1, 6.13), which may reflect that they hold both the expressed and entrenched beliefs of task value components (Keys, 2003). The beliefs in effort and hard working for success in physics (Assertions 5.5, 6.14) are indicators of the students' expectancy components of both self-efficacy and control beliefs.

General Assertion 8.6

Students have low motivation for studying physics and hold various types of motivational beliefs. They hold the beliefs of extrinsic goal orientation to get good grades or to pass examinations, and internal source of control beliefs to be successful through their effort and hard work. Even though the students believe that physics is important to our lives, many do not want to study physics.

Students' Beliefs about Physics Teaching

Many students had uninteresting and boring experiences of physics at secondary school (Nataya, Naree, Nisa; First Interviews, 12/12/2002; Assertion 6.9) where teaching was based on explanation through the texts, giving notes and exercises and working through examples of physics calculations (Ranee, Banyen, Bulan; First Interview, 11/12/2002, Thida, Tiwa, Thani, Tewi; First Intervew, 23/12/2002; Assertion 6.9). Although they believed that both teacher-centered and student-centered strategies are effective for teaching physics (Tables 5.7, 5.8; Assertion 5.2), there were more students who believed that the most effective strategy is clear explanation (Tables 5.7, 5.8, 7.9; Assertion 6.10, 7.8) rather than other strategies.

These students' perspectives indicate support for teaching strategies of traditional pedagogy, in which teachers play a dominant role in transmitting knowledge relying on articulation and explanation of the content while students act as passive absorbers. An important finding in physics education research is that traditional instruction is not the most effective for achieving educational goals (McNiel, 2005). This didactic pedagogy may be effective for only a small number from the vast majority of students who enrolled in introductory physics courses in colleges or universities (McNiel, 2005). Lee and Bao (2001) studied students' opinions about learning and teaching physics and found that both graduate and undergraduate students hold beliefs about effective teaching that are close to traditional pedagogy plus some extra student-centered strategies. Their findings (Lee & Bao, 2001) are consistent with the results described above. Trigwell, Prosser and Taylor (1994) arranged teaching strategies into five categories along a continuum from teacher-focused strategy that aims to transmit knowledge, to student-focused with the intention of changing students' concepts. The data from this study suggest that students' expected teaching approaches should be at about the middle of this continuum, which is the student-teacher interaction strategy, that students believe will help them to acquire the concepts of physics, however, actual physics lectures were not very interactive (Assertions 6.17 and 6.18).

General Assertion 8.7

Students believe that current physics teaching is not interesting with the traditional pedagogy of transmitting knowledge. They suggested that teaching should emphasise giving clear explanations and also include some other student-centered strategies that are enjoyable and attractive.

Students' Beliefs about Learning Physics

Most students accepted that although physics is difficult and complicated, it is very useful and should be taught to students (Table 7.2; Assertions 5.1, 5.6, 6.8, 7.1). They believe that being attentive to the classes is an effective learning strategy in physics (Tables 5.9, 7.8; Assertion 6.12). The students were passive learners but they expected to understand lessons and get good grades in physics (Table 5.10; Assertion 5.3). They indicated that mathematics and complicated topics in physics are the significant factors that make physics difficult to learn (Tables 5.16, 5.17; Assertion 5.6), however, good teaching could help them understand physics (Tables 5.18). The students also agreed that doing experiments and solving problems could help them to learn physics (Assertion 7.3).

The consideration about the combination of students' learning motivation and learning strategies implies that the students tend to employ surface approaches to learning (Biggs, 1987; Entwistle, 1981; Ramsden, Beswick & Bowden, 1989), which seem to be the surface passive rather than active approaches of learning (Entwistle, 1981). Obviously, these learning strategies rely on rehearsal or reproduction of knowledge telling by the instructors (Lonka & Lindblom-Ylanne, 1996). With these strategies, students are passive learners who consider knowledge to be discrete facts and information that they need to memorise (Hammer, 1994).

General Assertion 8.8

Students believe that physics is a difficult and complicated subject. They explained that they want to understand physics; however, they prefer to employ passive and surface approaches to learning to meet their goals.

Theme Three: Instructors' Approaches to Teaching

Instructors may employ different styles of teaching depending on their beliefs, and other factors and conditions. Beliefs and attitudes of each individual have been developed slowly through their experiences. A significant concern among physics educators is that most physics teachers experienced transmission pedagogy when they were school children and they form their beliefs from these experiences which influences their own teaching strategies so that they teach physics in the same manner (Barros & Elia, 1998; Carvalho & White, 1998). The majority of students would not achieve the goals of learning by this didactic pedagogy (McNiel, 2005).

Although some instructors hold modern beliefs about teaching and learning consistent with constructivist theory, these beliefs may be expressed beliefs and rarely enacted in their teaching (Keys, 2003). It is therefore important to examine actual teaching practice and compare it with teachers' beliefs.

The data about actual teaching practice in physics of Thai Rajabhat instructors were collected from a questionnaire, interviews with some participant instructors and the classroom observations. The assertions developed from these data provide a picture of instructors' approaches to teaching physics in Rajabhats.

This theme is developed in two sections. Section one: teaching practice; considers the actual teaching practices of the instructors, the roles of instructors and students in classrooms. Section two: the influence of beliefs on teaching practice; considers how the instructors' beliefs about teaching and learning influence their practice.

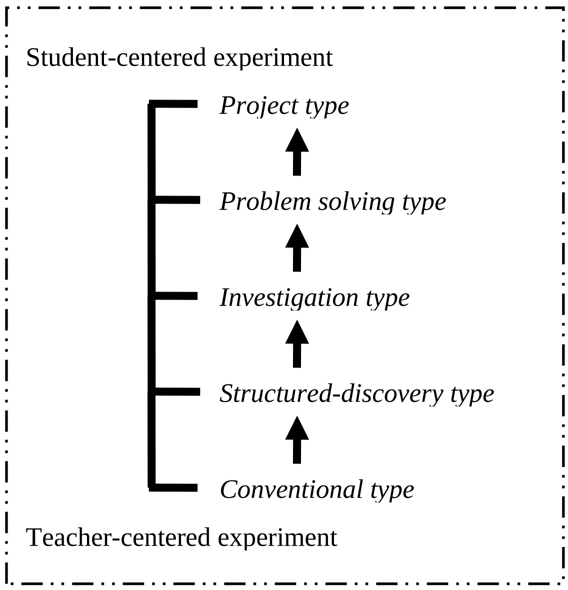
Teaching Practice

Instructors reported that they spent the largest proportion of their physics teaching time in explaining physics, whereas they allowed students to work as individuals or in small group about one quarter of class time (Table 4.6; Assertion 4.3). Although they believe that being facilitators of learning is an important role for effective teaching and learning (Assertion 4.4) and laboratory approaches could improve their physics teaching (Assertion 6.6, 6.7), they need to mainly employ knowledge transmitting strategies because there are many limitations constraining their practice (Assertion 6.5).

Classroom observations revealed that about 70 – 80% of the lecture class time was consumed by instructors explaining and giving notes rather than other activities (Assertion 6.17). On the other hand, in the laboratory session they spent 10 – 25% of class time for introducing the experiments and 20% of the time discussing experimental procedures, data analysis and writing-up with groups of students (Assertion 6.19). These data (Table 4.6) indicate that knowledge transmission strategies dominate teaching.

In the past, it was recognized that the lack of laboratory equipment and laboratories were a significant constraints on the quality of science teaching in most schools in Thailand. The Office of Rajabhat Institute Council (ORIC) of the Ministry of Educations, in 1997, then embarked on the Secondary Education Quality Improvement (SEQI) project in 30 Rajabhats around the country by establishing Science Centers and provided more laboratory equipment and facilities, including professional development for science instructors by short courses training both in-country and overseas.

Laboratory approaches have been introduced to Rajabhat physics instructors since that time. Reform of laboratory teaching requires the transformation from teacher-centered experiments to student-centered experiments; or from conventional to structured-discovery, investigation, problem solving and to project types of practical work (Mathew & Earnest, 2004).



(Mathew & Earnest, 2004)

Figure 8.2. Steps of laboratory development

Many instructors believed that this strategy of more student-centered experiments is effective for physics teaching but their understanding and practices and pedagogical content knowledge may be limited to implementing the conventional experiments with which they are familiar. In some of the case studies (e.g. Aree) laboratory lessons were used only to verify the theory from the lecture, which is at the lowest level of the teacher-centered, conventional type (Mathew & Earnest, 2004). Students completed structured laboratory exercises by passively following prescribed procedures (Assertion 6.19) They may not understand the new laboratory approaches, otherwise they may just hold expressed beliefs (Keys, 2003) about more inquiry-oriented laboratory teaching as they continue to teach in traditional ways.

General Assertion 8.9

Instructors spend a large proportion of class time explaining in lessons and giving notes to transmit knowledge and in order to get through the content. Laboratory sessions are used to verify theories rather than for investigation or construction of knowledge through inquiry.

Furthermore, because there is a lack of physics equipment laboratory work is usually organised on a rotational basis. For example, there is one set of equipment for each experiment and groups rotate through the set of experiments. This makes it very difficult to integrate theory and laboratory work in teaching practice.

The Influences of Beliefs on Practice

The first theme of this Chapter considered instructors' beliefs about teaching and learning. Each of these beliefs may influence instructors' teaching. This section considers the extent to which these beliefs appear to have affected the instructors' teaching practice.

Instructors' beliefs about the purposes of teaching physics can be classified into two parts. The first part is the belief that students should understand physics, and the second part is the belief that students should be able to apply physics knowledge (General Assertion 8.1). The first belief is clearly evident in the instructors' teaching practice, which is strongly revealed by the responses of most instructors to the questionnaire (Assertion 4.3), interviews (Anek, First Interview; 9/12/2002, Second Interview; 3/03/2003: Arun, First Interview; 13/12/2002), and classroom observations (Assertion 6.18) which show that instructors spend the largest proportion of class time in explaining lessons or 'teaching by telling' (McDermott, 1993). These strategies, however, are unlikely to develop meaningful understanding. For the second belief, it seems that the instructors hope their students will be able to solve physics problems and use physics to explain phenomena in real-world contexts; however, they only give students routine exercises rather than other strategies to promote students' application and problem solving skills.

The instructors expressed beliefs that both knowledge transmission and constructivist strategies are effective and important in teaching physics (General Assertion 8.2). The strategies of giving explanations and notes are knowledge transmission rather than constructivist strategies. Routine laboratory exercises are used to review or verify lectured content (Assertion 6.19) rather than developing investigation and problem solving skills, and providing opportunities to construct deeper understandings of concepts from experiences and scientific data. These strategies confirm the instructors' entrenched beliefs in the traditional 'transmissionist' teaching mode (McNiel, 2005).

The instructors strongly expressed beliefs that active learning or student-centered learning is the most effective learning strategy (General Assertion 8.3). There is very little evidence to indicate that the instructors employ suitable teaching strategies to support active or student-centered learning. This may represent expressed beliefs which the instructors are not willing to implement in their teaching (Keys, 2003). Some instructors may believe that their students should engage in active learning without any explicit instruction to support this (Redish, 2000).

Instructors believe that the motivations for studying physics are the intellectual challenge of the subject, good teaching, enhanced employment prospects and application to real situations (General Assertion 8.4). The belief about intellectual challenge would require students to apply understandings to solve novel problems, however, this does not appear to have influenced their teaching as instructors give a lot of explanations and routine exercises. The instructors may view good teaching as the transmission of knowledge by explaining lessons clearly for students' understanding. The belief about enhancing employment prospects would not be expected to influence their teaching strategies. The need for physics to be relevant and linked to real situations may motivate instructors to relate lecture topics to everyday experiences; however, most instructors were worried about covering the large amount of subject matter so they focused on explaining the important details of each topic within the limited class time.

In summary, the instructors' beliefs that appear to have most influenced their teaching practice are the entrenched beliefs that are associated with traditional pedagogy. Instructors may believe that transmission of knowledge is effective because it worked for them when they were students (McNiel, 2005). Many instructors who hold beliefs about transmitting knowledge employ traditional lecture methods even though it is an ineffective strategy regardless of how much experience they have of teaching (McDermott, 1993). The apparent relationship between instructors' beliefs and their teaching practice, as revealed by the data from this study, is summarised in Figure 8.3.

Category of beliefs		Teaching strategies
Types	*Beliefs*	
Expressed	Constructing knowledge Active learning	- -
Entrenched	Transmitting knowledge Learn for understanding Learn for application Intellectual challenge	Explanation Routine laboratory exercises Routine calculation and problems Cover large amounts of content

Figure 8.3. Relationships between beliefs and teaching practice

General Assertion 8.10

The instructors hold entrenched beliefs that students should understand and be able to apply physics, transmitting knowledge is an effective teaching strategy, and intellectual challenge and usefulness of the subject are motivations for studying physics. These beliefs are the ones that influence their teaching practice. The beliefs about active learning and constructivist teaching strategy are organisational expressed beliefs which appear to have very little influence on their practice.

Theme Four: Students' Approaches to Learning

Students bring some beliefs about learning and conceptual understandings of physics they developed from learning physics at secondary school. These beliefs and concepts influence their learning at the Rajabhat (Osborne & Wittrock, 1983), not only in terms of new concepts they will learn but also their approaches to learning.

This theme is devoted to the influences of students' beliefs on their approaches to learning. This theme is developed in two sections. The first section: study practices; deals with actual study strategies students employed in the introductory physics classes. The second section: the influence of beliefs on study practice; examines the extent to which students' beliefs about teaching and learning appear to influence their study practice. Both sections consider the data and assertions compiled from student questionnaires, interviews and classroom observations.

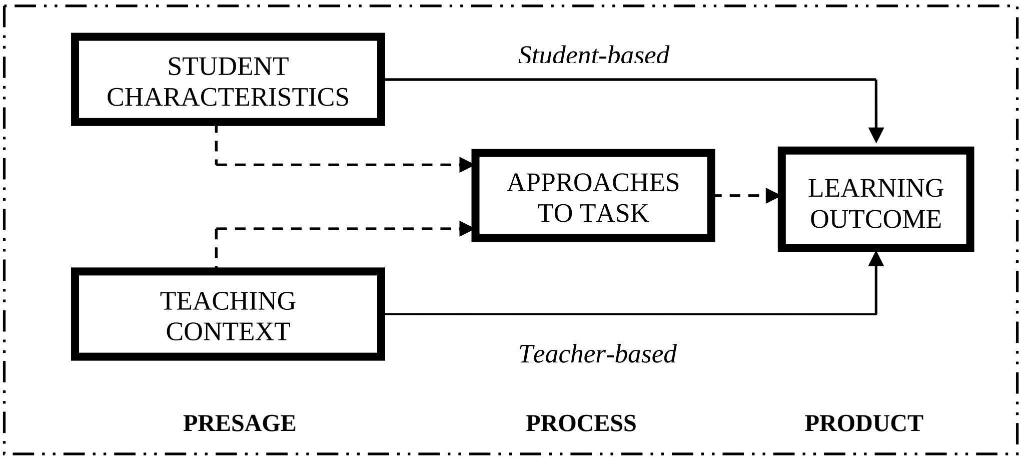
Study Practices

The responses to the first student questionnaire indicate that students spend most of their class time in listening to lectures and taking notes (Table 5.11; Assertion 5.4) and these data are consistent with the study strategies reported in the case studies (Assertion 6.11). These study strategies were clearly evident in the classroom observations (Assertion 6.18). Other strategies that students reported in the questionnaire; which are asking questions or discussing topics with friends, reading texts, doing exercises and homework (Table 5.11) were also mentioned by most students involved in the case studies (Assertion 6.11).

Redish (1996) explains that in a class based on traditional pedagogy, students are likely to be passive learners who receive factual knowledge transmitted by the teacher and reproduce similar information in examinations. Teachers should examine and analyse what students think and how they learn rather than concentrating on transmission of information and assessing memorised information (Redish, 1996). Students easily learn new concepts that are similar to their existing concepts, but, it is very difficult for them if they hold misconceptions from previous experiences (Posner et al., 1982). The strategies of reading and listening to lectures used by most students in a traditional class are not sufficient to study physics effectively and is unlikely to bring about accommodation of their misconceptions (Redish, 1996).

Biggs (1994b) explained that there are two families of student learning theories, teacher-based and student-based theories. The group of teacher-based learning theories focus on teachers and development of teaching skills. This group of theories might be called blames-the-teacher model because failures in education are blamed on the ineffectiveness of teaching (Biggs, 1994b). For example, the failure of traditional pedagogy has been reported in the field of physics education over the past few decades (McDermott, 1993; McNiel, 2005), and physics instruction needs to change to reflect a constructivist view of learning (Redish, 1996).

On the other hand, the group of student-based learning theories which come from cognitive psychology, indicate that learning outcomes are influenced by many student characteristics (Biggs, 1994b). These theories explain that failure in education may be the result of the inadequacy of student characteristics, such as low ability, ineffective learning style, poor background knowledge, lack of motivation, in addition to teaching and contextual factors (Biggs, 1994b).



(Biggs, 1994b)

Figure 8.4. Student-based and teacher-based learning theories

These two families of learning theories help to explain factors influencing learning outcomes. The quality of teaching influences the quality of the learning environment and opportunities for learning (Case & Gunstone, 2003). Student characteristics determine the extent to which learning opportunities are transformed into learning outcomes.

Each individual learns how to learn through long-term experience (Jacobson, 1998) of studying and students bring these learned study strategies to the classroom in the same way as they bring other existing science concepts and beliefs (Posner et al., 1982). Many case study students (Chapter 6) reported that they learned physics at high school by listening and making notes and by doing routine exercises. Although most physics students in this study were passive learners who listen and take notes quietly in the classroom (Assertion 6.18), some of them reported that they prefer to be more actively engaged in learning by asking questions and discussing ideas with friends or the instructor.

General Assertion 8.11

Most students were passive learners who spent more class time listening to lectures and taking notes in lecture sessions, and doing experiments following the given manuals in laboratory sessions. These learning strategies may have been learned from experiences of studying physics at high school. Some students may employ active strategies of learning such as practicing exercises by themselves, asking instructors questions or discussing ideas with friends.

The Influences of Beliefs on Study Practice

Students accept that physics should be taught because it is very important to people's lives and the development of technology (Assertions 5.1, 6.8, 7.1). They want to understand physics (Assertions 5.1, 5.3, 6.15, 7.1), however, this subject is complicated and difficult to learn because of the mathematics and abstract content (Assertions 5.6, 6.8, 7.1). Although they believe that both teacher-centered and student-centered strategies are important for effective teaching (Assertion 5.2), more students prefer the instructors to provide clear explanation and enjoyable instruction rather than other strategies (Tables 5.7, 5.8, 7.9; Assertions 5.2, 7.8). From their experiences of actual physics teaching, students conclude that physics is not interesting because there is too much explanation and notes (Assertion 6.9), and the subject is less enjoyable than other subjects (Assertion 7.5). Therefore, they want the instructors to improve teaching strategies that would help them learn physics (Assertion 7.8).

Most students believe that hard work could help them to be successful in physics (Assertions 6.14, 7.2), and doing experiments and solving physics problems help them learn (Assertion 7.3), and they like to do laboratory work (Assertion 7.7). They believe that being attentive to the class is an effective study strategy (Assertion 6.12). In physics classes most students are passive learners (Assertion 6.18). They reported that they spend most class time listening and taking notes in lectures (Assertions 5.4, 6.11, 6.17). Classroom observations show that students spent about 70 – 80% of class time listening and copying notes in lecture sessions (Assertion 6.17). Being attentive to the class is therefore, listening to the lecture carefully and copying notes quietly. In laboratory classes students complete routine laboratory exercises by following the procedure specified in the laboratory manual (Assertion 6.19).

Most students believe the blames-the-teacher theories of learning (Biggs, 1994a) and they are moderately passive students. They believe that success in physics depends on the instruction and their roles in studying are to follow the activities given by instructors. The belief that physics is difficult plunges them into a worse situation where they tend to be more passive.

Since physics instructors employ traditional approaches to teaching (Conway, 1997), most students have misconceptions about both the nature of physics and how best to study the subject. Students prefer to memorise facts and formulas so they can reproduce them in examinations rather than to gain higher learning skills such as analysis, synthesis or evaluation. Even in the case of problem solving, they tend to memorise the pattern of finding answers by selecting correct equations and substituting the appropriate numbers (Freedman, 1996). Furthermore, laboratory work is usually viewed as a process for verifying equations or concepts rather than another aspect of problem solving. Every instructor would have heard the complaint from students that they understand physics concepts but cannot solve the exam problems which are usually different from the examples or exercises they were given during the course (Freedman, 1996). They lack the deep understandings needed to transfer their learning to new contexts and tasks.

Some students reported, at the second interview, that they were successful in learning physics because of the support they received from working in a group (Thida, Thani, Tewi and Tanya; 24/02/2003). This is different from their intention in the first interview (23/12/02) that they focused on being attentive to the classes. This would indicate that they are learning how to learn with the assistance of their peers (Conway, 1997) and began to change from being passive to more active learners.

General Assertion 8.12

Two entrenched beliefs held by students, that influenced their actual study practice, are being attentive to the classes and hard work will help them to be successful in physics. As a consequence of these beliefs, students were passive learners and employed the strategies of listening to lectures and taking notes. Although they believe that physics is important and being an active learner is an effective approach for learning, these are expressed beliefs that have less influence on their actual study practice than their entrenched beliefs.

Theme Five: Classroom Environment, Opportunities for Learning and Students' Attitudes

Classroom environment and opportunities for learning are important factors that influence the quality of teaching and learning and students' attitudes towards the subject. This theme discusses classroom environment and opportunities for learning in Thai Rajabhat universities, and the Rajabhat students' attitudes towards physics. The discussion is divided into three sections. The first section: classroom environment; considers some aspects of the physical environment of physics classes of Rajabhat universities. The second section: opportunities for learning; deals with factors that support students to learn physics effectively. The third section: students' attitudes towards physics; considers students' opinions about the subject.

Classroom Environment

Most Rajabhat universities in Thailand have similar buildings, and in particular the Science Center buildings. They also have the same physics equipment and laboratories, programs of study, class sizes and syllabi. Classroom arrangements for lectures and laboratory classes are therefore very similar in the Rajabhats.

There are normally about 35 – 45 students and sufficient audio-visual facilities in a lecture class (Assertion 6.16) but rarely enough demonstration equipment for introductory physics courses at Rajabhat universities. A typical structure of a lecture class consists of a table for demonstration and audio-visual equipment set in front of the class with rows of student desks facing the instructor as shown in Figure 8.5.

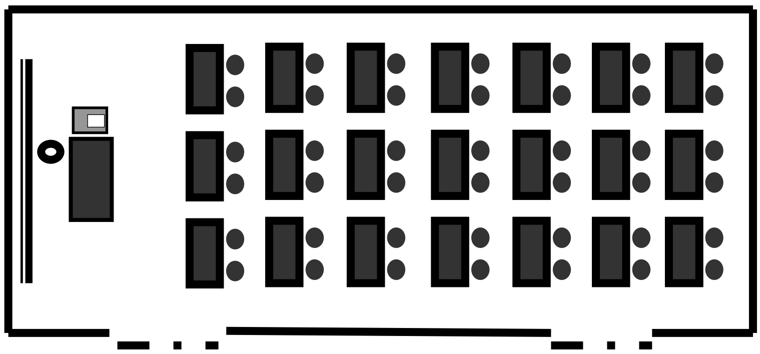


Figure 8.5. Typical structure of lecture classroom

In a typical laboratory class, students work in small groups of three to five students (Assertion 6.16). The classroom setting is illustrated in Figure 8.6.

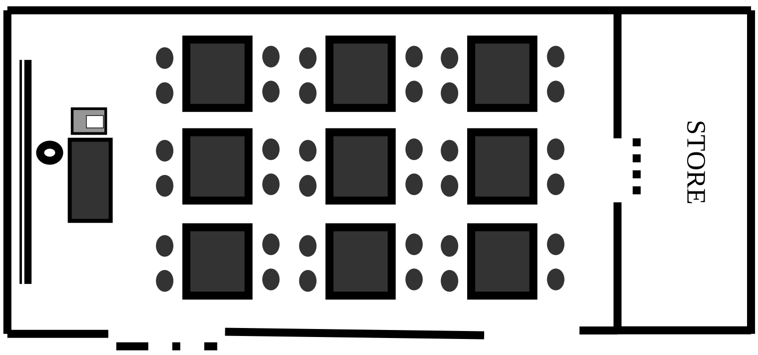


Figure 8.6. Typical structure of laboratory classroom

Classroom environment is an important factor for both cognitive and affective learning outcomes of students (Fraser & Fisher, 1982; Haertel, Walberg, & Haertel, 1981; Wong & Fraser, 1994). Research in some developed countries found that students and teachers preferred a better classroom environment than that they perceived in their actual situation, and teachers are likely to perceive classroom environment more positively than those of their students (Fraser, 1982, 1998; Moos, 1979; Wubbels, Brekelmans, & Hooymayers, 1991).

Classroom environment can be assessed in terms of physical and psychosocial components (Gilbert, Dunn, Mellard, & Lancaster, n.d.). Physical environment of a classroom includes many aspects such as lighting, visual environment, seating, shape and size of the room, location of the instructor, acoustics and noises, temperature, doorways and others aspects. Psychosocial environment may involve students' interest, teacher support, fairness and clarity of rules and tasks in the classroom (Rivera & Ganaden, 2001).

This research considers the physical classroom environment using classroom observations rather than any of the psychosocial classroom environment inventories because of the difficulties of translation and adaptation of English versions of those instruments (Rivera & Ganaden, 2001). In a typical lecture class, there are some aspects of classroom environment that would not support the active engagement of learners such as the seating arrangement, the instructor's actions and position in the room are usually the same all the time; there are few interactions between students and the instructor (Assertions 6.17 and 6.18) and consequently students at the back rows tend to lose their interest in the lessons.

The laboratory classes provide more opportunity for interaction and engagement because students are able to do more activities by themselves, are seated in groups that facilitate discussion, but the lack of equipment and the large size of some student groups limit opportunities for some students to be actively engaged. Computer based learning such as physics simulations and data loggers are not currently available in most Rajabhats. The management of classroom environment either for lecture or laboratory classes, however, is at the discretion of the instructor. That is, if the instructors believe firmly in constructivist views they would arrange the classroom environment to support that approach to teaching, however, the classroom arrangement is in the conventional manner because the instructors hold entrenched beliefs about traditional pedagogy. Further studies about classroom environment in Thailand, particularly in terms of psychosocial aspects needed to support a constructivist approach should be conducted in the future.

General Assertion 8.13

Both lecture and laboratory classes are arranged in typical formats for traditional pedagogy and would not support student-centered constructivist approaches to teaching and learning. The management of classroom environment depends on the instructors' beliefs, and this influences the effectiveness and quality of teaching and learning.

Opportunities for Learning

Students come to a class with some preconceptions from their prior experiences. Research in physics education has currently revealed that some of these preconceptions are inconsistent with physics concepts, and are difficult to change by the processes of teaching and learning at universities (Osborne & Wittrock, 1983). Furthermore, because the instructors prefer to use routine quantitative problem solving tests as the means of assessment, students may be able to solve the problems even though they do not understand physics, but follow memorised calculation procedures (McNiel, 2005). The persistence of alternative conceptions may indicate that students do not learn physics effectively from traditional instruction and passive approaches to learning.

The main objectives of studying introductory physics in Rajabhat universities are to understand physics concepts, develop a foundation of knowledge for further study, and be able to apply physics to real life situations (Chapter 6). Most instructors wish to achieve these objectives by providing lectures and laboratory exercises. In lecture sessions, however, the instructors prefer to explain topics and concepts rather than use other activities that actively engage students in learning (Assertions 4.3, 6.17) thus it is difficult to meet the goals of learning. Some interactive lecturing strategies (Meltzer & Manivannan, 2002) should be introduced to the classes for the improvement of lecture, which can help students to engage more actively in the learning process. There do, however, appear to be some cultural barriers to implementing more interactive teaching and learning strategies, as neither instructors nor students asked many questions in lectures (Assertions 6.17 and 6.18).

For laboratory sessions, investigation should be promoted rather than using laboratory exercises for the verification of physics laws. The lack of expensive equipment is not a significant problem if the instructors are able to design suitable experiments that use the simple equipment that is available. The focus on routine laboratory exercises observed in the case studies (Assertion 6.19) limits students' opportunities for learning investigation skills and developing an understanding of the nature of science.

The lack of learning materials (Assertion 6.5) and the limited quality and availability of textbooks are other factors that limit opportunities for learning in Rajabhat universities. As a consequence of the rotation of student groups through laboratory exercises each week, the laboratory program and lecture program are not integrated. This limits opportunities for students to make connections between theory and experiments. These are important constraints on students' opportunities for learning.

The SEQI project, which has been described in the first section of Theme Three, was devised to promote science education by providing laboratory equipment and laboratories, and teaching development programs, which are the first steps to improve teaching and learning of science. At this stage, the most important factors for improving opportunities for learning appear to be the improvement of instructors' teaching practice.

This thesis has not studied deeply the opportunities for learning physics in Rajabhat universities, however, some evidence from classroom observations and document analysis (Assertions 6.16 and 6.20) indicate that there are fewer opportunities for active learning compared with passive learning. The preference for traditional pedagogy makes students more passive learners.

General Assertion 8.14

By using traditional pedagogy in introductory physics classes, there are few opportunities for learning in both lecture and laboratory sessions that support students to be active learners, to accommodate misconceptions towards scientific conceptions, to learn investigation skills or develop an understanding of the nature of science.

Students' Attitudes towards Physics

Students believe that physics is a difficult but useful subject (Assertions 6.8, 7.1). Many students (including some teachers) consider physics to be the most abstract, irrelevant and confusing subject (Franz, 1983). Students in this study perceive physics less favorably than other subjects (Assertion 7.5), which is corroborated by other research that indicated that physics is the least popular science course in schools (Jones, Jone, & Zander, 1998). These beliefs and opinions certainly influence to some extent the students' attitudes towards physics. Students are required to study physics, it is not an option, however, they prefer to study physics by hands-on activities (Assertion 7.7), and wish that instructors would improve teaching strategies to help them learn better (Assertion 7.8).

An interesting conclusion from the second student questionnaire is that the majority of the student cohort has neutral attitudes towards physics (Assertion 7.4) and almost half of them do not want to study any more physics. Previous research in physics education confirm that students perceive physics to be a subject that contains too many facts and laws, needs complicated mathematics to learn, and uses difficult textbooks to study (Ogunsola-Bandele, 1996). Most students avoid studying physics because of its reputation for difficult mathematical applications (Toews, 1988). The fact that fewer and fewer students enrol in physics or physics education is an indication of students' negative attitudes towards physics (Jones et al., 1998; Wenning, 2002).

Hewitt (1994) introduced the conceptual physics approach for introductory-level high school students by reducing the complicated mathematics in the physics textbook and including more examples from real world situations. He stressed that students need to understand the concepts qualitatively before mathematical or quantitative applications of the concepts. This study of using a conceptual physics approach indicates that students have more positive attitudes towards physics (Jones et al., 1998). This is an example of providing a better opportunity for learning. Learning opportunities and classroom environment are important factors that are likely to influence students' attitudes towards the subject.

Teaching and learning physics in Thai Rajabhat universities may not be in the poorest situation since most students have neutral attitudes towards this subject. Fortunately, most students in science education programs at the Rajabhats do not view physics negatively (Table 7.3, Assertion 7.4). If physics teaching strategies and other relevant factors were improved then students' attitudes towards physics may be more positive.

General Assertion 8.15

A majority of students in Thai Rajabhat universities have neutral attitudes towards physics and they wish the instructors would improve their teaching strategies. Students' attitudes are likely to be more positive if teaching processes, classroom environment and opportunities for learning were improved.

Chapter Summary

The instructors' beliefs, and students' beliefs, goals and motivations are significant factors that influence teaching and learning processes. An important aim of this thesis was therefore to investigate the beliefs held by instructors and students in Thai Rajabhats about teaching and learning physics, and students' goals and motivations for studying physics. Moreover, this thesis also examines classroom environment, opportunities for learning and students' attitudes towards physics. Findings from this research will be used to develop recommendations for the improvement of teaching and learning of physics in Rajabhat universities in Thailand.

Data were collected from questionnaires administered to physics instructors in 36 Thai Rajabhats and first year students from Rajabhat universities in the South of Thailand, and four case studies of instructors and students. General assertions were developed from the analysis of these data, and these are listed below;

8.1 Physics instructors in Thai Rajabhats believe that students should understand and be able to apply factual knowledge of physics.

8.2 Physics instructors in Thai Rajabhat universities hold both entrenched beliefs of didactic and knowledge transmission teaching strategies and expressed platonic beliefs of student-centered, constructivist teaching strategies. They believe that the main limitations to the quality and effectiveness of their teaching are the factors associated with students and administration rather than their own teaching strategies.

8.3 The instructors espoused the belief that the most effective learning strategies in physics are active learning or student-centered strategies.

8.4 The instructors believe that motivations for studying physics are the intellectual challenge of the subject, good teaching, enhanced employment prospects and application to real situations; but these may not be motivational factors for students.

8.5 The instructors believe that the main purpose of assessment is to measure students' understanding and success in applying physics knowledge rather than to improve teaching or learning processes.

8.6 Students have low motivation for studying physics and hold various types of motivational beliefs. They hold the beliefs of extrinsic goal orientation to get good grades or to pass examinations, and internal source of control beliefs to be successful through their effort and hard work. Even though the students believe that physics is important to our lives, many do not want to study physics.

8.7 Students believe that current physics teaching is not interesting with the traditional pedagogy of transmitting knowledge. They suggested that teaching should emphasise giving clear explanations and also include some other student-centered strategies that are enjoyable and attractive.

8.8 Students believe that physics is a difficult and complicated subject. They explained that they want to understand physics; however, they prefer to employ passive and surface approaches to learning to meet their goals.

8.9 Instructors spend a large proportion of class time explaining in lessons and giving notes to transmit knowledge and in order to get through the content. Laboratory sessions are used to verify theories rather than for investigation or construction of knowledge through inquiry.

8.10 The instructors hold entrenched beliefs that students should understand and be able to apply physics, transmitting knowledge is an effective teaching strategy, and intellectual challenge and usefulness of the subject are motivations for studying physics. These beliefs are the ones that influence their teaching practice. The beliefs about active learning and constructivist teaching strategy are organisational expressed beliefs which appear to have very little influence on their practice.

8.11 Most students were passive learners who spent more class time listening to lectures and taking notes in lecture sessions, and doing experiments following the given manuals in laboratory sessions. These learning strategies may have been learned from experiences of studying physics at high school. Some students may employ active strategies of learning such as practicing exercises by themselves, asking instructors questions or discussing ideas with friends.

8.12 Two entrenched beliefs held by students, that influenced their actual study practice, are being attentive to the classes and hard work will help them to be successful in physics. As a consequence of these beliefs, students were passive learners and employed the strategies of listening to lectures and taking notes. Although they believe that physics is important and being an active learner is an effective approach for learning, these are expressed beliefs that have less influence on their actual study practice than their entrenched beliefs.

8.13 Both lecture and laboratory classes are arranged in typical formats for traditional pedagogy and would not support student-centered constructivist approaches to teaching and learning. The management of classroom environment depends on the instructors' beliefs, and this influences the effectiveness and quality of teaching and learning.

8.14 By using traditional pedagogy in introductory physics classes, there are few opportunities for learning in both lecture and laboratory sessions that support students to be active learners, to accommodate misconceptions towards scientific conceptions, to learn investigation skills or develop an understanding of the nature of science.

8.15 A majority of students in Thai Rajabhat universities have neutral attitudes towards physics and they wish the instructors would improve their teaching strategies. Students' attitudes are likely to be more positive if teaching processes, classroom environment and opportunities for learning were improved.

CHAPTER 9: LIMITATIONS, CONCLUSIONS AND IMPLICATIONS

Introduction

Physics education in Thailand, as in many countries around the world, has been confronted with the problem of students' low levels of achievement and falling enrolments. This has raised concerns about ineffective teaching and learning processes. There is no doubt that the beliefs held by instructors and students, and students' goals and motivations are important factors that affect the success of teaching and learning. These variables were the focus of this study.

Physics instructors and students who enrol in introductory physics courses at Thai Rajabhat universities were participants in this research. The data were collected by using questionnaires, interviews, classroom observations and document analysis. Assertions drawn from the analysis of these data provide a picture of teaching and learning in introductory physics courses and factors affecting their effectiveness.

Some unavoidable limitations affect the findings of the research. The consideration of these limitations provides a background to the conclusions of the research. Implications developed from the findings and conclusions provide direction for future action that can be taken to improve the teaching and learning of physics, and for further research.

This Chapter contains three sections. The first section: Limitations, considers those factors or conditions that may influence the confidence with which the conclusions can be stated and the generalisability of the findings. The second section: Conclusion, deals with the general answers to the research questions. The last section: Implications, provides some suggestions for improving the teaching and learning of physics in Rajabhat universities; and for further studies in this field.

Limitations

Several limitations of the study are apparent. These are associated with each step of the research; research design and instrument construction, data gathering, data analysis, and interpretation or generalising the findings.

Limitations of the Research Design and Instrument Construction

The study was based on a mixed methods design which combined surveys and case studies. Data were collected by questionnaires, interviews, classroom observations and document analysis to probe the opinions and practices of instructors and students in the introductory physics classes and gain insight into the implemented curriculum.

Participants were physics instructors and students in introductory physics courses at Rajabhat universities. Questionnaire data were collected from the entire population of physics instructors in the 36 Rajabhat universities, and from five groups of first year students from two Rajabhat universities at the South of Thailand. The sample of students who participated in this research and completed surveys would be a small number when compare with the total population of students enrolled in introductory physics courses and were not from every part of the country. Student surveys were limited to groups who participated in the case studies. The sampling limits the generalisability of findings derived from the student survey and case study data.

Various types of instruments for the research were constructed. All of the initial questions and statements in the instruments were written in English that could be approved by the research supervisors and experts. The instruments were then translated into Thai by the Researcher so that they could be administered to the participants. The translation to a different language and culture could not achieve exactly the same meaning as the original version.

Limitations of the Data Gathering

All of the survey questionnaires in this research comprised closed and open questions. Closed questions were answered more often than open questions. Some respondents may have not answered open questions to avoid giving a negative response for cultural reasons.

The instructors who participated in the case studies had less than five years teaching experience and all of them knew that the Researcher has been teaching physics in a Rajabhat university for many years. For Thai cultural reasons, the participants would believe in paying respect to the senior and might hide some opinions or behaviours during the interviews or classroom observations that they considered to be inappropriate responses. This would be a limitation of the study.

The students who participated in a case study were randomly selected. Furthermore, since they were interviewed as a group, students would have been influenced by the answers from others in the group.

Another limitation is the difference of occasions in gathering data, especially with the case studies and focus group discussions. Some cases, for example, that were conducted with interview and classroom observation just one week before final examinations might generate different data than from those that were conducted earlier.

Limitations of the Data Analysis and Interpretation

The responses to open questions of the questionnaires and interviews from both instructors and students were answered in Thai, which were translated to English by the Researcher. The answers of each individual could not be translated verbatim. The English translations are likely to have slightly different sense and meaning from the original Thai statements. The translation was made by the Researcher who has a deep understanding of discourse of physics and physics teaching and was done carefully to accurately reflect the intention of the respondents.

There was a range of opinions given as responses to each of the open questions and these were aggregated into categories. On several occasions, the Researcher had to go back to the original Thai version of the answers for decision-making about categorization to ensure responses were placed into appropriate categories.

Conclusions and Findings of the Research

The purpose of this study was to investigate physics instructors' beliefs about teaching and learning; students' beliefs, goals and motivations for study physics; and the influences of these on the classroom practices; classroom environment, opportunities for learning and students' attitudes towards physics in Thai Rajabhat universities. The findings of this study provide baseline data about physics teaching and learning in Rajabhat universities.

The study was conducted with physics instructors (n = 89) from all Rajabhat universities at the beginning of second semester in 2002, the same groups of first year students who enrolled in introductory physics courses at two Southern Rajabhats at the beginning (n = 140) and the end (n = 147) of that semester, and four case studies during the semester. Various detailed and general assertions were developed from the data analyses and these assertions were aggregated to determine the findings of the research.

Research Question 1

What are Thai Rajabhat physics instructors' beliefs about teaching and learning?

Physics instructors' beliefs about the purposes of teaching physics, effective strategies for teaching and limitations to the quality and effectiveness of teaching, effective strategies for learning, students' motivations for studying physics, and the purposes of assessment were investigated.

Thai Rajabhat physics instructors believe that students should understand and be able to apply factual knowledge of physics (General Assertion 8.1). The instructors hold both entrenched beliefs of didactic and knowledge transmission pedagogies and expressed platonic beliefs of student-centered constructivist teaching strategies. They believe that the main limitations to the quality and effectiveness of their teaching are factors associated with students and administration rather than their own teaching strategies (General Assertion 8.2).

The instructors believe that the most effective learning strategies in physics are active learning or student-centered strategies (General Assertion 8.3).

They believe that motivations for studying physics include the intellectual challenge of the subject, good teaching, enhanced employment prospects and application to real situations; however, these may not be motivational factors for students (General Assertion 8.4).

The instructors hold the beliefs that the main purpose of assessment is to measure students' understanding and success in applying physics knowledge rather than to improve teaching or learning processes (General Assertion 8.5).

Research Question 2

To what extent are instructors' approaches to teaching physics influenced by their beliefs about teaching and learning?

In lecture sessions, instructors spend most class time explaining and giving notes to transmit knowledge and get through the content, whereas laboratory sessions are used to verify theories rather than for investigation or construction of knowledge through inquiry (General Assertion 8.9). The beliefs that students should understand and be able to apply physics (General Assertion 8.1), transmitting knowledge is an effective teaching strategy (General Assertion 8.2), the motivations for studying physics are intellectual challenge and good teaching (General Assertion 8.4) and the main purpose of assessment is to measure students' understandings and success in applying physics knowledge (General Assertion 8.5) are entrenched beliefs that influenced their approaches to teaching (General Assertion 8.10).

Their beliefs that student-centered constructivist strategies are effective for teaching (General Assertion 8.2), active learning is the most effective approach to learning (General Assertion 8.3), and application to real situations are important (General Assertion 8.4) are expressed beliefs which appear to have very little influence on their practice (General Assertion 8.10). The instructors explained that some factors associated with students and administration are the main limitations on the quality and effectiveness of their teaching (General assertion 8.2).

Research Question 3

What are the students' beliefs about teaching and learning, goals and motivations for studying physics in Thai Rajabhat universities?

Rajabhat students' beliefs about teaching and learning physics, and goals and motivations for studying physics were investigated. The assertions developed through the analysis of data from student questionnaires, interviews and case studies were used to formulate the conclusions and findings.

The students believe that current physics teaching is not interesting with the traditional pedagogy of transmitting knowledge. They suggested that, however, teaching should emphasise giving clear explanations and also include some other student-centered strategies that are enjoyable and attractive (General Assertion 8.7).

Rajabhat students explained that physics is a difficult and complicated subject, and they want to understand physics; however, they prefer to employ passive and surface approaches to learning to meet their goals (General Assertion 8.8).

The students have low motivation for studying physics and hold various types of motivational beliefs. They hold beliefs of extrinsic goal orientation to get good grades or to pass examinations, and internal source of control beliefs to be successful through their effort and hard work. Even though the students believe that physics is important to people's lives, many students do not want to study any more physics (General Assertion 8.6).

Research Question 4

To what extent are students' approaches to learning influenced by their beliefs, goals and motivation for studying physics?

Students spent most class time listening and taking notes in lecture sessions, and doing experiments following the given manuals in laboratory sessions (General Assertions 8.11). Students believe they need to be attentive to the classes and hard working (General Assertion 8.12) to be successful. These approaches to learning are influenced by: their instructors' approaches to teaching; their belief that giving clear explanations is an effective teaching strategy (General Assertion 8.7); and, their motivations that they want to understand physics (General Assertion 8.8), their extrinsic goal orientation to get good grades or to pass examination, and internal source of control beliefs to be successful through effort and hard work (General Assertions 8.6, 8.12).

The students' beliefs that physics is a difficult and complicated subject (General Assertion 8.8), current physics teaching is not interesting with the traditional pedagogy of transmitting knowledge (General Assertion 8.7); having low motivation for studying physics and not wanting to study physics (General Assertion 8.6) influence students' study practice to employ passive and surface approaches to learning to meet their goals of mastering the content so they can pass the exams (General Assertions 8.6, 8.8) so that most students are passive and surface learners (General Assertions 8.11, 8.12).

Some students who employ active strategies for learning such as practicing exercises by themselves and asking instructors questions or discussing ideas with friends (General Assertion 8.11) may hold the beliefs that active learner is effective (General Assertion 8.12). Unfortunately most of the case study students adopted passive approaches to learning physics which may have been developed from experiences of learning physics at high school (General Assertion 8.11).

The beliefs that physics is important to people's lives (General Assertion 8.6), student-centered teaching strategies are enjoyable and attractive (General Assertion 8.7), and being an active learner is an effective approach to learning (General Assertion 8.12) have less influence on the most students' approaches to learning (General Assertion 8.12)

Research Question 5

What combination of factors appears to influence classroom environment, opportunities for learning and students' attitudes towards physics?

The physical classroom environment of physics classes at Rajabhat universities was studied by classroom observation. Opportunities for learning physics were investigated by classroom observation and document analysis.

Both physics lecture and laboratory classes are arranged in typical formats for traditional pedagogy and would not support active and interactive approaches to teaching and learning. The management of classroom environment depends on the instructors' beliefs, and this influences the effectiveness and quality of teaching and learning (General Assertion 8.13).

There are few opportunities for deep conceptual learning and for developing investigation and problem solving skills, and an understanding of the nature of science in introductory physics classes at Rajabhat universities because of the traditional pedagogy and the lack of active learning by students (General Assertion 8.14).

Rajabhat students have neutral attitudes towards physics and they wish the instructors to improve teaching strategies. Students' attitudes are likely to be more positive if teaching processes, classroom environment and opportunities for learning were improved (General Assertion 8.15).

Implications

Thailand's National Education Act B.E. 2542 (1999) was introduced to reform the education system of the country. One of the significant tasks according to this Act is learning reform by attaching the highest importance to learners. Rajabhat universities, which originated from teachers colleges, are expected to lead other educational institutes in carrying out this task of improving education. In particular, physics teaching and learning is in need of reform.

Two broad sets of implications arise from the findings of this research and these relate to the improvement of teaching and learning of physics and the need for further research into physics education in Thailand. This section outlines some strategies related to these implications.

The Improvement of Teaching and Learning of Physics

Four aspects for the improvement of teaching and learning physics in Rajabhat universities arise from the findings of this study. These are the improvement of the physics curriculum, improvement of teaching, and the development of classroom environment and opportunities for learning, and the supports for teaching and learning.

Improvement of the physics curriculum

Physics instructors believe that one of the motivations for studying physics is its application to real situations, and they wish their students to be able to apply physics. Students also expressed the view that physics is important to people's lives and the development of technology, but, physics is difficult and complicated, they have low motivation for studying physics and they do not want to study physics. These findings imply that there are inconsistencies between an ideal physics curriculum and the implemented curriculum. Therefore, the physics curriculum in Rajabhat universities needs to be revised. Physics must be more relevant to everyday experiences and more applicable for students. The revision of the curriculum is the first step towards improvement of teaching and learning. Some recommended actions are listed below.

1. An academic organisation among Rajabhat physics instructors should be established. This could be named the Rajabhat University Physics Instructors Association (RUPIA). The organisation would be expected to take action to support the professional development of its members.

2. RUPIA should study the problems associated with the current physics curriculum and strategies of physics curriculum improvement in Rajabhat universities.

3. There should be a workshop hosted by RUPIA for revising the physics curriculum. The revised curriculum should be submitted to each Rajabhat academic board and university council.

The improvement of teaching physics

Many assertions in this study indicate that most Rajabhat physics instructors hold entrenched beliefs about traditional pedagogy of knowledge transmission whereas students believe that these teaching strategies are not interesting and limit their motivation for studying physics. The findings also indicate that the instructors hold expressed beliefs about active or constructivist approaches to teaching and learning and the factors that they assert are constraining their practice should be addressed. A continuous process of professional learning is needed to transform these platonic expressed beliefs into entrenched beliefs so that they are enacted in their practice. Importantly, expressed beliefs about constructivist approaches to teaching and learning can become accommodated into entrenched beliefs and practice when instructors experience these approaches to teaching as intelligible, plausible and fruitful. Some recommended actions to improve physics teaching are presented.

1. The development of physics teaching in Rajabhat universities that started years ago in the SEQI project should be continued and further promoted.

2. Laboratory approaches to teaching and learning, and the strategies of teaching and learning by investigation and interactive forms of teaching should be promoted.

3. Short-courses training or workshops on effective teaching in physics and other cooperative activities should proceed regularly among small groups of the instructors on a regional basis. National symposia or workshops on these issues should then follow. These actions could be carried out by RUPIA.

The development of classroom environment and opportunities for learning

The findings from this study show that students are passive learners, and many do not want to study physics, the classroom environment does not support constructivist approaches to teaching and learning and opportunities for learning are constrained. These are some recommended actions.

1. RUPIA could regularly organise seminars or workshops for physics instructors on classroom environment and student-centered constructivist approaches to teaching and learning to physics instructors.

2. The universities should encourage their instructors in developing more learning materials and new laboratory investigation tasks using simple and inexpensive equipment. This action needs the support of professional development workshops that could be coordinated by RUPIA.

3. Modern educational technology and innovation, for example computers and audio-visual facilities should be introduced and used broadly in physics classrooms.

Support for teaching and learning

The improvement of teaching and learning physics would not succeed without appropriate supports. The two most important are administration and financial supports.

1. Rajabhat universities should provide administrative support by promoting the establishment of the professional organisation (RUPIA, for example) and academic roles of these organisations, supporting professional development programs, and clarifying academic tasks of their instructors.

2. The physics department and the faculty of science in each Rajabhat university should seek sufficient financial support from both within and outside the university sector for more physics laboratory equipment and other learning materials.

Further Research in Physics Education

This section proposes some recommendations about research in physics education that would be interesting for Thai physics educators.

Teaching and learning culture

Contemporary teaching and learning theories originated in Western developed nations and yet teaching and learning is a socio-cultural activity. It seems sometimes that the Thai culture is an obstacle for students learning science and physics. The comparison between Western and Thai cultures for teaching and learning is therefore an interesting area to study. Effective ways of teaching and learning physics which are consistent with Thai culture should be developed.

Classroom environment

The Thai physics classroom environment should be systematically studied in both physical and psychosocial aspects. Such studies would help to shape pedagogy so that more progressive approaches can be introduced in ways that are sensitive to Thai social norms and culture.

Student's approaches to learning

Many students adopted surface passive approaches to learning and there is need for further research into strategies that assist students to be more active and metacognitive in their learning.

Epilogue

This study arose from the concerns about the problems in teaching and learning of introductory physics in Thai Rajabhat universities. All knowledge generated from this study could be contributed to the improvement of physics teaching and learning at Rajabhat universities in particular, but hopefully it will also be useful for schools and other universities in the country.

On July 20, 1969; when Neil Armstrong was the first to set foot on the Moon, he said "***That's one small step for a man, one giant leap for mankind***". The Researcher would like to transform his precious verse for this study as "***That's one small step for a research, (I hope it will also be) one giant leap for physics education in Thailand***".

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APPENDIX A: Letter of informed consent for instructors
is not included in this version of the thesis

Consent Form

<u>Project title</u>: Physics Teaching and Learning in Thai Rajabhat Institutes

I have been informed about all aspects of the above project and any questions I have asked have been answered to my satisfaction.

I agree to participate in this research project, realising that I may withdraw at any time.

I understand that I will be interviewed and the interview will be tape recorded. I also understand that the recording will be erased once the interview is transcribed and my name is replaced with a code.

I agree that the research data gathered for this study may be published providing that I, my Rajabhat or my students are not identifiable.

______________________ ______________

Instructor Date

______________________ ______________

Anusak Hongsa-ngiam Date

APPENDIX B: Letter of informed consent for students is not included in this version of the thesis

Consent Form

<u>Project</u> <u>title:</u> **Physics Teaching and Learning in Thai Rajabhat Institutes**

I have been informed about all aspects of the above project and any questions I have asked have been answered.

I agree to participate in these interviews, realising that I may withdraw at any time.

I understand that I will be interviewed and the interview will be tape recorded. I also understand that the recording will be erased once the interview is transcribed and my name is replaced with a code.

I agree that the research data gathered for this study may be published providing that I (the student), my Instructor, or my Rajabhat are not identified.

______________________ ______________

Student Date

______________________ ______________

Researcher – Anusak Hongsa-ngiam Date

APPENDIX C: Instructor Questionnaire

EDITH COWAN UNIVERSITY
PERTH WESTERN AUSTRALIA

แบบสอบถามสำหรับอาจารย์
INSTRUCTOR QUESTIONNAIRE

ข้อมูลส่วนบุคคล
Personal Information

	Code
ชื่อ (หากไม่ประสงค์ระบุ โปรดข้ามไป) Name ……………………………………………..……………	
สถาบันราชภัฏ Rajabhat Institute ……………………………………………………..	
คุณวุฒิ ualifications ……………………..………………………………	
วิชาเอก Major ……………………………………………………….	
จำนวนปีที่สอนฟิสิกส์ในสถาบันราชภัฏ Years of physics teaching experience in Rajabhat institutes ……..	

เรียน อาจารย์ที่เคารพทุกท่าน

แบบสอบถามฉบับนี้มุ่งสำรวจความเห็นและความเชื่อของท่านที่มีต่อการเรียนการสอนวิชาฟิสิกส์ ซึ่งคำถามแต่ละข้อจะไม่มีคำตอบที่ถูกหรือผิด ข้อมูลที่ได้จากแบบสอบถามครั้งนี้จะนำไปใช้เพื่อประเมินสถานการณ์การเรียนการสอนวิชาฟิสิกส์ในสถาบันราชภัฏ โดยข้อมูลเหล่านี้จะถูกรวบรวมแปลและสรุปเป็นรายงานการวิจัย หากมีข้อความใดจากผู้ตอบแบบสอบถามซึ่งปรากฏในรายงานและต้องอ้างถึงผู้ให้ข้อมูลก็จะใช้นามแฝงในทุกกรณี ทั้งนี้เพื่อมิให้กระทบต่อความเป็นส่วนตัวของท่าน และจะไม่ปรากฏชื่อของบุคคลหรือสถาบันราชภัฏใดอยู่ในรายงานการวิจัยทั้งสิ้น ข้อมูลส่วนบุคคลที่รับจากแบบสอบฉบับนี้จะไม่รั่วไหลไปสู่คณะวิชา สถาบันและสำนักงานสภาสถาบันราชภัฏ(สรภ)เด็ดขาด ทั้งนี้โดยผ่านความเห็นชอบจากคณะกรรมการจรรยาบรรณของมหาวิทยาลัยอีดิธโคแวน รัฐออสเตรเลียตะวันตก เพื่อการศึกษาครั้งนี้แล้ว

ขอขอบพระคุณในความร่วมมือตอบบบสอบถามในครั้งนี้เป็นอย่างยิ่ง

Dear instructors

This questionnaire seeks your opinions and beliefs about teaching and learning physics. There is no right or wrong answer to each question. Information from these questionnaires will be used to evaluate the situation of teaching and learning physics in

Thai Rajabhat institutes. The information will be aggregated and summarized for inclusion in research reports. Any statements made by individuals that are included in research reports will use pseudonyms to retain anonymity of the participants. No person or Rajabhat will be identified in any reports. No personal information in this study will be accessible to your faculty, Rajabhat or Office of Rajabhat Instutute Council (ORIC). The Ethics Committee of Edith Cowan University, Western Australia has approved this study.

Thank you for your participation in this study.

Part A

โปรดอธิบายโดยย่อถึงความเห็นและความเชื่อของท่านในประเด็นต่อไปนี้

Briefly describe your opinions and beliefs about the following.

1. **ด้านธรรมชาติของฟิสิกส์**
   The nature of physics
   - โดยธรรมชาติของวิชา สิ่งที่นักศึกษาควรได้เรียนรู้เกี่ยวกับฟิสิกส์คืออะไร?
     What should students learn about the nature of physics?

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   ……………………………………………………………………………………
   ……………………………………………………………………………………

2. **ด้านการสอนสอนฟิสิกส์**
   Teaching physics
   - กรุณากะประมาณจำนวนเปอร์เซ็นต์ของเวลาสำหรับการสอนในรูปแบบต่างๆซึ่งท่านใช้สอนตามปกติในแต่ละสัปดาห์ และจำนวนเปอร์เซ็นต์ของเวลาที่ท่านคิดว่าควรจะเป็น แล้วระบุลงในตารางข้างล่างนี้
     In the table below record the percentage of time on each teaching strategy you typically spend each week when teaching physics, and the percentages for ideal teaching circumstances.

รูปแบบการสอน Teaching strategy	**เปอร์เซ็นต์ของเวลา** Percentage of teaching time	
	ค่าจริง Actual teaching	ค่าที่คาดหวัง Ideal teaching
อธิบายเนื้อหาแก่ชั้นเรียน: Explaining physics to the whole class		
ซักถามและอภิปรายกับนักศึกษาทั้งชั้น: Questioning and discussion with the whole class		
บอกหรือเขียนให้จดบันทึก: Giving notes		
ใช้วิดีโอหรือคอมพิวเตอร์ช่วยในการสอน: Showing videos or computer simulations		

สาธิตการทดลอง: Demonstrating experiments		
ให้นักศึกษาปฏิบัติงานรายบุคคลรวมทั้งการค้นจากตำรา: Students working individually including working from the text		
ให้นักศึกษาปฏิบัติงานกลุ่มย่อยเพื่อปฏิบัติการหรือกิจกรรมอื่นๆ: Students working in small groups to complete experiments and other activities		

- การสอนวิชาฟิสิกส์ที่มีประสิทธิภาพควรมีลักษณะอย่างไรบ้าง?
  What are the characteristics of effective physics teaching?
  …………………………………………………………………………
  …………………………………………………………………………
- บทบาทที่สำคัญของอาจารย์เพื่อให้การสอนฟิสิกส์มีประสิทธิภาพคืออะไรบ้าง?
  What are the important roles of the instructor in effective physics teaching?
  …………………………………………………………………………
  …………………………………………………………………………
- ปัจจัยหลักใดที่เป็นขีดจำกัดต่อคุณภาพและประสิทธิภาพในการสอนวิชาฟิสิกส์ของท่าน?What is the main factor that limits the quality and effectiveness of your physics teaching?
  …………………………………………………………………………
  …………………………………………………………………………

3. ด้านการเรียนวิชาฟิสิกส์
Learning physics

- รูปแบบการเรียนแบบใดที่ทำให้เรียนรู้ฟิสิกส์ได้ดีที่สุด?
  What are the most effective strategies for learning physics?
  …………………………………………………………………………
  …………………………………………………………………………
- อะไรคือแรงจูงใจให้นักศึกษาอยากเรียนวิชาฟิสิกส์?
  What is the motivation for students to study physics?
  …………………………………………………………………………
  …………………………………………………………………………
- ปัจจัยใดที่เป็นข้อจำกัดมิให้นักศึกษามีผลการเรียนฟิสิกส์ที่ดี?
  What factors limit students' success in getting good grades in physics?
  …………………………………………………………………………
  …………………………………………………………………………

4. ด้านการประเมินผลการเรียนวิชาฟิสิกส์
Assessment in physics

- จุดมุ่งหมายหลักในการประเมินผลการเรียนวิชาฟิสิกส์คืออะไร?
  What is the main purpose of assessment in physics?

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- ท่านประเมินผลการรียนวิชาฟิสิกส์ของนักศึกษาอย่างไร?
  How do you assess your students in physics?

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5. ด้านการปรับปรุงการเรียนการสอนวิชาฟิสิกส์
Improving physics

- การเรียนการสอนฟิสิกส์ในสถาบันราชภัฏควรมีการปรับปรุงอย่างไร?
  How could physics teaching and learning be improved in Rajabhat institutes?

  ……………………………………………………………………………………
  ……………………………………………………………………………………

Part B

โปรดวงกลมรอบตัวเลขที่สอดคล้องกับความเห็นของท่านสำหรับข้อความเกี่ยวกับการเรียนการสอนฟิสิกส์ในแต่ละข้อต่อไปนี้
Please circle the number in each item that corresponds to your opinion of the following statements about physics teaching in Rajabhat institutes.

1 = ไม่เห็นด้วยอย่างยิ่ง strongly disagree, 2 = ไม่เห็นด้วย disagree, 3 = เฉยๆ not disagree or agree, 4 = เห็นด้วย agree, 5 = เห็นด้วยอย่างยิ่ง strongly agree.

ในการสอนของท่าน คาดหวังว่านักศึกษาจะ ...
From your teaching, you anticipate the students will …

1. จดจำข้อเท็จจริงและกฎเกณฑ์ต่างๆทางฟิสิกส์ที่ท่านสอนได้ memorise the facts and laws of physics that you teach.	1	2	3	4	5
2. มองเห็นแนวความคิดต่างๆทางฟิสิกส์และความสัมพันธ์ระหว่างแนวความคิดเหล่านั้น ซึ่งทำใหห้เกดความเข้าใจได้ make sense of the physics concepts and the relationships between concepts so they understand them.	1	2	3	4	5
3. สร้างคำอธิบายสำหรับตนเองในเนื้อหาที่ท่านสอนได้ construct their own meaning for the concepts you teach.	1	2	3	4	5
4. สามารถประยุกต์ใช้ความรู้ทางฟิสิกส์มาอธิบายเรื่องราวในชีวิตประจำวันได้ be able to apply their physics concepts to explain the world around them in their everyday experiences.	1	2	3	4	5
5. เกิดทักษะในการวางแผนทำการทดลอง learn skills of planning experiments	1	2	3	4	5
6. เกิดทักษะในการปฏิบัติการทดลอง learn skills of doing experiments.	1	2	3	4	5

แนวทางการสอนวิชาฟิสิกส์ของท่านคือ ...
Your approach to teaching physics is to …

7. การถ่ายทอดความรู้ให้แก่นักศึกษา transmit knowledge to students.	1	2	3	4	5
8. การช่วยให้นักศึกษาค้นหาความรู้ help students search for knowledge.	1	2	3	4	5

9. การช่วยเหลือนักศึกษาในการแก้โจทย์ปัญหา help students to solve problems.	1	2	3	4	5
10. การร่วมกับนักศึกษาสร้างสรรค์ความรู้ work with students in the construction of knowledge.	1	2	3	4	5
11. การทำหน้าที่เป็นผู้จัดการให้เกิดกิจกรรมต่างๆในชั้นเรียน be the manager of activities in the classroom.	1	2	3	4	5

ในชั้นเรียนของท่าน ...
In your class …

12. ท่านมีเวลาช่วยเหลือนักศึกษาเรียนรู้เป็นรายบุคคลได้ Your have time to help each student with his/her learning.	1	2	3	4	5
13. ท่านสามารถสร้างความสนใจให้แก่นักศึกษาได้ You are able to create student interest.	1	2	3	4	5
14. ต้องเป็นชั้นเรียนที่สงบเงียบเรียบร้อย เพื่อการเรียนที่มีประสิทธิภาพ It must be quiet with little discussion for effective learning.	1	2	3	4	5
15. ท่านใช้รูปแบบการสอนที่หลากหลายเพื่อให้สอดคล้องกับวิธีการเรียนที่แตกต่างกัน You use many different teaching strategies to meet the needs of different learning styles.	1	2	3	4	5
16. ท่านต้องเร่งรีบสอนเนื่องจากรายวิชามีเนื้อหามากเหลือเกิน You have to rush through the course as there is so much content to cover.	1	2	3	4	5
17. ท่านมีอิสระในการเลือกแนวทางการสอนได้น้อย เพราะต้องปฏิบัติตามที่หลักสูตรกำหนf You have little freedom to teach the way you like as you have to follow the syllabus.	1	2	3	4	5
18. ท่านใช้คำถามจำนวนมากกับนักศึกษาเพื่อให้พวกเขามีส่วนร่วมในการเรียนรู้	1	2	3	4	5

You ask the students many questions to engage them in their learning.					
19. นักศึกษาจดบันทึกคำบรรยายหรือเนื้อหาจากตำราด้วยตนเองStudents make-up their own notes from your lectures and the text.	1	2	3	4	5
20. นักศึกษาจดบันทึกโดยการคัดลอกถ้อยคำจากการบรรยายของท่านStudents copy the notes that you give them in lectures.	1	2	3	4	5
21. ในการทำการทดลอง นักศึกษาต้องปฏิบัติตามคำแนะนำจึงจะได้ผลStudents must follow the instructions you give them for experiments so that they are successful.	1	2	3	4	5
22. นักศึกษาสามารถวางแผนการทดลองของตนเองในบางเรื่องได้ Students are able to plan some of their own experiments.	1	2	3	4	5
23. นักศึกษาที่มีทักษะทางคณิตศาสตร์ที่เพียงพอจะประสบความสำเร็จในการเรียนฟิสิกส์ Students have sufficient mathematical skills and knowledge to be successful with physics.	1	2	3	4	5

Part C

ข้อเสนอแนะเพิ่มเติม
Final comments

ขอขอบพระคุณอย่างยิ่งที่ท่านได้สละเวลาอันมีค่าในการสรุปความคิดเห็นเพื่อตอบแบบสอบถามทั้งหมดนี้
หากท่านมีข้อเสนอแนะหรือข้อคิดเห็นเพิ่มเติมใดๆ
กรุณาเขียนตอบลงในที่ว่างข้างล่างนี้

Thank you for taking the time to consider your opinions and completing this questionnaire. Please feel free to make any comments about any other matters in the space below.

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Questionnaire prepared by Anusak Hongsa-ngiam in consultation with A/Prof. Mark Hackling

EDITH COWAN UNIVERSITY
PERTH WESTERN AUSTRALIA

APPENDIX D: Student Questionnaire

แบบสอบถามนักศึกษา
STUDENT QUESTIONNAIRE

ข้อมูลส่วนบุคคล
Personal Information

Code

ชื่อ (หากไม่ประสงค์จะระบุ โปรดข้ามไป): Name
……………………………………….

สถาบันราชภัฏ: Rajabhat Institute
….……………………………………………

วิชาเอก/โปรแกรมวิชา: Major/Program of study
………………………………….

นักศึกษาทุกท่าน

ขอขอบคุณที่ท่านตกลงใจตอบแบบสอบถามอันเกี่ยวกับความเชื่อเป้าหมายและแรงจูงใจในการเรียนวิชาฟิสิกส์ฉบับนี้และโปรดเข้าใจว่าคำถามแต่ละข้อไม่มีคำตอบที่ถูกหรือผิด จุดประสงค์คือการสำรวจความเห็นและความเชื่อของท่านเพื่อประเมินสภาวะของการเรียนการสอนวิชาฟิสิกส์ในสถาบันราชภัฏเท่านั้น ฉะนั้นจึงขอให้ท่านช่วยอธิบายความคิดเห็นของท่านให้สมบูรณ์ที่สุดเท่าที่จะเป็นไปได้

แบบสอบถามฉบับนี้มิใช่แบบทดสอบ คำตอบของท่านจึงไม่มีผลต่อคะแนนหรือผลการเรียนของท่าน

ข้อมูลใดๆที่ได้รับจากท่านจะเป็นประโยชน์ในการปรับปรุงการเรียนการสอนวิชาฟิสิกส์ในสถาบันราชภัฏ คำตอบของท่านจะถูกรักษาไว้เป็นความลับ บรรดารายงานการวิจัยจะไม่ระบุชื่อจริงของนักศึกษาอาจารย์หรือสถาบันราชภัฏใดๆทั้งสิ้น แต่หากมีข้อความจากบุคคลซึ่งต้องอ้างอิงในรายงานการวิจัยก็จะใช้นามสมมุติแทนเพื่อรักษาความเป็นส่วนบุคคลของผู้ให้ข้อมูลนั้น ข้อมูลส่วนบุคคลของท่านจะไม่รั่วไหลไปสู่อาจารย์คณะวิชาหรือสถาบันราชภัฏโดยเด็ดขาด ทั้งนี้

โดยได้ผ่านการเห็นชอบจากคณะกรรมการจรรยาบรรณ มหาวิทยาลัยอีดิธ โคแวน รัฐออสเตรเลียตะวันตก ในการทำการศึกษาครั้งนี้แล้ว

Dear students

Thank you for your agreeing to complete this questionnaire about your beliefs, goals and motivation for studying physics. There is no right or wrong answer in each question. The questionnaire aims to seek your beliefs and ideas for evaluating the situation of teaching and learning physics in Thai Rajabhat institutes. Please explain your answer as fully as possible.

This is not a test and your answers will not affect your scores and grades.

The information you provide will be useful to improve the ways of teaching and learning physics in Rajabhat institutes. Your answers will remain confidential and any aspects about this research will not name any students, instructors or Rajabhats. Any statements made by individuals that are included in research reports will use pseudonyms to retain anonymity of the participants. No personal information in this study will be accessible to your instructor, faculty, or Rajabhat. The Ethics Committee of Edith Cowan University, Western Australia has approved this study.

Part A

1. ท่านต้องการเรียนวิชาฟิสิกส์หรือไม่? ☐ ต้องการ ☐ ไม่ต้องการ

   Do you want to study physics? ☐ Yes ☐ No

   เพราะเหตุใด?
   Why?

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2. สิ่งใดที่ท่านอยากได้จากการเรียนวิชาฟิสิกส์?
   What do you want to get from studying physics?

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3. การสอนวิชาฟิสิกส์ที่ดีควรมีลักษณะอย่างไร?
   What are the characteristics of good physics teaching?

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4. นักศึกษาควรใช้รูปแบบการเรียนแบบใดจึงจะทำให้เรียนวิชาฟิสิกส์อย่างมีประสิทธิภาพ?
   What study strategies should students use to learn physics effectively?

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5. โปรดเติมตัวเลขในตารางข้างล่างนี้เพื่อแสดงถึงจำนวนเปอร์เซ็นต์ของเว

ลาสำหรับกิจกรรมการเรียนแบบต่างๆ
ที่ท่านมักใช้ในการเรียนวิชาฟิสิกส์ของแต่ละสัปดาห์
และจำนวนเปอร์เซ็นต์ของเวลาที่ท่านคาดหวังว่าควรจะเป็น
Complete the table below to show the percentage of time typically spend in class on various learning activities each week in physics, and the percentages for ideal teaching and learning circumstances.

รูปแบบการเรียน **Learning strategy**	**จำนวนเปอร์เซ็นต์ของเวลา: Percentage of time**	
	การเรียนจริง: Actual studying	การเรียนที่คาดหวัง: Ideal studying
ฟังคำบรรยายของอาจารย์ Listening to the instructor's lecture		
จดบันทึกคำบรรยาย Taking and copying notes		
ซักถามและอภิปราย Questioning and discussing		
ปฏิบัติการทดลอง Doing laboratory work		
อ่านตำราและคู่มือ Reading texts and manuals		
ทำแบบฝึกหัดและการบ้าน Doing exercises and homework		
ทำงานเป็นกลุ่ม Working in group		

6. ท่านเห็นด้วยหรือไม่ว่าฟิสิกส์เป็นวิชาสำหรับคนเก่งเท่านั้น?

   ☐ เห็นด้วย ☐ ไม่เห็นด้วย

   Do you agree that physics is a subject only for the clever people?

   ☐ Yes ☐ No

   เพราะเหตุใด?

   Why?

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7. ท่านเชื่อหรือไม่ว่าถ้าท่านขยันมากขึ้นแล้วท่านจะได้เกรดวิชาฟิสิกส์ดีขึ้น?

   ☐ เชื่อ ☐ ไม่เชื่อ

Do you believe that if you work hard you can get good grades in physics?

☐ Yes ☐ No

เพราะเหตุใด?

Why?

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8. สิ่งใดมีอิทธิพลต่อการได้เกรดที่ดีในวิชาฟิสิกส์มากกว่า?

☐ ความสามารถ ☐ ความพยายาม

What is more important for getting good grades in physics?

☐ Ability ☐ Effort

เพราะเหตุใด?

Why?

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9. นักศึกษาหลายคนบอกว่าฟิสิกส์เป็นวิชาที่ยาก
สิ่งใดที่ทำให้ฟิสิกส์ยากต่อการเรียนและการได้เกรดที่ดี?

Many students say that physics is a difficult subject. What is it that makes physics difficult to learn and get good grades?

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10. “ จำเป็นอย่างยิ่งที่ต้องทำให้อาจารย์และพ่อแม่พอใจในการเรียนของท่าน ดังนั้นท่านต้องขยันเรียนให้มากขึ้น”

“It is very important to please your physics instructor and your parents so you must work harder”

เพราะเหตุใดท่านจึงเห็นด้วยหรือไม่เห็นด้วยกับคำกล่าวนี้?

Why do you agree or disagree with the above statement?

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11. " มันน่าละอายมากหากต้องเป็นนักศึกษาที่เรียนอ่อนในชั้น ฉะนั้น ฉันต้องขยันเรียนให้หนักขึ้น"

"It is very shameful to be a poor student in the class, so I must work harder."

เพราะเหตุใดท่านจึงเห็นด้วยหรือไม่เห็นด้วยกับคำกล่าวนี้?

Why do you agree or disagree with the above statement?

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Part B

โปรดวงกลมรอบตัวเลขของแต่ละหัวข้อที่สอดคล้องกับความเห็นของท่านเกี่ยวกับการเรียนการสอนฟิสิกส์ในสถาบันราชภัฏ
Please circle the number in each item that corresponds to your opinion of the following statements about physics teaching and learning in Rajabhat institutes.

	ไม่เห็นด้วยอย่างยิ่ง : Strongly disagree	ไม่เห็นด้วย : Disagree	เฉยๆ : Not disagree or agree	เห็นด้วย : Agree	เห็นด้วยอย่างยิ่ง : Strongly agree
1. ฉันไม่อยากเรียนฟิสิกส์เพราะวิชานี้ไม่เกี่ยวข้องกับชีวิตจริง I don't want to study physics because it is not relevant to real life.	1	2	3	4	5
2. ฉันอยากเรียนฟิสิกส์เพราะวิชานี้ช่วยให้ฉันเข้าใจเรื่องราวต่างๆในโลกนี้ I want to study physics because it helps me to understand the world.	1	2	3	4	5
3. ฉันต้องเรียนวิชาฟิสิกส์ตามความต้องการของบุคคลอื่น I have been required to study physics by other people.	1	2	3	4	5
4. การเรียนวิชาฟิสิกส์จะมีประโยชน์กับอาชีพของฉัน Studying physics will help me with my career.	1	2	3	4	5
5. ฉันต้องจำเนื้อหาทางฟิสิกส์ให้มากที่สุดเท่าที่จะทำได้ I must remember as many facts and laws as possible in physics.	1	2	3	4	5
6. การสอบผ่านให้ได้เป็นสิ่งที่ฉันคำนึงถึงมากที่สุดในการเรียนวิชาฟิสิกส์ Passing exam is my biggest concern about studying physics	1	2	3	4	5
7. เป็นเรื่องจำเป็นที่ฉันต้องพยายามมองเห็นคว	1	2	3	4	5

ามสำคัญและเข้าใจเนื้อหาวิชาฟิสิกส์จริงๆ It is important that I try to make sense of physics concepts and really understand them.					
8. การถกเถียงเรื่องราวทางฟิสิกส์กับเพื่อนนักศึกษาไม่ได้ช่วยให้ฉันเข้าใจฟิสิกส์เพิ่มขึ้น Discussing physics ideas with other students does not help me understand them.	1	2	3	4	5
9. ฉันเพียงแค่ต้องการได้เกรดดีๆและไม่สนใจว่าจะต้องเข้าใจเนื้อหาวิชาฟิสิกส์ I just want to get a good grade and I am not interested in understanding physics ideas.	1	2	3	4	5
10. การบรรยายและจดบันทึกเป็นกิจกรรมการเรียนที่สำคัญที่สุดในชั่วโมงวิชาฟิสิกส์ Lecturing and giving notes are the most important activities in the physics class.	1	2	3	4	5
11.บทเรียนวิชาฟิสิกส์ต้องมีความสัมพันธ์กับชีวิตประจำวันซึ่งจะทำให้เราเห็นว่าฟิสิกส์มีผลกระทบต่อชีวิตเราอย่างไร Physics instruction must relate to everyday experiences so we can see how it affects us in our daily lives.	1	2	3	4	5
12. ฉันอยากแลกเปลี่ยนความคิดเห็นกับเพื่อนๆเกี่ยวกับวิชาฟิสิกส์บ้างเพื่อช่วยให้ฉันเข้าใจวิชานี้เพิ่มขึ้น I need some opportunities to discuss physics ideas with my classmates to help me understand physics.	1	2	3	4	5
13. การปฏิบัติการฟิสิกส์เป็นเรื่องยากสำหรับฉัน Laboratory work in physics is difficult for me.	1	2	3	4	5
14. การทดลองช่วยให้ฉันเข้าใจวิชาฟิสิกส์ Experiments help me to understand physics.	1	2	3	4	5
15. อาจารย์น่าจะรับฟังความคิดเห็นของนักศึกษาด้วย The instructor should listen to the class opinions.	1	2	3	4	5
16. อาจารย์ควรจะอธิบายเนื้อหาแต่ละเรื่องอย่างละเอียด The instructor should explain each topic in detail.	1	2	3	4	5
17. บทเรียนวิชาฟิสิกส์ควรจัดให้สนุกสนาน The physics lessons should be enjoyable.	1	2	3	4	5
18. อาจารย์น่าจะให้พวกเราคิดแก้ปัญหาและทำแบบฝึกหัดเป็นกลุ่มย่อยๆ เพื่อช่วยให้เราเรียนรู้ฟิสิกส์ The instructor should let us work on problems and	1	2	3	4	5

exercises in small groups to help us learn physics.					
19. ฉันอยากเรียนรู้ด้วยตนเองโดยมีอาจารย์เป็นผู้ให้คำชี้แนะ I need to learn by myself with the guidance from the instructor.	1	2	3	4	5
20. ความเข้าใจในวิชาฟิสิกส์ของฉันขึ้นอยู่กับการสอนของอาจารย์เป็นหลัก My understanding in physics mainly depends on how well I am taught by my instructor.	1	2	3	4	5
21.ระหว่างการบรรยายของอาจารย์ ฉันจดบันทึกตรงตามคำที่อาจารย์พูดและเขียนบนกระดาน In a lecture session, I take notes by writing down exactly what the instructor says and what he writes on the board.	1	2	3	4	5
22. ฉันชอบทำแบบฝึกหัดที่มีลักษณะคล้ายกับตัวอย่างที่อาจารย์ให้ I prefer to practice with the exercises that are similar to the examples given by the instructor.	1	2	3	4	5
23. ฉันใช้คำพูดของตนเองเพื่อสรุปแนวความคิดจากตำราเรียนและคำบรรยายในวิชาฟิสิกส์ I use my own words to summarise concepts from texts and lectures in physics.	1	2	3	4	5
24. ฟิสิกส์เป็นวิชาสำหรับคนเก่งเท่านั้น Physics is a subject only for smart people.	1	2	3	4	5
25. ถ้าฉันจำเนื้อหาได้มากฉันจะได้คะแนนและเกรดในวิชาฟิสิกส์สูงขึ้น If I remember more facts and laws, I will get higher scores and grades in physics.	1	2	3	4	5
26. ถ้าฉันขยันมากขึ้นแล้ว ฉันจะได้เกรดวิชาฟิสิกส์ดีขึ้น If I work hard I will get good grades in physics.	1	2	3	4	5
27. ถ้าคุณไม่ใช่คนหัวดีแล้วละก็จะไม่มีทางได้เกรดวิชาฟิสิกส์ดีๆแน่ If you are not a clever student you will not get good grades in physics.	1	2	3	4	5
28.ความสำเร็จในการเรียนวิชาฟิสิกส์ขึ้นอยู่กับความมานะพยายามมากกว่าความเก่ง Success in studying physics depends more on effort than ability.	1	2	3	4	5
29. ถ้าจะให้ได้เกรดวิชาฟิสิกส์ดีๆแล้ว คุณต้องเข้าใจแนวความคิดทางฟิสิกส์ด้วย มิใช่การจำอย่างเดียว To get good grades in physics you must understand	1	2	3	4	5

the ideas, remembering the facts is not enough.					
30. ฉันต้องเป็นนักศึกษาที่สงบเสงี่ยมในชั้นเรียน I must be an obedient student in class.	1	2	3	4	5
31. ฉันมักมีคำถามที่อยากซักถามหรือถกเถียงกับอาจารย์เสมอ I always have some questions to ask or discuss with the instructor.	1	2	3	4	5
32. คณิตศาสตร์ต่างหากที่เป็นอุปสรรคสำคัญต่อการเรียนรู้ฟิสิกส์ มิใช่ตัววิชาฟิสิสก์เอง Mathematics is the main difficulty with learning physics, not physics itself.	1	2	3	4	5
33. ฉันชอบทำข้อสอบแบบปรนัยมากกว่าข้อสอบแบบอื่นๆ I prefer to do multiple-choices tests than other types of tests.	1	2	3	4	5
34. จุดประสงค์หลักของการปฏิบัติการฟิสิกส์คือเพื่อยืนยันความถูกต้องของเนื้อหาฟิสิกส์ The main purpose of laboratory work is to verify physics concepts and laws.	1	2	3	4	5
35. ฟิสิกส์เป็นวิชาที่มีความสำคัญอย่างมากต่อการพัฒนาเทคโนโลยี Physics is very important for the development of technology.	1	2	3	4	5

Part C

ข้อเสนอแนะเพิ่มเติม

Final comments

ขอขอบคุณที่ท่านช่วยตอบแบบสอบถามนี้โดยสมบูรณ์ หากท่านจะมีความคิดเห็นหรือข้อเสนอแนะเพิ่มเติมใดๆ โปรดเขียนลงในที่ว่างข้างล่างนี้

Thank you for your participation in completing this questionnaire. If you have any other matters to comment, please feel free to write in the space below.

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Questionnaire prepared by Anusak Hongsa-ngiam in consultation with A/Prof. Mark Hackling

Instructor Interview

Code

Name ………………………………………………...

Rajbhat institute ..……………………………………………...

Date of 1st interview……………………………………..…….

Date of 2nd interview……………………………………..…….

This interview aims to seek your opinions and beliefs about teaching and learning physics in Thai Rajabhats. Thank you for participating.

First interview

Your background

1. Please tell me briefly about your educational background and teaching experiences.
   …………………………………………………………………………………
   …………………………………………………………………………………
   …………………………………………………………………………………
2. What is your main motivation for studying and teaching physics?
   …………………………………………………………………………………
   …………………………………………………………………………………

Nature of physics

3. What do you hope your students will learn about the nature of physics?
   …………………………………………………………………………………
   …………………………………………………………………………………

Teaching physics

4. In your opinion, what are the most effective strategies in teaching physics?
   …………………………………………………………………………………
   Why are these strategies effective?
   …………………………………………………………………………………
   …………………………………………………………………………………
5. What teaching strategies do you use most often in physics?
   …………………………………………………………………………………
   Why do you use these strategies?
   …………………………………………………………………………………
   …………………………………………………………………………………
   …………………………………………………………………………………

Learning physics

6. What study and learning strategies should students use to be successful in physics?
…………………………………………………………………………………
…………………………………………………………………………………
How do these strategies help students learn?
…………………………………………………………………………………
…………………………………………………………………………………
…………………………………………………………………………………
7. Why do many students find physics difficult?
…………………………………………………………………………………
…………………………………………………………………………………
…………………………………………………………………………………
8. Why do many students not like physics?
…………………………………………………………………………………
…………………………………………………………………………………

Second interview

1. Which teaching strategies did you use most often in physics this semester?
…………………………………………………………………………………
…………………………………………………………………………………
Why did you use these strategies?
…………………………………………………………………………………
…………………………………………………………………………………
………………………………………………
What factors limit the quality and effectiveness of your teaching in physics?
…………………………………………………………………………………
…………………………………………………………………………………
…………………………………………………………………………………
2. Are you satisfied with the students' learning this semester?
…………………………………………………………………………………
…………………………………………………………………………………
How could student learning be improved?
…………………………………………………………………………………
…………………………………………………………………………………
3. What changes would you like to make to your teaching?
…………………………………………………………………………………
…………………………………………………………………………………
…………………………………………………………………………………
…………………………………………………………………………………
4. If you had the authority, what change would you make to improve the way physics is taught in Thai Rajabhat?
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APPENDIX F: Student Interview

Student Interview

Code

Name ………………………………………………...

Rajabhat institute ..…………………………………………….

Date of 1st interview …………………………………….…….

Date of 2nd interview……………………………………….…….

Thank you for agreeing to participate in this interview. I am interested in your ideas and opinions about teaching and learning physics in Thai Rajabhats. Your ideas will help us improve the way we teach physics.

First interview

Your physics experiences

1. What was physics teaching look like in your secondary school?
   ……………………………………………………………………………
   ……………………………………………………………………………
   What were the most common teaching strategies?
   ……………………………………………………………………………
   ……………………………………………………………………………
   How did you learn? What were the main study methods you used?
   ……………………………………………………………………………
   ……………………………………………………………………………
   ……………………………………………………………………………
2. Please identify the meaning of physics in your own words.
   ……………………………………………………………………………
   ……………………………………………………………………………
   ……………………………………………………………………………

Your beliefs about teaching and learning physics

3. How do you think physics should be taught?
   ……………………………………………………………………………
   ……………………………………………………………………………
   What teaching methods should school teachers and Rajabhat instructors use to teach physics?
   ……………………………………………………………………………
   ……………………………………………………………………………
4. Please tell me your plan for studying physics in this semester. What study methods will you use?
   ……………………………………………………………………………
   ……………………………………………………………………………

Goals and motivation

5. Are you interested in studying physics? Why?
   ………………………………………………………………………………
   ………………………………………………………………………………
   If you were free to choose your subjects this year, would you choose to study physics?
   ………………………………………………………………………………
   ………………………………………………………………………………
6. What are your goals for studying physics this year?
   ………………………………………………………………………………
   ………………………………………………………………………………

Attribution to success

7. Among your classmates, who will success in physics? Why?
   ………………………………………………………………………………
   ………………………………………………………………………………
   Will it be the clever students only, or can hard working students get good grades too?
   ………………………………………………………………………………
   ………………………………………………………………………………

Learning orientation

8. Which of the following would be the most satisfactory result for you in studying physics: meaningful understanding, good grades, pleasing your instructor, or pleasing your parents? Why?
   ………………………………………………………………………………
   ………………………………………………………………………………
   ………………………………………………………………………………
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   ………………………………………………………………………………

Second interview

1. Which learning strategies did you use most often in physics this semester?
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……………………………………………………………………………………
Why did you use these strategies?
……………………………………………………………………………………
……………………………………………………………………………………
2. How could you improve your approach to learning? What strategies would you change? Why?
……………………………………………………………………………………
……………………………………………………………………………………
3. What factors and conditions limit your success in learning physics?
……………………………………………………………………………………
……………………………………………………………………………………
4. Are you satisfied with the physics instructor's teaching this semester?
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……………………………………………………………………………………
Would you like the instructor to make any changes in teaching?
……………………………………………………………………………………
……………………………………………………………………………………
What changes would you like to see made to the physics course?
……………………………………………………………………………………
……………………………………………………………………………………
5. Do you think you have been successful in learning physics this semester? What helped you be successful OR What stopped you being successful?
……………………………………………………………………………………
……………………………………………………………………………………

APPENDIX G: Classroom Observation

Classroom Observation

Instructor: ……………………………. Date: ……………………… Time: ……………………. Session Type: …………………

Instructor's Teaching											Students' Studying										
Activities	Time (min.)										Activities	Time (min.)									
	10	20	30	40	50	60	70	80	90	100		10	20	30	40	50	60	70	80	90	100
Lecturing											Listening										
Explaining											Making notes										
Giving notes											Reading										
Questioning											Copying										
Encouraging											Solving problem										

Instructor's Teaching											Students' Studying										
Activities	Time (min.)										Activities	Time (min.)									
	10	20	30	40	50	60	70	80	90	100		10	20	30	40	50	60	70	80	90	100
Assigning/ Giving instructions											Group working										
Demonstrating											Doing experiment										
Supervising student practical or other work											Responding to questions and participating in whole class discussion										
Assessing																					
Others											Others										

Comments:

Classroom Environment	Instructor’s Teaching	Students’ Studying
…………………………………	…………………………………	…………………………………
…………………………………	…………………………………	…………………………………
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Observer ……………………………............

EDITH COWAN UNIVERSITY
PERTH WESTERN AUSTRALIA

STUDENT OPINIONS ABOUT PHYSICS QUESTIONNAIRE

ข้อมูลส่วนบุคคล
Personal Information

ชื่อ (หากไม่ประสงค์ระบุ โปรดข้ามไป): Name

………………………………………………………………………

สถาบันราชภัฏ: Rajabhat Institute

………………………………………………………………………………

วิชาเอก/โปรแกรมวิชา: Major/Program of study

………………………………………………………………

Code
…… ……
…… ……
…… ……

นักศึกษาทุกท่าน

แบบสอบถามนี้ต้องการสำรวจความเห็นของท่านเกี่ยวกับวิชาฟิสิกส์ โปรดตอบและแสดงความคิดเห็นของท่าน ตามความเป็นจริง ในคำถามแต่ละข้อจะไม่มีคำตอบที่ถูกหรือผิด คำตอบของท่านจะไม่กระทบต่อคะแนนหรือผลการเรียนของท่านแต่อย่างใด ข้อมูลส่วนบุคคลของท่านจะไม่รั่วไหลไปยังอาจารย์หรือสถาบันราชภัฏ รายงานใดๆของการวิจัยครั้งนี้จะไม่ระบุชื่อของนักศึกษา อาจารย์หรือสถาบันราชภัฏใดๆทั้งสิ้น โดยที่คณะกรรมการจรรยาบรรณแห่งมหาวิทยาลัยอีดิธ โคแวน รัฐออสเตรเลียตะวันตก ได้ให้ความเห็นชอบในการทำการศึกษาครั้งนี้แล้ว

ขอขอบคุณในความร่วมมือ

Dear Student

This questionnaire seeks your opinions about physics. Please answer honestly and express your real opinions. There is no right or wrong answer in each question. Your answers will not affect your scores and grades. Personal information will not be accessible by your instructors or Rajabhat. No students, instructors or Rajabhats will be identified in any reports of this research. The Ethics Committee of Edith Cowan University, Western Australia has approved this study.

Thank you for participating.

Part A

โปรดวงกลมรอบตัวเลขในแต่ละข้อที่ตรงกับความคิดเห็นของท่าน
Please circle the number in each item that corresponds to your opinion.

ท่านคิดเห็นอย่างไรเกี่ยวกับวิชาฟิสิกส์? *What do you think about physics?*	[illegible] ยิ่ง : Strongly	ไม่เห็นด้วย : Disagree	เฉยๆ : Not disagree or agree	เห็นด้วย : Agree	เห็นด้วยอย่างยิ่ง : Strongly agree
1. ฟิสิกส์เป็นวิชาที่น่าสนใจ Physics is interesting.	1	2	3	4	5
2. ฟิสิกส์เป็นวิชาที่น่าชื่นชอบและเรียนสนุก Physics is enjoyable and fun.	1	2	3	4	5
3. ฟิสิกส์เป็นวิชาที่มีประโยชน์ Physics is useful.	1	2	3	4	5
4. ฟิสิกส์เป็นวิชาที่ยาก Physics is difficult.	1	2	3	4	5
5. ฟิสิกส์เป็นวิชาที่ยุ่งยากซับซ้อน Physics is complicated.	1	2	3	4	5
6. ฟิสิกส์เป็นวิชาที่น่าเบื่อหน่าย Physics is tedious and boring.	1	2	3	4	5
7. ฟิสิกส์เป็นวิชาที่ไม่เกี่ยวข้องกับชีวิตจริง Physics is irrelevant to real life.	1	2	3	4	5
8. การสอนที่ดีๆ ไม่เคยปรากฏในชั้นเรียนวิชาฟิสิกส์ Good teaching never happens in physics classes.	1	2	3	4	5
9. ฉันต้องการรู้ฟิสิกส์ให้มากกว่านี้ I need to learn more physics.	1	2	3	4	5
10. วิธีที่จะทำให้ได้เกรดดีๆคือพยายามจำเรื่องต่างๆให้ได้ The way to get good grades is to memorise the facts.	1	2	3	4	5
11.	1	2	3	4	5

วิธีที่จะทำให้ได้เกรดดีๆคือเรียนให้เข้าใจและสามารถนำไปประยุกต์ใช้ได้ The way to get good grades is to understand and be able to apply the ideas.					
12. การทำการทดลองช่วยให้ฉันเรียนรู้วิชาฟิสิกส์ Doing experiments helps me learn physics.	1	2	3	4	5
13. การแก้ปัญหาในวิชาฟิสิกส์ช่วยให้ฉันเรียนรู้ฟิสิกส์ Solving physics problems helps me learn physics.	1	2	3	4	5
14. วิชาฟิสิกส์ช่วยให้ท่านเข้าใจเรื่องต่างๆในโลกนี้และช่วยการตัดสินใจในชีวิตของท่าน Physics helps you understand the world and make decisions in your life.	1	2	3	4	5
15. ท่านต้องขยันเรียนให้หนักขึ้นจึงจะได้เกรดที่ดีในวิชาฟิสิกส์ You need to study hard to get good grades in physics.	1	2	3	4	5
16. ท่านต้องเป็นคนฉลาดจึงจะได้เกรดดีๆในวิชาฟิสิกส์ You need to clever to get good grades in physics.	1	2	3	4	5
17. ท่านจำเป็นต้องเก่งวิชาคณิตศาสตร์จึงจะทำให้ได้เกรดดีๆในวิชาฟิสิกส์ You need to be good at maths to get good grades in physics.	1	2	3	4	5

Part B

โปรดตอบในแต่ละข้อต่อไปนี้โดยการทำเครื่องหมายหรือเติมคำตอบในช่องว่าง

Please answer by checking or fill in the blank of each question.

1. ถ้าเปรียบเทียบกับวิชาอื่นๆแล้ว วิชาฟิสิกส์จะเป็นอย่างไร?

   How does physics compare with other subjects?

   โปรดวงกลมรอบตัวเลขซึ่งแสดงว่าท่านชอบวิชาฟิสิกส์อยู่ในลำดับใดเมื่อเปรียบเทียบใน 10 วิชากับวิชาอื่นๆ

   Please circle the number that shows how much you like physics compared with ten other subjects.

10	9	8	7	6	5	4	3	2	1

วิชาที่ชอบมากที่สุด

วิชาที่ชอบน้อยที่สุด

Most favorite subject Least favorite subject

2. ท่านต้องการเรียนฟิสิกส์เพิ่มเติมอีกหรือไม่?

   Would you like to study more physics?

   ☐ ต้องการ ☐ ไม่ต้องการ

   ☐ Yes ☐ No

   เพราะเหตุใด?

   Why?

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3. ท่านชอบวิชาฟิสิกส์ในด้านใดบ้าง?

   What do you like about physics?

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ท่านไม่ชอบวิชาฟิสิกส์ในด้านใดบ้าง?

What do you dislike about physics?

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4. ท่านคิดว่าควรจะมีการเปลี่ยนแปลงอย่างไรเพื่อให้วิชาฟิสิกส์ดีขึ้น?

How would you change physics to make it better?

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5. ท่านมีข้อเสนอแนะเพิ่มเติมอื่นๆเกี่ยวกับวิชาฟิสิกส์หรือไม่?

Do you have any other comments about physics?

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Questionnaire prepared by Anusak Hongsa-ngiam in consulation with A/Prof Mark Hackling

APPENDIX I: Coding of Instructor Questionnaire

Personal information

Item	Excel column heading	Codes	
Name	Subject	1, 2, 3, …	
Rajabhat	Rajabhat	Suansunandha	1
		Suandusit	2
		Chandhakasem	3
		Pranakorn	4
		Thonburi	5
		Bansomdetchaophraya	6
		Chiangmai	7
		Chiangrai	8
		Lampang	9
		Uttaradith	10
		Pibulsongkram	11
		Kampaengpetch	12
		Nakornsawan	13
		Petchaboon	14
		Udornthani	15
		Mahasarakam	16
		Loei	17
		Sakolnakorn	18
		Nakornratchasima	19
		Buriram	20
		Surin	21
		Ubonratchathani	22
		Pranakornsi-ayudhaya	23
		Rampaipannee	24
		Rajanakarin	25
		Thepsatri	26
		Walai-alongkorn	27
		Petchuburi	28
		Kanchanaburi	29
		Nakornpathom	30
		Mubanchombung	31
		Suratthani	32
		Nakornsithammarat	33
		Phuket	34
		Songkhla	35
		Yala	36
Qualifications	Under_S	B.Sc	1 or 0
	Under_E	B.Ed	1 or 0
	Post_S	M.Sc	1 or 0
	Post_E	M.Ed	1 or 0
	Post_D	Postgraduate Diploma	1 or 0
	Post_P	Ph.D	1 or 0

Item	Excel column heading	Codes	
Major	Major	Physics	1
		Education	2
		Others	3
Teaching experience	Teachexp	< 5 yrs	1
		6 - 10 yrs	2
		11 - 15 yrs	3
		16 - 20 yrs	4
		> 20 yrs	5

Part A

Item	Excel column heading	Codes	
Q1: What should students learn about the nature of physics?	Q1_1	Relevance to real life	1 or 0
	Q1_2	Principles, laws and concepts	1 or 0
	Q1_3	Mathematical skills	1 or 0
	Q1_4	Interactions among matters	1 or 0
	Q1_5	Application of physics	1 or 0
	Q1_6	History of physics	1 or 0
	Q1_7	Scientific process	1 or 0
	Q1_8	Physical phenomena	1 or 0
	Q1_9	Quantities in physics	1 or 0
	Q1_10	Skills in doing experiments	1 or 0
Q2-1: What are the percentages of your actual and ideal teaching circumstances?	Q2_1EA	Explaining physics-actual%	Percentage
	Q2_1EI	Explaining physics-ideal%	Percentage
	Q2_1QDA	Questioning and discussing-actual%	Percentage
	Q2_1QDI	Questioning and discussing-ideal%	Percentage
	Q2_1GA	Giving notes-actual%	Percentage
	Q2_1GI	Giving notes-ideal%	Percentage
	Q2_1SVA	Showing video-actual%	Percentage
	Q2_1SVI	Showing video-ideal%	Percentage
	Q2_1DA	Demonstration-actual%	Percentage
	Q2_1DI	Demonstration-ideal%	Percentage
	Q2_1IWA	Individual work-actual%	Percentage
	Q2_1IWI	Individual work-ideal%	Percentage

Item	Excel column heading	Codes	
Q2-1: (continued)	Q2_1SGA	Small group work-actual%	Percentage
	Q2_1SGI	Small group work-ideal%	Percentage
Q2-2: What are the characteristics of effective physics teaching?	Q2_2CA	Cooperative atmosphere	1 or 0
	Q2_2CE	Clear explanation	1 or 0
	Q2_2CT	Critical thinking	1 or 0
	Q2_2DEP	Do experiment/Laboratory approaches	1 or 0
	Q2_2DEX	Doing calculation and exercises	1 or 0
	Q2_2EI	Educational innovation (media)	1 or 0
	Q2_2EL	Enjoy lessons	1 or 0
	Q2_2ES	Encouraging students	1 or 0
	Q2_2GA	Good attitude towards physics	1 or 0
	Q2_2GD	Group discussion	1 or 0
	Q2_2GE	Good evaluation	1 or 0
	Q2_2PS	Problem solving and inquiry	1 or 0
	Q2_2SC	Student centred	1 or 0
	Q2_2SM	Scientific method	1 or 0
	Q2_2VM	Use various methods	1 or 0
Q2-3: What are the important roles of physics instructors in effective physics teaching?	Q2_3EP	Encourage, promote and conduct students to learn	1 or 0
	Q2_3GE	Being as a good evaluator	1 or 0
	Q2_3HS	Help, advise or coach students	1 or 0
	Q2_3MA	Manage suitable learning activities	1 or 0
	Q2_3TK	Transfer physics knowledge	1 or 0

Item	Excel column heading	Codes	
Q2-4: What is the main factor that limits the quality and effectiveness of your physics teaching?	Q2_4BA	Students have bad attitudes towards physics	1 or 0
	Q2_4EC	Students pay less effort and some problems from cultural background	1 or 0
	Q2_4IT	Insufficient time to complete physics lessons	1 or 0
	Q2_4LE	Insufficiency of laboratory and educational equipment	1 or 0
	Q2_4MS	Too many students in a class	1 or 0
	Q2_4OT	Overload tasks and responsibilities of instructors	1 or 0
	Q2_4SA	Lack of support from the administration	1 or 0
	Q2_4SBK	Students have low ability and background knowledge	1 or 0
	Q2_4TL	Lack of texts and learning materials	1 or 0
	Q2_4TS	Using ineffective teaching strategies	1 or 0
Q3-1: What are the most effective strategies for learning physics?	Q3_1AA	Analytical activities	1 or 0
	Q3_1DE	Doing exercises	1 or 0
	Q3_1HA	Hands-on activities or laboratory approaches: Active learning	1 or 0
	Q3_1PS	Problem solving base and inquiry method	1 or 0
	Q3_1QD	Questioning and discussing	1 or 0
	Q3_1RL	Reading and listening	1 or 0
	Q3_1VS	Use various strategies	1 or 0
Q3-2: What is the motivation for students to study physics?	Q3_2AP	Application of physics to real situations	1 or 0
	Q3_2CP	Challenging to do with the subject	1 or 0
	Q3_2FP	The successes of famous physicists	1 or 0
	Q3_2GT	Good teaching and the successes in studying	1 or 0

Item	Excel column heading	Codes	
Q3-2: (continued)	Q3_2IP	Awareness to the importance of physics	1 or 0
	Q3_2NM	No motivation in physics	1 or 0
	Q3_2OJ	Opportunities in finding jobs	1 or 0
Q3-3: What factors limit students' success in getting good grades in physics?	Q3_3BA	Bad attitudes towards physics, less effort and attention	1 or 0
	Q3_3EM	Lack of encouragement and motivation	1 or 0
	Q3_3ET	Insufficiency of laboratory equipment and texts	1 or 0
	Q3_3IA	Inappropriate assessment	1 or 0
	Q3_3IQ	Low IQ and ability	1 or 0
	Q3_3KM	Low background knowledge of physics and mathematics	1 or 0
	Q3_3MC	Too much difficult contents in a short period	1 or 0
	Q3_3RL	Employ ineffective and rote learning strategies	1 or 0
	Q3_3TS	Ineffective teaching strategies	1 or 0
Q4-1: What is the main purpose of assessment in physics?	Q4_1AKU	To measure the ability in applying physics knowledge and understanding	1 or 0
	Q4_1EC	To evaluate and categorise students	1 or 0
	Q4_1ITL	To improve teaching and learning strategies	1 or 0
	Q4_1PSA	To measure ability of solving problem	1 or 0
	Q4_1PSL	To measure practical skills in laboratory work	1 or 0
	Q4_1SDA	To measure students development and achievement	1 or 0

Item	Excel column heading	Codes	
Q4-2: How do you assess your students in physics?	Q4_2AA	Assignment assessment	1 or 0
	Q4_2CA	Continuous assessment	1 or 0
	Q4_2CE	Criterion evaluation	1 or 0
	Q4_2NE	Norm evaluation	1 or 0
	Q4_2NS	Not specified	1 or 0
	Q4_2OA	Observation assessment	1 or 0
	Q4_2OEA	Oral enquiry assessment	1 or 0
	Q4_2PT	Pencil-and-paper tests	1 or 0
	Q4_2PW	Practical work assessment	1 or 0
Q5: How could physics teaching and learning be improved in Rajabhat institutes?	Q5_1	Provide sufficient support of material, staffs and budget	1 or 0
	Q5_2	Raise the ability of instructors	1 or 0
	Q5_3	Curriculum development	1 or 0
	Q5_4	Provide more texts and other information sources	1 or 0
	Q5_5	Improve teaching and learning strategies, focus on laboratory approaches	1 or 0
	Q5_6	Improve administrative system	1 or 0
	Q5_7	Quality assurance in teaching and learning	1 or 0
	Q5_8	Improve assessment procedures	1 or 0
	Q5_9	Focus on research work	1 or 0
	Q5_10	Use student-centred strategies	1 or 0
	Q5_11	Stress on affective domain	1 or 0
	Q5_12	Hard working both in teaching and studying	1 or 0
	Q5_13	Cooperative working among physics instructors	1 or 0

Item	Excel column heading	Codes	
Q5: (continued)	Q5_14	Decrease workload for the development of teaching career	1 or 0
	Q5_15	Decrease some details in physics contents	1 or 0
	Q5_16	Select smart students to study physics	1 or 0

Part B

Item	Excel column heading	Codes
Q1	I1	1 or 2 or 3 or 4 or 5
Q2	I2	1 or 2 or 3 or 4 or 5
Q3	I3	1 or 2 or 3 or 4 or 5
Q4	I4	1 or 2 or 3 or 4 or 5
Q5	I5	1 or 2 or 3 or 4 or 5
Q6	I6	1 or 2 or 3 or 4 or 5
Q7	I7	1 or 2 or 3 or 4 or 5
Q8	I8	1 or 2 or 3 or 4 or 5
Q9	I9	1 or 2 or 3 or 4 or 5
Q10	I10	1 or 2 or 3 or 4 or 5
Q11	I11	1 or 2 or 3 or 4 or 5
Q12	I12	1 or 2 or 3 or 4 or 5
Q13	I13	1 or 2 or 3 or 4 or 5
Q14	I14	1 or 2 or 3 or 4 or 5
Q15	I15	1 or 2 or 3 or 4 or 5
Q16	I16	1 or 2 or 3 or 4 or 5
Q17	I17	1 or 2 or 3 or 4 or 5
Q18	I18	1 or 2 or 3 or 4 or 5
Q19	I19	1 or 2 or 3 or 4 or 5
Q20	I20	1 or 2 or 3 or 4 or 5
Q21	I21	1 or 2 or 3 or 4 or 5
Q22	I22	1 or 2 or 3 or 4 or 5
Q23	I23	1 or 2 or 3 or 4 or 5

Part C

Item	Excel column heading	Codes	
C1: (Problems of teaching and learning in Rajabhats)	C1_IBK	Instructors' beliefs about tenable physics knowledge	1 or 0
	C1_IPL	Irrelevant physics lessons to real-life situations	1 or 0
	C1_LCS	Students have low competency (intelligence) to learn	1 or 0
	C1_LSA	Lack of support from administration	1 or 0
	C1_LSB	Lack of sufficient budget	1 or 0
	C1_NSI	Non-sophisticated instructors	1 or 0
	C1_ODC	Out of date curriculum	1 or 0
	C1_OTR	Overload tasks and responsibilities of instructors	1 or 0
	C1_PKE	Students have not enough prior knowledge and experiences	1 or 0
	C1_SBA	Students have bad attitudes towards physics	1 or 0
	C1_SLE	Shortage of laboratory equipment and technician support	1 or 0
C2: (How to improve physics teaching and learning in Rajabhats)	C2_ARP	Do more academic research and publications	1 or 0
	C2_ASI	Assessment system improvement	1 or 0
	C2_BPE	Begin physics lessons at the early ages of students	1 or 0
C2: (continued)	C2_CIT	Continuously improve teaching strategies	1 or 0

Item	Excel column heading	Codes	
	C2_FUM	Focus on student understanding rather than memorising	1 or 0
	C2_INI	Increase the number of instructors and technical staffs	1 or 0
	C2_IPC	Improve physics curriculum	1 or 0
	C2_MTS	Motivate talent students to study physics	1 or 0
	C2_RVP	Raise the value of physics profession	1 or 0
	C2_SQI	Secondary school education quality improvement	1 or 0
	C2_STM	Provide suitable texts and materials	1 or 0
	C2_STS	Provide sufficient time for student learning	1 or 0
C3: (Other comments)	C3_NRC	Irrelevant comments to teaching and learning physics	1 or 0

APPENDIX J: Coding of Students' Questionnaire

Personal Information

Item	Excel column heading	Codes	
Name	Student	1, 2, 3, …	
Rajabhat	Rajabhat	Phuket	1
		Suratthani	2
Major	Major	Food Science	1
		Environmental Science	2
		General sciences	3
		Physics Education	4
		Public Health	5

Part A

Item	Excel column heading	Codes	
S1-1: Do you want to study physics?	S1_1	1 or 0	
S1-2: Why?	S1_201	It can apply to real life, create technology	1 or 0
	S1_202	It is important to my career	1 or 0
	S1_203	It is an interesting and a challenging subject	1 or 0
	S1_204	I want to be a smart person	1 or 0
	S1_205	Physics is difficult	1 or 0
	S1_206	I don't like maths and physics	1 or 0
	S1_207	I have a poor background in physics and maths	1 or 0
	S1_208	It is not relevant to real life	1 or 0
S2: What do you want to get from physics?	S2_01	Ability in applying knowledge to real life	1 or 0
	S2_02	Fun and enjoyable lessons, not serious classes	1 or 0
	S2_03	Content of physics that related to real life	1 or 0
	S2_04	Skills of solving problems and maths	1 or 0
	S2_05	To pass an examination and get good grades	1 or 0

Item	Excel column heading	Codes	
S2: (continued)	S2_06	Good teachers and good teaching	1 or 0
	S2_07	Understanding and knowledge in physics	1 or 0
	S2_08	Nothing from physics	1 or 0
S3: What are the characteristics of good physics teaching?	S3_01	Make physics lessons to be enjoyable and fun	1 or 0
	S3_02	Explain clearly for the students' understanding	1 or 0
	S3_03	With hands-on activities and sudent-centered	1 or 0
	S3_04	Emphasize on solving problems with maths	1 or 0
	S3_05	Teaching with appropriate media and materials	1 or 0
	S3_06	With student participation in the lesson	1 or 0
	S3_07	Relate to real situations	1 or 0
	S3_08	Begin from fundamental to advanced in slow steps	1 or 0
	S3_09	Understanding/attending to students individaul needs	1 or 0
S4: What study strategies should students use to learn physics effectively?	S4_01	Pay attention to classes for understanding lessons	1 or 0
	S4_02	Taking and copying notes	1 or 0
	S4_03	Doing exercises and homework	1 or 0
	S4_04	Working in groups	1 or 0
	S4_05	Doing laboratory work	1 or 0
	S4_06	Listening to the instructor's lecture	1 or 0
	S4_07	Memorize formulae and theory	1 or 0
	S4_08	Questioning and discussing	1 or 0
	S4_09	Review lessons after classes	1 or 0
	S4_10	Reading texts and manuals	1 or 0
	S4_11	Not relevant answer	1 or 0

Item	Excel column heading	Codes	
S5: What are the percentages of your actual and ideal learning circumstances?	S5_01	Listening to the instructor's lecture-actual%	Percentage
	S5_02	Listening to the instructor's lecture-ideal%	Percentage
	S5_03	Taking and copying notes-actual%	Percentage
	S5_04	Taking and copying notes-ideal%	Percentage
	S5_05	Questioning and discussing-actual%	Percentage
	S5_06	Questioning and discussing-ideal%	Percentage
	S5_07	Doing laboratory work-actual%	Percentage
	S5_08	Doing laboratory work-ideal%	Percentage
	S5_09	Reading texts and manuals-actual%	Percentage
	S5_10	Reading texts and manuals-ideal%	Percentage
	S5_11	Doing exercises and homework-actual%	Percentage
	S5_12	Doing exercises and homework-ideal%	Percentage
	S5_13	Working in group-actual%	Percentage
	S5_14	Working in group-ideal%	Percentage
	S5_15	Other activities-actual%	Percentage
	S5_16	Other activities-ideal%	Percentage
S6-1: Do you agree that physics is a subject only for the clever people? S6-2: Why?	S6_1	1 or 0	
	S6_201	Effort and hard working help people to learn	1 or 0
	S6_202	Physics is a subject for every one	1 or 0
	S6_203	You can learn if you interested and enjoy physics	1 or 0
	S6_204	Good teachers and teaching help us to learn	1 or 0
	S6_205	Clever people are able to learn quickly	1 or 0
	S6_206	Physics is a difficult subject	1 or 0

Item	Excel column heading	Codes	
S7-1: Do you believe that if you work hard you can get good grades in physics?	S7_1	1 or 0	
S7-2: Why?	S7_201	Success is always a result of hard work	1 or 0
	S7_202	You can memorize better by working hard	1 or 0
	S7_203	Working hard helps you to understand physics	1 or 0
	S7_204	Working hard helps you to be smarter	1 or 0
	S7_205	You will be able to do exercises and tests	1 or 0
	S7_206	I just think it should be better if I work hard	1 or 0
	S7_207	Useless if you are very weak in maths	1 or 0
	S7_208	Working hard doesn't mean you understand it	1 or 0
S8-1: What is more important for getting good grades in physics?	S8_1	1 or 2	
S8-2: Why?	S8_201	Success is a result of enough effort	1 or 0
	S8_202	Ability only is not enough for success	1 or 0
	S8_203	Effort raises your ability and understanding	1 or 0
	S8_204	You can pass exams by your effort	1 or 0
	S8_205	You may get some rewards from your effort	1 or 0
	S8_206	Without abilty, effort is useless	1 or 0
	S8_207	Ability helps people to understand easily	1 or 0
	S8_208	Ability is an innate characteristic	1 or 0
	S8_209	People succeed in studying with their ability	1 or 0
	S8_210	Effort and ability are equally important	1 or 0

Item	Excel column heading	Codes	
	S8_211	Not relevant answer/ I just think like that	1 or 0
S9: Many students say that physics is a difficult subject. What is that makes physics difficult to learn and get good grades?	S9_01	Teaching and assessment strategies	1 or 0
	S9_02	Lots of difficult mathematics	1 or 0
	S9_03	Abstract and complicated contents	1 or 0
	S9_04	Irrelevant to real life, doesn't make sense	1 or 0
	S9_05	Students have insufficient ability to learn	1 or 0
	S9_06	Less effort and attention, laziness and worrying	1 or 0
	S9_07	Having bad attitudes to the subject	1 or 0
	S9_08	Not familiar with laboratory equipment	1 or 0
	S9_09	I don't think so	1 or 0
	S9_10	Not relevant answer	1 or 0
S10: "It is very important to please your physics instructor and your parents, so you must work hard." Why do you agree or disagree with the above statement?	S10_A01	A: It must be only this way	1 or 0
	S10_A02	A: To pay gratitude to my parents	1 or 0
	S10_A03	A: To make them happy and proud to me	1 or 0
	S10_A04	A: To satisfy with their aspirations	1 or 0
	S10_A05	A: Agree with not relevant explanation	1 or 0
	S10_D01	D: I must control myself, nobody else	1 or 0
	S10_D02	D: Disagree with not relevant answer	1 or 0
S11: "It is very shameful to be a poor student in the class so I must work hard." Why do you agree or disagree with the above statement?	S11_A01	A: Being a poor student is a disadvatage	1 or 0
	S11_A02	A: It is unacceptable to other people	1 or 0
	S11_A03	A: It may affect to my career in the future	1 or 0
	S11_A04	A: People are able to succeed by themeselves from their hard working	1 or 0

Item	Excel column heading	Codes	
	S11_A05	A: Nobody wants to be the weakest person in the class	1 or 0
	S11_A06	A: Poor students get low grades and fail	1 or 0
	S11_A07	A: Parents are ashamed of having weak children	1 or 0
	S11_D01	D: Embarrassment motivate students	1 or 0
	S11_D02	D: You can be better in another way	1 or 0
	S11_D03	D: Feeling as a poor student discourages people	1 or 0
	S11_D04	D: Individuals are always different	1 or 0
	S11_D05	D: This is a difficult subject	1 or 0

Part B

Item	Excel column heading	Codes
I1	SI_01	1 or 2 or 3 or 4 or 5
I2	SI_02	1 or 2 or 3 or 4 or 5
I3	SI_03	1 or 2 or 3 or 4 or 5
I4	SI_04	1 or 2 or 3 or 4 or 5
I5	SI_05	1 or 2 or 3 or 4 or 5
I6	SI_06	1 or 2 or 3 or 4 or 5
I7	SI_07	1 or 2 or 3 or 4 or 5
I8	SI_08	1 or 2 or 3 or 4 or 5
I9	SI_09	1 or 2 or 3 or 4 or 5
I10	SI_10	1 or 2 or 3 or 4 or 5
I11	SI_11	1 or 2 or 3 or 4 or 5
I12	SI_12	1 or 2 or 3 or 4 or 5
I13	SI_13	1 or 2 or 3 or 4 or 5
I14	SI_14	1 or 2 or 3 or 4 or 5
I15	SI_15	1 or 2 or 3 or 4 or 5
I16	SI_16	1 or 2 or 3 or 4 or 5
I17	SI_17	1 or 2 or 3 or 4 or 5

Item	Excel column heading	Codes
I18	SI_18	1 or 2 or 3 or 4 or 5
I19	SI_19	1 or 2 or 3 or 4 or 5
I20	SI_20	1 or 2 or 3 or 4 or 5
I21	SI_21	1 or 2 or 3 or 4 or 5
I22	SI_22	1 or 2 or 3 or 4 or 5
I23	SI_23	1 or 2 or 3 or 4 or 5
I24	SI_24	1 or 2 or 3 or 4 or 5
I25	SI_25	1 or 2 or 3 or 4 or 5
I26	SI_26	1 or 2 or 3 or 4 or 5
I27	SI_27	1 or 2 or 3 or 4 or 5
I28	SI_28	1 or 2 or 3 or 4 or 5
I29	SI_29	1 or 2 or 3 or 4 or 5
I30	SI_30	1 or 2 or 3 or 4 or 5
I31	SI_31	1 or 2 or 3 or 4 or 5
I32	SI_32	1 or 2 or 3 or 4 or 5
I33	SI_33	1 or 2 or 3 or 4 or 5
I34	SI_34	1 or 2 or 3 or 4 or 5
I35	SI_35	1 or 2 or 3 or 4 or 5

Part C

Item	Excel column heading	Codes	
SC-1: Comments on learning physics	SC_L01	Physics is not too difficult if you pay enough attention	1 or 0
	SC_L02	To understand physics needs your effort and patience	1 or 0
	SC_L03	You can learn physics if you understand it	1 or 0
	SC_L05	Physics is difficult, I don't want to study it	1 or 0
	SC_L06	Many students never succeed in physics	1 or 0

Item	Excel column heading	Codes	
	SC_L07	If we are good in maths we will be good in physics	1 or 0
	SC_L08	Success in physics is the result of good teaching	1 or 0
	SC_L09	We learn better by hands-on activities with appropriate help	1 or 0
	SC_L10	Physics lessons should be started at the early ages	1 or 0
SC-2: Comments on teaching physics	SC_T01	Clear explanations help students to understand physics	1 or 0
	SC_T02	Arouse the class with enjoyable lessons, not too strict	1 or 0
	SC_T03	Physics must be relevant to real life and my career	1 or 0
	SC_T04	Lecture should be follow by doing exercises and labs	1 or 0
	SC_T05	Teachers must be friendly and helpful to students	1 or 0
	SC_T06	Teachers always pay their attention only on teaching	1 or 0
	SC_T07	Teachers must understand each individual student	1 or 0
	SC_T08	Please improve your approaches to teaching	1 or 0

APPENDIX K: Coding of Student Opinion Questionnaire

Personal Information

Item	Excel column heading	Codes	
Name	Student	1, 2, 3, …	
Rajabhat	Rajabhat	Phuket	1
		Suratthani	2
Major	Major	Food Science	1
		Environmental Science	2
		General sciences	3
		Physics Education	4
		Public Health	5

Part A

Q1	Q1	1 or 2 or 3 or 4 or 5
Q2	Q2	1 or 2 or 3 or 4 or 5
Q3	Q3	1 or 2 or 3 or 4 or 5
Q4	Q4	1 or 2 or 3 or 4 or 5
Q5	Q5	1 or 2 or 3 or 4 or 5
Q6	Q6	1 or 2 or 3 or 4 or 5
Q7	Q7	1 or 2 or 3 or 4 or 5
Q8	Q8	1 or 2 or 3 or 4 or 5
Q9	Q9	1 or 2 or 3 or 4 or 5
Q10	Q10	1 or 2 or 3 or 4 or 5
Q11	Q11	1 or 2 or 3 or 4 or 5
Q12	Q12	1 or 2 or 3 or 4 or 5
Q13	Q13	1 or 2 or 3 or 4 or 5
Q14	Q14	1 or 2 or 3 or 4 or 5
Q15	Q15	1 or 2 or 3 or 4 or 5
Q16	Q16	1 or 2 or 3 or 4 or 5
Q17	Q17	1 or 2 or 3 or 4 or 5

Part B

Item	Excel column heading	Codes	
B1: How does physics compare with other subjects?	B1	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10	
B2-1: Would you like to study more physics?	B2_1	1 or 0	
B2-2: Why	B2_2AP	Application of physics is useful	1 or 0
	B2_2AS	I can't avoid studying physics	1 or 0
	B2_2BG	I don't want to get a bad grade	1 or 0
	B2_2DL	I don't like physics	1 or 0
	B2_2DU	It is difficult to understand	1 or 0
	B2_2LM	I want to learn more and do better in physics	1 or 0
	B2_2PB	Physics is boring	1 or 0
	B2_2PC	Physics is challenging	1 or 0
	B2_2RL	Physics is not relevant to my life	1 or 0
	B2_2NR	No reason	1 or 0
B3-1: What do you like about physics?	B3_1AAP	All aspects of physics	1 or 0
	B3_1ARS	Application to real-life situations	1 or 0
	B3_1IT	Instructors and their teachings	1 or 0
	B3_1LE	Laboratory experiments	1 or 0
	B3_1MC	Mathematical calculation	1 or 0
	B3_1TC	Some theoretical contents	1 or 0
	B3_1NO	None	1 or 0
B3-2: What do you dislike about physics?	B3_2AAP	All aspects of physics	1 or 0
	B3_2CL	Complicated lectures	1 or 0
	B3_2LE	Laboratory experiments	1 or 0

Item	Excel column heading	Codes	
	B3_2MC	Mathematical calculation	1 or 0
B3-2: (continued)	B3_2SDC	Some difficult contents	1 or 0
	B3_2TE	Tests and examinations	1 or 0
	B3_2NO	None/ I don't know	1 or 0
B4: How would you change physics to make it better?	B4_PAW	Pay more attention and work harder to understand	1 or 0
	B4_RMC	Read and try to memorise contents	1 or 0
	B4_SSG	Study within a small group	1 or 0
	B4_NO	No comment/It is OK/I don't know	1 or 0
B5: Do you have any other comments about physics?	B5_BKM	Provide basically physics knowledge and mathematics	1 or 0
	B5_DC	Do not emphasise on the deep theoretical contents	1 or 0
	B5_EI	Make the lessons to be enjoyable and interesting	1 or 0
	B5_EU	Make the lessons to be clear and easy to understand	1 or 0
	B5_GIT	Provide good instructors with good teachings	1 or 0
	B5_GME	Give more examples and similar exercises	1 or 0
	B5_LW	Provide more laboratory work	1 or 0
	B5_MC	Make conclusion at the end of each lesson	1 or 0
	B5_MED	Give more explanation in details	1 or 0
	B5_MIC	Provide more intensive contents	1 or 0
	B5_NGP	No grading in physics	1 or 0

Item	Excel column heading	Codes	
B5: (continued)	B5_PES	Physics should be elective subjects	1 or 0
	B5_RL	Physics contents should be relevant to real life	1 or 0
	B5_TP	More times for tutorial and practicing sessions	1 or 0
	B5_TS	Effective learning depends on good teaching strategies	1 or 0
	B5_TSC	Teaching and studying strategies should be changed	1 or 0
	B5_UI	Instructors should aware of individual differences	1 or 0
	B5_WH	Students must pay more attention and work harder	1 or 0
	B5_NO	No comment	1 or 0