On the Way of Educational Reform: Thai High School Physics Teachers' Conceptions of the Student-Centered Approach and Their Perceptions of Their Classroom Practices

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Abstract

During the past two decades, the student-centered approach has been widely promoted and accepted by the educational community as one of the most effective instructional approaches. It has been continually developed and revised to match our current understanding of how humans learn (American Psychological Association, 1997). It is based upon the belief that students should take responsibility for their own learning. Thus, curriculum, instruction, and assessment should be carefully designed to stimulate, facilitate, and accelerate students' learning as much as possible. In order to do so, the teacher needs to take the following factors into consideration: students’ cognitive structures, metacognitive and regulative skills, motivation and affective states, developmental and individual differences, and social supports. However, the term *student-centered* has been defined and described by researchers and scholars in many different ways. Little is known about how practicing teachers conceptualize this term and how they perceive their classroom practices in relation to these conceptions.

The purpose of this study was to utilize a qualitative multiple-case study approach to investigate teachers’ conceptions of the student-centered approach and their perceptions of their classroom practices. Four Thai high school physics teachers, who were considered products of the current student-centered educational reform movement in Thailand, participated in this study. Data were collected for one learning unit (three to eight weeks) through classroom observations, semi-structured interviews, and document analysis.

The data analysis revealed that teachers’ conceptions of student-centered curriculum, instruction, and assessment had three common characteristics: (a) students’ active participation; (b) special emphasis on students’ background knowledge, understanding, motivation, affective states, and learning capability; and (c) benefits to students. The results also indicated that there were some similarities and differences between teachers' conceptions of the student-centered approach and the underlying principles of the student-centered approach. Moreover, this study showed that teachers' conceptions of the student-centered approach were not always consistent with their classroom practices. In addition, these teachers used various instructional activities perceived by them as being non-student-centered, such as developing curriculum based on the national high school physics textbooks and teacher's experiences, delivering knowledge through lecture, and assessing students' understanding by using teacher-constructed test questions. Furthermore, findings from this study provide implications for researchers, teacher educators, and policy makers with regards to successfully implement the reform-based, student-centered approach in the actual science classroom.

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CHAPTER ONE

INTRODUCTION

Yes, you may well doubt, you may well be uncertain ... Do not accept anything because it is the authoritative tradition, because it is often said, because of rumor or hearsay, because it is found in the scriptures, because it agrees with a theory of which one is already convinced, because of the reputation of an individual, or because a teacher said it is thus and thus . . . But experience it for yourself.

The Lord Buddha
Translated by Bhikku (1975)

This dissertation explores Thai high school physics teachers' conceptions of the student-centered approach, and the relationship between their conceptions and their actual classroom practices. This chapter provides an introduction to the dissertation. It begins with the background to the study by giving an overview of the student-centered educational reform, discussing the current situation of the educational reform in Thailand, and presenting a brief description of the Promotion of Science and Mathematics Talented Teachers (PSMT) program. It then provides the rationale for the research, including the statement of the problem, the focus and purpose of the study, the research questions, and the significance of the study. In the end of this chapter, the structure of this thesis is presented.

Student-Centered Educational Reform

At the end of the twentieth century, the terms *child-centered, student-centered,* and *learner-centered* have been widely used in the educational community to refer to educational contexts in which students have major responsibility for their own learning. In addition, the student-centered approach has been accepted and promoted as one of the most effective ways of teaching and learning, and has been regarded as being at the heart of current educational reforms in various countries, including the United States (American Psychological Association [APA] Work Group of the Board of Educational Affairs, 1997; National Research Council [NRC], 1996, 2000, 2012) and Thailand (Office of the National Education Commission [ONEC], 2000).

A well-known publication supporting the use of the student-centered approach is *Learner-Centered Psychological Principles: A Framework for School Reform and Redesign*, published by APA (1993, revised in 1997). The main purpose of this publication is to summarize, analyze, and synthesize recent research and theories from psychology and education for framing the redesign of schools and the reform of education. From this work, fourteen learner-centered principles were developed (Appendix A). These learner-centered principles emphasize the roles of learners within four interactive domains: (a) the cognitive and metacognitive domain, (b) the motivational and affective domain, (c) the developmental and social domain, and (d) the individual difference domain. McCombs (2001), the primary author of *Learner-centered Psychological Principles: Guidelines for School Redesign and Reform*, has defined student-centered or learner-centered as follows:

> The perspective that couples a focus on individual learners–their heredity, experiences, perspectives, backgrounds, talents, interests, capacities, and needs – with focusing on learning – the best available knowledge about learning and how it occurs and about teaching practices that are most effective in promoting the highest level of motivation, learning, and achievement for all learners. This dual focus then informs and drives educational decision making. (p.186)

She believed that the effective teacher should recognize the importance of students' background knowledge, experiences, and interests in learning. Moreover, McCombs and

Whisler (1997) have identified five premises underlying the learner-centered model. These premises are as follows:

1. Learners are distinct and unique.
2. Learners' unique differences include their emotional state of mind, learning rates, learning styles, stages of development, abilities, talents, feelings of efficacy, and other academic and nonacademic attributes and needs.
3. Learning is a constructive process that occurs best when what is being learned is relevant and meaningful to the learner and when the learner is actively engaged in creating his or her own knowledge and understanding by connecting what is being learned with prior knowledge and experience.
4. Learning occurs best in a positive environment, one that contains positive interpersonal relationships and interactions, that contains comfort and order, and in which the learner feels appreciated, acknowledged, respected, and validated.
5. Learning is a fundamentally natural process; learners are naturally curious and basically interested in learning about and mastering their world (p.10).

These five premises represent the current understanding of how people learn and are compatible with constructivist learning theory.

Constructivists believe that learning occurs only when students mentally construct their own understanding. New knowledge construction is based on students’ existing knowledge and experiences, and driven by their own internal motivation (e.g., Gunstone, 2000; Posner et al., 1982; Pintrich et al., 1993; Von Glasserfled, 1998; Yager, 1995). From this view, teachers should design curriculum, instruction, and assessment by taking into account of what knowledge, skills, attitudes, beliefs, and values students bring into their classrooms. Learning activities should be designed and conducted to facilitate and motivate students to construct their own understanding as meaningfully and effectively.

In general, the student-centered approach is viewed as opposite to the traditional transmissive or teacher-centered approach, whereby factual and procedural knowledge is directly transferred from teachers to students through imitative processes such as memorization, recitation, and reproduction (Jackson, 1986). Based on this view, students are seen as a “blank slate,” an “empty vessel,” or “tabula rasa” to be filled with knowledge by the teacher (e.g., Cuban, 1990; Locke, 1996). The transmissive teaching approach has been recently criticized by educators as ineffective in both improving students’ conceptual understanding and correcting students' misconceptions about scientific phenomena (Driver et al., 2000; Duit, 2009; Halloun & Hestenes,1985a; McDermott & Redish, 1999; Minstrell, 2001; Reddish & Steinberg 1999; Strike & Posner, 1992).

There is no common agreement on the criteria for determining which characteristics of curriculum, instruction, and assessment are student-centered and which are not. The universal list of student-centered characteristics is also not well-formulated because the term student-centered does not have a standardized definition in the research and educational literature, especially in science education. Paris and Combs (2000) have analyzed the learner-centered literature and noted that “[a]lthough widely used, the term ‘learner-centered’ is rarely defined” (p.3). Moreover, the definition of the student-centered approach has been developed, edited, and changed over time in order to be consistent with contemporary knowledge and beliefs about how students learn (APA, 1997). In science education, the student-centered approach has also been promoted through various forms of instructional strategies such as discovery learning (Bruner, 1961), cooperative or collaborative learning (Johnson & Johnson, 1980, 1986), conceptual change learning (Posner et al., 1982), project-based learning (Marx et. al., 1994), and inquiry-based learning (NRC, 1996).

Educational Reform in Thailand

During the past decade, educators in Thailand have shifted their views of teaching and learning from the teacher-centered approach toward the student-centered approach. This change primarily started from the enactment of the first *National Education Act of Thailand* (ONEC, 1999). This Act has served as the fundamental law for the administration and provision of education and training in Thailand. It provides a set of guidelines for comprehensive educational reform with a special emphasis on learning reform through the student-centered approach, considered the heart of educational reform (ONEC, 2000). This student-centered emphasis is described in Chapter Four, named *The National Education Guidelines,* of the Thai National Education Act as follows:

> Education shall be based on the principle that all learners are capable of learning and self-development, and regarded as being most important. The teaching and learning process shall aim at enabling the learners to develop themselves at their own pace and to the best of their potential (p. 10).

The Act calls for the implementation of integrated curriculum, authentic learning experiences, and authentic assessment. It also suggests that curriculum, instruction, and assessment should be in line with students' needs, abilities and interests.

In 2000, ONEC published a document, *Learning Reform: A Learner-centered Approach*, to clarify and provide the general interpretation of the learner-centered approach mentioned in the National Education Act. It describes the learner-centered learning process as follows:

> The process involves identification of objectives, contents, activities, learning source, instructional media and evaluation, aimed at development of the 'person' and enrichment of their 'lives.' Learners should therefore be allowed learning experience to their highest potential and in line with their aptitudes, interests and needs (p. 24).

This publication suggests that learning activities should be designed to meet the individual student's needs and should enable learners to construct their own understandings from their first-hands experiences.

Even though Thai educators and policy makers made several efforts to inform teachers about the student-centered approach, many educational institutions reported some misconceptions held by Thai teachers about the student-centered approach (e.g., Atagi, 2002; Fry, 2002). For example, Fry (2002) pointed out that there were four common misconceptions about student-centered learning held by Thai teachers. First of all, some teachers equated student-centered learning with activity-based learning. Second, some teachers perceived that the student-centered approach devalues memorization. Third, some teachers believed that student-centered teachers should never interfere with the students' learning process. Finally, some teachers argued student-centered learning does not put an emphasis on academic rigor.

One of most common misconceptions that impeded Thai teachers' implementation of the student-centered approach could be found in the replacement of the term "child-centered" with the term "khwai-centered" or "buffalo-centered" (Atagi, 2002; Yokfar, 2005). In addition, the term *buffalo-centered* was developed from the view that students were too dumb, like buffaloes, to learn by themselves. As a result, the teachers with this conception tended to consider the student-centered approach as being ineffective and continue adopting the traditional lecture-based teaching approach in their classrooms (Atagi, 2002; Fry, 2002; Yokfar, 2005).

In order to clarify Thai teachers' understanding of what it means to be student-centered teachers, Finley (2000), speaking at an academic seminar called *Learner-Centered Education*, stressed that the student-centered approach did not refer to:

- learning alone – without other students, teachers, parents and other community members;
- learning whatever the student decides he or she wants to know;
- learning from completely open and minimally planned activities; and
- never being evaluated according to some standard of knowledge and performance (p.23).

He also pointed out that the phrases "learning by themselves" and "learning on their own," frequently mentioned in many student-centered educational reform documents, did not mean the absence or minimization of the teacher's role in the student's learning process. He further explained that the student-centered teacher played a crucial role in students' learning by using his/her experiences to help students decide what, when, and how to learn, or even to make decision for the students.

Promoting the implementation of the student-centered approach in science classrooms has also been the central focus of the Institution for the Promotion of Teaching Science and Technology of Thailand (IPST). Under the direction of the Ministry of Education, IPST aims to improve the quality of Thailand's science, mathematics and technology education. The six main goals of IPST include the following:

1. To initiate, promote, coordinate and conduct studies and research on curriculum development, teaching-learning methodology and evaluation of science, mathematics and technology teaching and learning at all levels focusing on basic education;
2. To promote, coordinate and conduct personnel development by training teachers and students in teaching, learning and researching in the field of science, mathematics and technology;

3. To promote, coordinate and conduct studies and research to improve and produce lessons, exercises, academic documents and all kinds of materials and equipments for teaching and learning of science, mathematics and technology;
4. To promote benchmarking and quality assurance system development for formal science, mathematics and technology education;
5. To develop and nurture talents in science and technology among teachers and students alike; and
6. To exclusively advise ministries, departments, divisions, government or private agencies responsible for education or educational institute management in accordance with the goals as per items 1 to 5 above (IPST, 2005).

In addition, during the current educational reform period, IPST has put significant efforts on promoting the implementation of student-centered inquiry-based instruction in science classrooms. In *Thai National Science Curriculum Standards*, IPST (2004) highlights the importance of learners and their abilities to conduct scientific inquiries as the following:

> Learning of science should be a developmental process so that the learner acquires proper knowledge, process, and attitude. Every learner should be stimulated and encouraged to be interested in and enthusiastic about learning science. The learner should also be curious and eager to learn about the surrounding natural world, be determined and happy about doing research and searching for knowledge, be capable of accumulating data, analyzing results to reach to answers for questions, making decision based on reasonable use of data and finally, communicating questions, answers, data and discoveries from their learning to others (p. 3).

At the end of the Standards, the 5-E inquiry-based learning cycle, consisting of five recursive steps of scientific investigation, including engagement, exploration, explanation, elaboration, and evaluation, was introduced to science teachers as one of the most effective student-centered teaching strategies. This learning cycle is embedded in most of the contemporary science textbooks and teachers manuals published by IPST (Pisarn, 2001).

The Promotion of Science and Mathematics Talented Teachers (PSMT) Program

The PSMT program was launched by a collaboration of the Ministry of Education, the Ministry of University Affairs, and the Institute for the Promotion of Teaching Science and Technology of Thailand. This program has two main goals: (a) to solve the teacher shortage problems in science and mathematics, and (b) to improve the quality of science and mathematics teachers. In addition, as reported by IPST (2011), in 2007, there are shortages of 10,831 science and 11,922 mathematics teachers in Thai primary and secondary schools under the supervision of the Office of the Basic Education Commission (OBEC).

The PSMT program is now in the third phase (2010-2018). Each year, 580 scholarships will be granted to students who hold a Bachelor's degree in science or mathematics and are willing to become science teachers after finishing the one-year graduate teaching certificate program in the faculties of education (IPST, 2011). In other words, this program will produce 580 science and mathematics teachers yearly who hold both a Bachelor's degree and a teaching certificate in science. Moreover, every year, this program also grants full scholarships to 580 PSMT teachers who have more than two years of teaching experience to pursue a Masters degree in science or mathematics education.

Since the PSMT program started in 1996, there have been 3,472 PSMT teachers in the Thai educational system. In addition, there are 844 PSMT teachers who hold a Bachelor's degree in physics (IPST, 2011). Most of these teachers teach high school physics. Some of them are teaching at other educational levels such as the primary school level, the middle school level, or in higher education. Moreover, some of them are currently working on their Master's or doctoral degrees in education with financial support from the PSMT program.

Statement of the Problem

As mentioned earlier, science educators have made great effort to promote the implementation of various student-centered instructional strategies in the actual science classroom. However, little is known about which forms of student-centered instructional strategies are accepted and used by science teachers to develop their conceptions of the student-centered approach. Since these teachers tend to develop their own conceptions of the student-centered approach based on their existing knowledge, beliefs, experiences, and the information presented to them, they may hold different conceptions of this approach (Hewson & Hewson, 1989; Nespor, 1987; Pajares, 1992; Tobin, Tippins, & Gallard, 1994). As a result, it is possible that those with different conceptions of student-centered teaching and learning may perceive the same teaching-learning event in different ways. Many research studies reported the contradictions between teachers' and researchers' interpretations of the classroom activities (e.g., King, Shumow, & Lietz, 2001; Koballa et al. 2000; Mallado1997; Simmons et al. 1999). Simmons et al. (1999), for example, conducted a three-year study with 166 beginning secondary science teachers' to understand the relationship between their classroom behaviors and their conceptions of teaching and learning. After collecting data every year for three years, they found that the teachers' epistemological views of teaching and learning were inconsistent with what the observers saw in these teachers' classrooms. In addition, they reported that the teachers perceived their practices as being student-centered while the observers categorized the instructional activities as being teacher-centered (p.947).

These differences between teachers' reports on their teaching practices and observers' notes on the same classroom practices can also be found in the study of four urban elementary teachers by King, Shumow, and Lietz (2001). On the one hand, the researchers found that these teachers described their classroom instruction by using the conventional terms such as “inquiry,” “facilitator,” “hands-on,” “critical thinking,” and “science process.” On the other hand, the observers characterized the lessons as teacher-centered instruction in which students read textbooks aloud, were asked to remember key concepts, and answered recall questions. These observers also reported that they rarely saw instruction that could be described as the inquiry-based or student-centered approach to science.

These studies seem to indicate that people who have different knowledge, beliefs, and experiences in teaching and learning may interpret the same classroom instruction in different ways. Yet, few research studies have been done to examine how teachers conceptualized the term student-centered, as well as how they perceive their classroom practices in relation to their conceptions. It is difficult for science educators to change and/or improve teachers’ classroom actions without knowing what these teachers know, believe, and perceive (Hewson & Hewson, 1988; Kagan, 1992; Pajares, 1992; Posner et al., 1982; Prawat, 1992). Thus, teachers’ conceptions of the student-centered approach and their interpretations of their classroom practices need to be investigated.

Focus of the Study

This study was conducted in Thailand during the period of student-centered educational reform. The study utilized a qualitative multiple-case approach to explore Thai physics teachers' conceptions of the student-centered approach, as well as their perceptions of their classroom practices. The focus of this study was on Thai physics teachers in the PSMT program. This group of teachers was selected because they were expected to become highly-qualified teachers and academic leaders in both their schools and educational communities (Pisarn, 2001). In addition, they were anticipated to have a strong scientific background from their Bachelors degree in physics, as well as recent educational background from their graduate diploma in the teaching profession. These teachers could be considered as products of current educational reform because they had finished one-year graduate teaching programs firstly approved by Khurusapah, the Teacher's Council of Thailand, as programs focusing on student-centered education (Khurusapah, 2005a, 2005b). These limits on participants were developed to ensure that the participants of this study had significant knowledge of teaching and learning science during the educational reform period.

For the purpose of this study, the term *conception* is defined as a personal construct, an individual way of seeing things based on individual's existing knowledge, beliefs, experiences, values, and other interconnected cognitive structures. In other words, a personal conception of something refers to an idea constructed by an individual to describe what it is or is not. As a result, this study uses the term conception interchangeably with the other terms related to a personal construct such as beliefs, ideas, and perceptions. Moreover, it is important to note that this study was designed to determine teachers’ conceptions of the student-centered approach without paying any attention to understanding how these conceptions developed.

This research study also attempted to examine teacher’s conceptions of the student-centered approach within three aspects of the education system: curriculum, instruction and assessment. These three aspects are considered as “central and operative” elements of the educational system (Pellegrino, 2006, p.2). First, curriculum refers to the lists of educational goals of both the course and the everyday instructional lessons (Pellegrino, 2006). These goals include knowledge, skills, attitudes, beliefs, values, and experiences that the teacher expects to teach his or her students. Curriculum may also refer to a sequence for teaching and learning to accomplish each of these educational goals (NRC, 2012). In other words, curriculum is the process of designing what to teach and when to teach it. Second, instruction can be defined as teaching and learning activities in which both teachers and students are engaged (NRC, 2012; Pellegrino, 2006). These activities are made and implemented by the teacher to help their students accomplish the educational goals mentioned in curriculum. Instruction also includes the roles, actions, and responsibilities of teachers and students in each classroom activity. Thus, instruction is the description of how teachers teach and how students learn. Finally, assessment is defined as the way of measuring the educational outcomes (NRC, 2012; Pellegrino, 2006). The results of assessment report how well students learned. Assessment could be administered anytime before, during, and after instruction.

Assessment also includes the description of how the teacher and students used the assessment results in improving the teaching and learning processes.

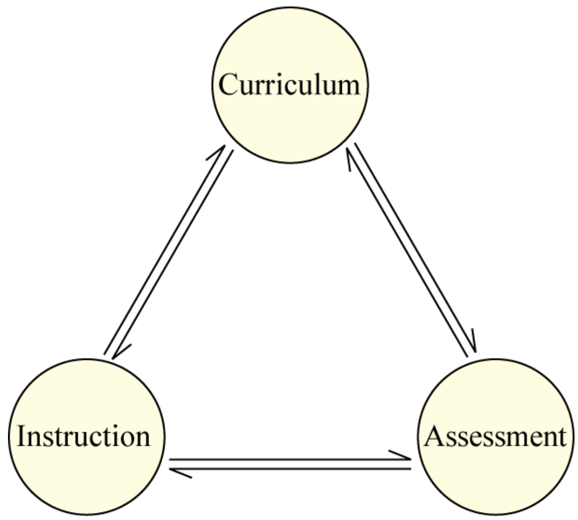


Figure 1.1. Curriculum-instruction-assessment triad.

An underlying assumption of this study is that all three educational aspects, including curriculum, instruction, and assessment, are connected and interrelated with one another (See Figure 1.1). This assumption is analogous to that made by Pellegrino (2006) and NRC (2012). In addition, Pellegrino (2006) argued that these three elements should be “directed toward the same ends and reinforce each other, rather than working at cross-purposes” (p.3). Based on this assumption, the reform of education through the student-centered approach has to align these three elements along the same direction. An improperly synchronized connection between two of these three functions could impede and distort the implementation of the student-centered approach (NRC, 2012; Pellegrino, 2006). For example, if assessment emphasizes rote memorization and recitation rather than higher-order thinking and understanding, the teacher may fail to execute instruction that is encouraging students to critically think about what they learned.

Purpose of the Study

The primary purpose of this study is to examine Thai physics teachers' conceptions of the student-centered approach (curriculum, instruction, and assessment) and their perceptions of their classroom practices in relation to these conceptions. This study had three main goals: (a) to explore and understand Thai physics teachers' conceptions of the student-centered approach, (b) to examine Thai physics teachers' interpretations of their classroom practices, and (c) to investigate the factors influencing how Thai physics teachers implement their conceptions of the student-centered approach in their actual classroom.

Research Questions

This study was driven by the following questions:

1. What are Thai physics teachers' conceptions of the student-centered approach?
2. What are Thai physics teachers' perceptions of their classroom practices in relation to their conceptions of the student-centered approach?
3. What reasons do Thai physics teachers give for supporting or opposing the implementation of student-centered practices in their own classroom?
4. What are Thai Physics teachers' reflections on the student-centered educational reform movement in relation to their conceptions of the student-centered approach?

Significance of the Study

This research study anticipated that the results would contribute to better understanding Thai physics teachers' conceptions of the student-centered approach. The results would be beneficial to the science education community both theoretically and practically. On a theoretical level, the results may suggest a refined definition of the student-centered approach that can address both theoretical and practical concerns.

On a practical level, the results would be useful resources to support Thai science educators in developing an effective plan for further promotion of the student-centered approach. Since this study focused on physics teachers in the PSMT program who had two years of teaching experiences and had a high chance to receive scholarships from IPST to pursue a Master's degree in science education, there are at least four groups of educators who may find the results of this study beneficial if they believe that the results are relevant to the contexts in which they are working. First, this study will provide valuable information to curriculum developers and professors in the teaching professional program who have already informed these PSMT teachers about the student-centered approach. In addition, the results from this study will illustrate what aspects of teachers' conceptions of the student-centered approach need to be addressed or strengthened before they start teaching in the school. Second, curriculum developers and professors in the Master's degree program who can inform these PSMT teachers may use the results of this study to design their program. In short, the first two groups may use the results to create an effective teacher preparation program that promotes appropriate conceptions of the student-centered approach. Third, IPST and other professional development institutions could use the results of this study to design helpful professional development programs, and to provide suitable supports to practicing physics teachers in order to promote the implementation of the student-centered approach.

Finally, the current study would also provide a significant contribution to science education community. As mentioned earlier, the student-centered approach in science education can appear in many forms (such as inquiry-based learning, conceptual change learning, and project-based learning) and science educators put a lot of effort into implementing these forms in the actual science classroom. Teachers' conceptions of the student-centered approach might be one of the factors facilitating or hindering the implementation of these forms. Thus, the results of this study would make science educators to know more about how to succeed in doing so. Moreover, since science teachers' conceptions of the student-centered approach are rarely studied in the science education literature, the findings from this study would help science educators and researchers to understand more about teachers' thought processes and actions. In addition, many researchers have studied teachers' beliefs about curriculum, instruction, and assessment separately rather than together like the current study. In particular, teachers' beliefs about curriculum and assessment have not been much investigated yet in the science education literature. Thus, this study would be significant in that it aims to understand a complete set of teachers' knowledge and beliefs about curriculum, instruction, and assessment. Furthermore, since this study was conducted in the school context driven by the government policy (The Office of Basic Education Commission of

Thailand, 2010), it is envisaged that this study would reveal important information about the effect of the government policy on teachers' thought processes and actions.

Overview of the Dissertation

This research study aimed to examine how Thai high school physics teachers conceptualized the term student-centered, and what were the perceptions of their classroom practices in relation of their conceptions of student-centered education. The target participants of this study were Thai high school physics teachers who were in the PSMT program.

This dissertation is organized into six chapters. The first chapter provides an overview of the research study. It includes the introduction of the student-centered approach, the study context, research goals, research questions, and the significance of the study.

Chapter two presents the review of literature, and consists of two major sections. The first section provides readers with the theoretical framework of the student-centered approach. In this section, the contemporary views of how students learn and how teachers teach are described. It also provides a brief review of current student-centered reform documents. The second section aims to review and synthesize current research on teachers' conceptions of teaching and learning and their classroom practices. This section begins by presenting the theoretical framework of teachers' conceptions of teaching and learning. Then, a thorough review of research studies on topics related to teachers' conceptions and classroom practices is presented.

Chapter Three details the methodology of the study, including the methodology, research design, data collection, and data analysis. In addition, this chapter places a special emphasis on providing the reader with a detailed description of how data were collected and analyzed. The end of this chapter discusses the credibility, limitations and delimitations of the study.

Chapter Four presents findings from four individual cases. Each case study is summarized according to the three aspects of education, including (a) curriculum, (b) instruction, and (c) assessment. Each case study consists of the teacher's background information, their perceptions of their classroom practices, and their conceptions of the student-centered approach. Each case study also reports the strengths and weaknesses of student-centered activities, as well as other factors facilitating and hindering the implementation of the student-centered approach. In order to provide a complete picture of how the teachers defined the student-centered approach, teachers' conceptions of the non-student-centered approach are also presented.

Chapter Five reports the findings from the cross-case analysis. Characteristics of the student-centered and non-student-centered approaches emerging across four individual cases are presented and discussed. This chapter also presents three models illustrating factors affecting teachers' implementation of student-centered curriculum, instruction, and assessment.

Chapter Six presents the discussion for this study. This chapter also provides implications for teacher education as well as further research in examining teachers' conceptions of the student-centered approach.

CHAPTER TWO

LITERATURE REVIEW

Education is growth.
Philosophy of Srinkharinwirot University

This chapter presents a brief review of the literature and theoretical frameworks used for developing interview protocols, selecting lab equipment, analyzing data, and interpreting the results of this study. It is divided into two sections. The first section presents the characteristics of the student-centered approach described in the literature. It starts with reviewing the contemporary views of teaching and learning by using Mayer's (1992) three metaphors: (a) learning as response acquisition, (b) learning as knowledge acquisition, and (c) learning as knowledge construction. Then, the conceptions of constructivism and the student-centered approach are defined and discussed in detail. At the end of the first section, a brief review of current reform documents in both United States and Thailand is presented. Three metaphors of teaching and a brief review of current reform documents were used to compare and contrast the findings from the present study.

The second section is a review of the literature on teachers' conceptions of teaching and learning and their classroom practices. At the beginning of this section, the theoretical framework on teachers' conceptions of teaching and learning guiding this research study is discussed. It presents a model illustrating the relationship between teacher's thought processes and actions. This model was used to direct the data collection process. After that, this section provides the definitions of the terms *conceptions, knowledge*, and *beliefs*, and gives the reason why the current study uses these three terms interchangeably. At the end of this section, a brief review of research studies on teachers' conceptions and classroom practices is presented. Issues and gaps found in the research literature that this study aimed to address are also discussed.

Student-Centered Approach

Three Major Views of Teaching and Learning

Ideas about how students learn and how to teach them have been developed and changed over the past two centuries. As suggested by Mayer (1992), various views of teaching and learning that have had a major influence on psychology and education during the last century can be grouped into three metaphors. These metaphors include (a) learning as response acquisition, (b) learning as knowledge acquisition, and (c) learning as knowledge construction. Table 2.1 illustrates key ideas of these three metaphors. The first two views are usually classified as traditional views of teaching and learning. These views have dominated psychology and education until the first half of the twentieth century. Then, learning as knowledge construction has been developed and promoted as the contemporary view of teaching and learning since the second half of the twentieth century. This section presents the description of these three metaphors.

Table 2.1

Metaphors of Learning and Teaching (Adapted from Mayer, 1992)

		Implications for instruction and learning outcomes	
Learning	Teaching	Instructional focus	Learning outcomes focus
1. Response acquisition	Giving reinforcements and feedbacks	Correct behaviors	The strength of associations
2. Knowledge acquisition	Presenting information	Appropriate information	The amount and accuracy of obtained information
3. Knowledge construction	Guiding cognitive process	Meaningful understanding	The structure of the constructed knowledge

Learning as response acquisition. The belief in learning as response acquisition dominated psychology and education for most of the first half of the twentieth century. It was developed through research studies of animal behaviors. Based on this view, learning is seen as a change in behavior as a result of experience (Ormrod, 2005). This view of learning is generally known as behaviorism. Behaviorist learning theories focus on how the external environment shapes learners' behaviors. They emphasize the importance of reinforcement (rewards and punishments) in establishing, modifying, and maintaining desired behaviors as well as extinguishing undesired behaviors (e.g. Hull, 1943; Skinner, 1938; Smith & Guthrie, 1920; Thorndike, 1911; Watson, 1928).

Behaviorists believe that human beings are born equally as blank slates or tabula rasa. In other word, human beings at birth have no disposition to behave in a certain way. They argue that human behaviors are exclusively developed from their experiences. Based on this perspective, a behavior can be strengthened or weakened by its consequences. For example, in his law of effect, Thorndike (1911) noted that a response followed by satisfaction would be more likely to occur again; whereas, a response followed by dissatisfaction would be less likely to occur again.

There are two primary goals of behaviorist teaching. These goals include (a) strengthening desirable behaviors and (b) weakening undesirable behaviors. In order to accomplish these goals, behaviorist learning theories suggests at least three educational implications. First of all, students are viewed as active learners. In addition, students learn only when they have a chance to behave and experience the consequence of their behavior. As a result, the behaviorist teacher will create situations that elicit students' responses and then provide an appropriate consequence of each response. Students' desirable responses must be followed by rewards while students' undesirable responses must be followed by punishments.

Second, practicing plays an important role in strengthening the connection between students' behaviors and its consequences. Behaviorists believe that the more stimulus-response connection is repeated, the more strengthened the connection is (Thorndike, 1911). In other word, students will behave more frequently when the behavior is reinforced numerous times. Thus, the behaviorist teacher will set up learning situations in which students have a chance to perform appropriate behaviors and to receive the reinforcements as much as possible.

Third, behavioral objectives should be created and used to guide instruction. Behavioral objectives refer to observable and measurable behaviors that students should perform after instruction (Mager, 1975). The behaviorist teacher will use these objectives to specify the amount of both desirable and undesirable behaviors in order to provide appropriate consequences of students' behaviors. On one hand, if students meet the behavioral objectives, they will receive a positive reinforcement. On the other hand, if they cannot achieve the behavioral objectives, the teacher will give them a punishment or negative reinforcement. The example of behavioral objectives is "on weekly written spelling test, the student will correctly spell at least 85% of the year's 500 spelling words" (Omrod, 2005).

Learning as knowledge acquisition. The view of learning as knowledge acquisition has dominated education for a long period of time. It still can be found in many classrooms because it is resonant with commonsense beliefs about knowledge and knowing holding by many teachers (Cuban, 1993). Based on this perspective, both factual and procedural knowledge is viewed as static and can be directly transferred from one person to another (Jackson, 1986). In addition, learning is viewed as a process of receiving knowledge from the knower. As a result, teachers and textbooks become major sources of knowledge to be learned by students. Instruction based on this view is generally called the "teacher-centered," "subject matter-centered," or "content-centered" approach. Similar to the behaviorist perspective, the teacher-centered advocates perceive learners as a "blank slate" or "vessel to fill" (Cuban, 1990, 1993). The underlying assumption of the teacher-centered approach is that knowledge can be directly poured into students' brain. Thus, students are seen as passive learners who passively receive and memorize the information presented by their teacher or textbooks.

The main instructional goal of the teacher-centered instruction is to transfer all essential knowledge from the teacher to the students. The teacher-centered instruction mainly consists of a chalk-and-talk or lecture-based teaching strategy where the teacher writes texts, pictures, equations, and graphs on the blackboard and then explains what they have written (Cuban, 1990). The major role of the students is to memorize and recite the knowledge the teacher has presented. Because knowledge has a special property in which it can be judged right or wrong in reference to teachers’ knowledge or textbooks, learning outcomes are evaluated by measuring the amount of correct knowledge students have received (Jackson, 1986). As a result, the teacher-centered teacher normally uses multiple-choice exams as a major assessment tool to determine whether students are able to choose correct answers or not. This approach has been equated with learning like a parrot that can remember and repeat phrases without knowing what they mean or how to use them (Yokfar, 2005).

Learning as knowledge construction. The notion of learning as knowledge construction has emerged from two different perspectives: psychological and epistemological. First, the psychological framework is grounded on the cognitive studies of the human memory system. Various models of human information processing have been developed to illustrate components of human memory, ways of storing information in human memory, the nature of knowledge in the memory, and the factors that influence storage and retrieval of knowledge in the memory (Omrod, 2005). However, these models shares at least three common features. The first common feature is that human memory is selective and interpretive. In addition, cognitive scientists believe that humans store knowledge in the long-term memory in terms of meanings rather than the exact information they receive from the outside environment. The second common feature is that humans enhance their ability for storage and retrieval by relating and organizing knowledge in the long-term memory. Many cognitive scientists believe that the more organized knowledge network in long-term memory is, the more easily new information can be memorized and then retrieved later. The third common feature is that the capacity of working memory is limited. Humans can process information only from five to nine units at one time (Miller, 1956).

Second, the epistemological framework is grounded on the ideas of how human learns, how knowledge emerges, and how knowledge changes. This framework is mostly influenced by the works of Piaget and the conceptual change learning theory proposed by Posner et al. (1982). The underlying assumption of this framework is that people do not directly receive information about their world around them but they actively construct its meaning. This meaning construction is based on personal existing knowledge and experiences. This assumption is repeatedly supported by the discovery of students' conceptions about the natural phenomena before they have been taught in science classes (e.g., Driver et al., 2000; Finley, 1985; Gunstone, 1991; Halloun & Hestenes, 1985b; Heller & Finley, 1992; Pocovi & Finley, 2002). In addition, many studies have showed that these conceptions are often different from the accepted scientific conception. As a result, these conceptions have been labeled as "misconceptions", "preconceptions", "alternative conceptions", "common sense concepts", and "children's science." More importantly, many studies have found that these conceptions are highly resistant to change by traditional instruction (Driver et al., 2000; Duit, 2009; Halloun & Hestenes,1985a; McDermott & Redish, 1999; Minstrell, 2001; Reddish & Steinberg

1999; Strike & Posner, 1992). For example, the studies by Halloun and Hestenes (1985a) and Reddish and Steinberg (1999) showed that the traditional lecture-based instruction of introductory physics courses failed to either improve students' conceptual understanding or address students' misconceptions.

Based on the epistemological framework mentioned above, learning consists of two main processes. The first process is called "assimilation" (Piaget, 1955) or "conceptual capture" (Hewson, 1981). This process occurs when individuals learn by adding new information to expand, clarify, and confirm their existing conceptions. This second process is called "accommodation" (Piaget, 1955) or "conceptual exchange" (Hewson, 1981). This process occurs when individuals are unable to assimilate new information to their existing conceptual framework and then they develop the more satisfied conceptual framework to assimilate this information. In other word, it occurs when individuals feel dissatisfied with their existing conception and are able to develop a new conception which is more intelligible, plausible, and fruitful than the existing conception (Posner et al., 1982).

At the beginning of twentieth century, the conceptual change model has been modified and expanded to include the influences of motivational, affective, and contextual factors in knowledge construction. This change has been primary influenced by the publication of Pintrich, Marx, and Boyle in 1993. In their paper, Printrich et al. (1993) have called for the need to see "beyond cold conceptual change" and pay attention to motivational, affective, and contextual factors. Sinatra and Pintrich (2003) noted that learning is an intentional process where learners control their own learning process.

Based on this view, the learners always have their own learning goals, standards, and expectations to arouse and motivate them to learn. The learners also regularly control and regulate their actions in order to meet their goals and standards.

The modified conceptual change model has also pointed out that social interaction can enhance learning process. Students can learn better when they have appropriate supports from their teachers or peers. Vygotsky (1978) suggested the term *zone of proximal development (ZPD)*, representing the level of development that students cannot reach alone but can achieve with the support of their teachers or peers. Discussion with others also provides students a chance not only to make their existing conceptions more explicit to them but also to evaluate their existing conceptions with more information from the others. As noted by Chinn and Brewer (1993), facing anomalous data alone may not lead to the process of conceptual change because individuals tend to ignore, reject, exclude, reinterpret, or hold the data without changing their existing conceptions. They suggested that discussion with other students who face the same anomalous data would confirm the perception of these data as anomalous and lead to a conceptual change process.

The view of learning as the knowledge construction developed from both psychological and epistemological frameworks is known as constructivism. In this study, the constructivist learning theories provide theoretical supports for develop the appropriate conceptions of the student-centered approach. Based on this view, the major goal of education is to set learning environments that facilitates, motivates, and enhances students' learning process as meaningful and effective as possible. The meaningful learning refers to a situation when students are able to connect new knowledge to existing knowledge in an organized way. Effective learning refers to a situation when students are able to learn at their highest learning capability. It also includes the situation when students can construct their own meanings that are consistent with knowledge accepted by educational communities.

In order to create a meaningful and effective learning environment, the current literature review suggested that the constructivist, student-centered teacher should carefully consider various factors relating to student learning (American Psychological Association [APA], 1997). These factors were classified into five interrelated domains: (a) students' cognitive structures, (b) students' metacognitive and regulative skills, (c) students' motivation and affective states, (d) students' social supports, and (e) students' development and individual differences. The model of the constructivist, student-centered approach is presented in Figure 2.1. Based on the model, successful student-centered instruction requires the teacher to know what their students know, what their students are interested in, how to motivate their students to learn, what their students' learning capabilities are, and how to help them to learn at their highest capability. The student-centered teacher also needs to know when their students need helps, guidances, or freedom to learn. Thus, the student-centered teacher will use various teaching strategies to promote students learning such as cognitive apprenticeship, cooperative and collaborative learning, illustrating ideas through concept maps, analogies and metaphors, inquiry-based activities, problem-based activities, and formative-summative assessments.

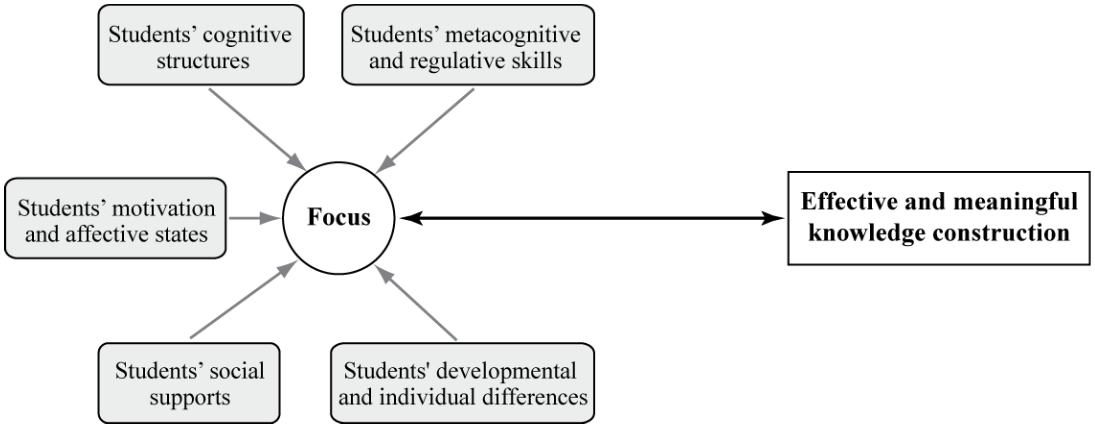


Figure 2.1. Model of the student-centered approach.

Characteristics of the Student-Centered Approach

The focus of this section is to review current reform documents in the United States, such as *A framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (National Research Council [NRC], 2012); *The National Science Education Standards* (NRC, 1996); *Learner-Centered Psychological Principles: A Framework for School Reform & Redesign* (APA, 1997); in Thailand, such as *National Education Act B.E. 2542 (1999) and Amendments B.E. 2545 (2002)* (Office of the National Education Commission [ONEC], 2003); *Learning Reform: A Learner-Centered Approach* (ONEC, 2000); and *National Science Curriculum Standards: The Basic Education Curriculum B.E. 2544* (Institute for the Promotion of Teaching Science and Technology [IPST], 2004), and the related works (i.e., McCombs & Miller, 2007; Lambert & McCombs, 1998). This section is organized into three parts: (a) student-centered curriculum, (b) student-centered instruction, and (c) student-centered assessment.

Student-centered curriculum. Based on the current literature on the student-centered approach, there are three main characteristics of student-centered curriculum. The first main characteristic of student-centered curriculum is that its places a special emphasis on the benefits of curriculum to the students. For instance, all three Thai student-centered reform documents including the *National Education Act* (ONEC, 2003), *Learning Reform: A Learner-Centered Approach* (ONEC, 2003), and *The National Science Curriculum Standards* (IPST, 2004) noted that one of the major goals of student-centered curriculum is to develop students' knowledge and skills essential for lifelong learning in a constantly changing world. The ONEC (2003) also stated that curriculum should focus on preparing students for a successful career and happy life. Similarly, in their book, *Learner-Centered Classroom Practices and Assessments,* McCombs and Miller (2007) noted that student-centered curriculum should aim at promoting lifelong and continuous learning among students. The NRC (1996) also noted in the *U.S. Science Standards* that one of the main goals of the science curriculum is to educate students to be able to "use appropriate scientific processes and principles in making personal decisions" (p.13).

The second major characteristic of student-centered curriculum frequently mentioned in the literature is that it takes students' attributes, such as prior knowledge and skills, past experiences, motivation, interest, and learning capability, into consideration. For instance, the IPST (2004) stressed, "The curriculum and teaching/learning should respond to the aptitude and various interests of the learners with respect to the utilization of science for further education and future profession in science" (p.2). McCombs and

Miller (2007) suggested, “Students whose teachers use learner-centered practices are aware that their unique learning needs, interests, and talents are being considered and are valued and respected” (p.7). Similarly, in the *U.S. Science Education Standards*, NRC (1996) noted,

> In determining the specific science content and activities that make up a curriculum, teachers consider the students who will be learning the science. Whether working with mandated content and activities, selecting from extant activities, or creating original activities, teachers plan to meet the particular interests, knowledge, and skills of their students and build on their questions and ideas. Such decisions rely heavily on a teacher’s knowledge of students’ cognitive potential, developmental level, physical attributes, affective development, and motivation—and how they learn (p.30-31).

The third suggested characteristic of student-centered curriculum is that it integrates various types of knowledge and skills. The integrated curriculum is recommended by many educational reformers as being more applicable and relevant to students than the stand-alone or single-subject curriculum. The promotion of the use of integrated curriculum is one of the main goals of Thai educational reform. In the *Thai Educational Act*, the ONEC (2003) called for “the integration” of diverse knowledge and skills in the school curriculum with special emphasis on both Thai national and local wisdoms (p.10). They also suggested the school to develop their own curriculum that is in line with “needs of the community and the society, local wisdom and attributes of desirable members of the family, community, society, and nation” (p.12). Similarly, the IPST (2004) highlighted the need for the inclusion of “the utilization of local knowledge sources” in the school curriculum (p.3). Furthermore, in addition to the integration of the local wisdom, both ONEC (2003) and IPST (2004) suggested that teachers should combine, integrate, and connect curriculum across various disciplines such as science, mathematics, and technology. This trend is similar to what is currently happening in the United States, known as the STEM education movement (National Academic of Science, 2011; NRC, 2012; President's council of Advisors on Science and Technology, 2010). This movement has called for the implementation of the curriculum that integrates science, technology, engineering, and mathematic (STEM) together as a multidisciplinary curriculum.

Student-centered instruction. Based on the literature on the student-centered approach, the characteristics of student-centered instruction can be divided and described in five interrelated domains: (a) cognitive domain, (b) metacognitive and regulative domain, (c) motivation and affective domain, (d) social domain, and (e) development and individual difference domain (APA, 1997).

First, the underlying learning principle of the cognitive domain is that students should be encouraged to mentally and actively construct their own meaningful understanding. In Thailand, the student-centered reform movement placed a special emphasis on promoting the use of active learning over passive learning. It also highlighted the importance of "hands-on" or "first-hand" experience in students' learning (IPST, 2004; ONEC, 2003). For instance, the ONEC (2003) suggested that the student-centered teacher should "organize activities for learners to draw from authentic experience" (p.11). In addition to the promotion of students' physically active participation, U.S. student-centered reformers highlighted the role of students' cognitive engagement in learning. For instance, the APA (1997) defined learning as an intentional process of constructing meaning, creating meaningful representations of knowledge, and linking new information with existing knowledge. In the *U.S. National Science Education Standards*, the NRC (1996) stressed, “In the National Science Education Standards, the term ‘active process’ implies physical and mental activity. Hands-on activities are not enough—students also must have ‘minds-on’ experiences” (p.20). They believe that learning science should be both physically and cognitively active processes.

In the second domain, metacognitive and regulative domain, student-centered educational reformers suggested that the student-centered teacher should encourage students to metacognitively regulate their learning process. The APA (1997) noted in their fourth learner-centered principle that students learn effectively when they “use a repertoire of thinking and reasoning strategies” to guide and direct them towards their learning goal (p.4). In their fifth learner-centered principle, they pointed out that the effective learning occurs when students set reasonable goals, select appropriate strategies, and monitor their progress toward these goals. It is important to note that metacognitive and regulative skills were not directly stated in Thai student-centered reform documents. However, Thai student-centered educational reformers suggested Thai teachers to help their students developing various skills related to effective metacognition. These skills involved critical thinking, decision making, logical thinking, analytical thinking, higher-order thinking, scientific thinking (IPST, 2004; ONEC, 2003).

The third domain focuses on the effect of students’ motivation and affective states on learning. The main learning principle related to this domain is that students learn effectively when they feel engaged and motivated in the learning process. For example, the ONEC (2003) noted that learning activities should be “in line with the learners’ interests and aptitudes” (p.11). In the *Thai National Science Curriculum Standards*, the IPST (2004) highlighted the importance of students’ motivation and affective by saying that,

> Every learner should be stimulated and encouraged to be interested in and enthusiastic about leaning science. The learner should also be curious and eager to learn about the surrounding natural world, be determined and happy about doing research and searching for knowledge (p.3).

Students’ motivation and affective states were also emphasized by U.S. reformers as important factors affecting students' learning. For instance, the APA (1997) mentioned in their seventh learner-centered principle that the students’ curiosity could be seen as a factor enhancing students’ motivation to learn while negative emotions such as anxiety, panic, anger, insecurity could become factors diminishing students’ motivation to learn. McCombs and Miller (2007) emphasized that the student-centered teacher should “support students’ inherent curiosity, desire to learn, and motivation to develop responsibility for their learning” (p.4). They also pointed out that the teacher should give students some choice and control over their own learning process in order to help students become “self-motivated” learners (p.4).

The fourth domain is the social domain emphasizing the importance of interaction with others in learning process. Many student-centered educational reformers believed that students’ social interaction with their classmates or teacher could enhance their learning capability, develop higher order thinking skills, and cultivate positive emotions toward learning (APA, 1997; IPST, 2004; NRC 1996). Based on this view, the teacher should ask their students to work cooperatively and/or collaboratively with their peers. For example, one of the recommended successful science teaching strategies mentioned in the *Thai National Science Curriculum Standards* (IPST, 2004) is cooperative learning, where students work as a collaborative group to accomplish a learning task.

The last domain emphasizes the role of developmental and individual differences in student learning. The literature on student-centered instruction in this domain suggested that students learn effectively when they are engaged in a learning activity fitting with their individual learning abilities, styles, and backgrounds (APA, 1997; ONEC, 2003). For instance, the APA (1997) pointed out that students would exhibit a high level of motivation and academic accomplishment when they perceive “their individual differences in abilities, backgrounds, cultures, and experiences are valued, respected, and accommodated in learning tasks and contexts” (p.6). Based on this view, the teacher should provide students a learning activity that takes factors relating to students’ developmental and individual differences into account. For instance, the ONEC (2003) stressed that the teacher should design a learning activity “bearing in mind individual differences” (p.11). Similarly, the IPST (2004) noted that the science teacher should recognize individual differences in learning and make use of these “to respond to the needs, interests, and learning methods of the learners” (p.3). The role of students’ developmental and individual differences was also recognized by the U.S. reformers as importance factors affecting students’ learning. For example, the NRC (1996) suggested that in order to maintain or improve the quality and equity of education for all students, the science teacher should assign the learning task matching the diversity of the students’ needs, experiences, and backgrounds.

In order to address issues across all five domains mentioned above, student-centered educational reformers recommended the teacher to use various instructional strategies rather than a single teaching method. For instance, in the *Thai National Science Curriculum Standards,* the IPST (2004) recommended various instructional strategies that could lead to effective science teaching. These strategies included 5E inquiry-based pedagogy, problem-based learning, a hands-on and mind-on activity, a Think-Pair-Share learning activity, and a jigsaw activity. Similarly, while the NRC (1996) put a special emphasis on the implementation of inquiry-based instruction in the U.S. science classroom, they reminded the teacher to use the variety of teaching methods in their classroom. They said, “Although the Standards emphasize inquiry, this should not be interpreted as recommending a single approach to science teaching. Teachers should use different strategies to develop the knowledge, understandings, and abilities described in the content standards (p.32).” They believed that using various instructional strategies would enhance students’ learning more than using only one strategy.

Student-centered assessment. The literature on the student-centered approach frequently referred student-centered assessment to the use of various assessment tools to evaluate students understanding (ONEC, 2003; IPST, 2004). In addition to assess students’ understanding through a written test at the end of the learning unit, the ONEC (2003) suggested that the teacher should assess “students’ performance” in the classroom from various sources such as classroom observations, student artifacts, student works, and student classroom behaviors (p.12). Similarly, the IPST (2004) promoted the use of various assessment tools assessing students’ understanding and called this type of assessment as “authentic assessment” (p.39). They pointed out that authentic assessment consists of three main goals. The first goal is to acquire enough information for reflecting students’ authentic growth, performances, and abilities. The second goal is to provide a meaningful feedback to students. The third goal is to summarize the effect of instruction on student development. The use of multiple assessment methods was also promoted as a recommended assessment strategy in the United States. For instance, the NRC (1996) noted that the classroom assessment should involve many forms such as performance tasks, written reports, pictorial works, models, and other expressions representing student understanding. In addition, they suggested that the science teacher should choose the assessment method to best fit the particular learning goal since each method has particular strengths and weaknesses.

Self-assessment was also promoted as one form of student-centered assessment strategies in the United States. It was frequently recommended to use as a tool to enhance students’ metacognitive and regulative skills. For instance, the APA (1997) noted that “Self-assessments of learning progress can also improve students self appraisal skills and enhance motivation and self-directed learning” (p.7). Similarly, the NRC (1996) recommended the U.S. science teacher to give their students a chance to assess themselves in order to develop self-assessment and self-reflection.

Teacher’s Conceptions and Classroom Practice

Teachers’ Thought and Actions

Over the last three decades, research on teachers’ thought processes has received considerable attention in the science education community (Abell, 2007; Clark &

Peterson, 1986; Fang, 1996; Kagan, 1992; Nespor, 1987; Pajares, 1992; Prawat, 1992; Richardson, 1996; Shulman, 1986). The underlying assumption of this research area is that “teacher behavior is substantially influenced and even determined by teachers’ thought processes” (Clark & Peterson, 1986, p.255). The researchers in this area have expected that understanding what teachers think, know, and believe would contribute to a better understating of what they do in their classroom.

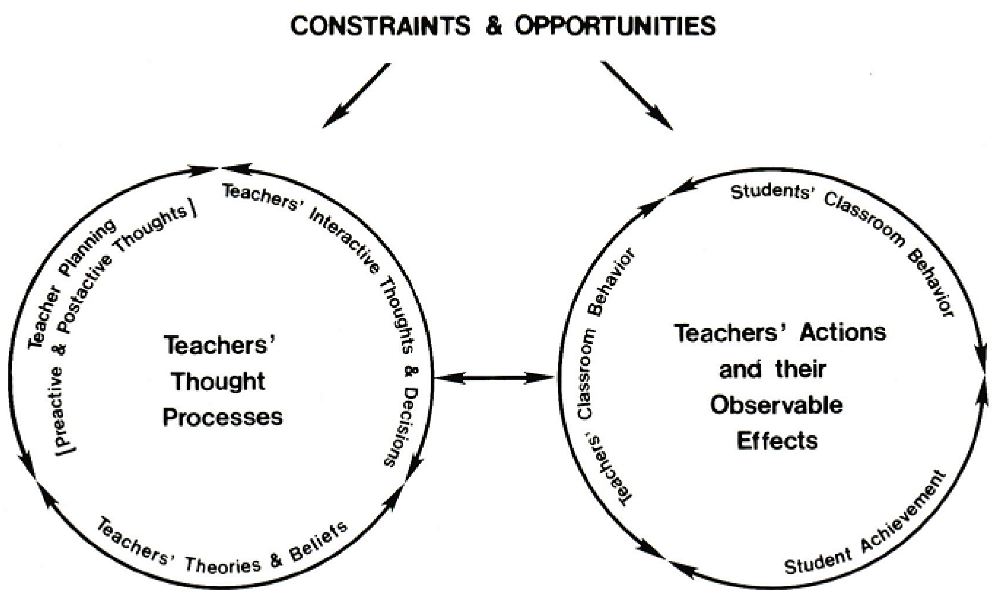


Figure 2.2. Model of teacher thought and action (from Clark & Peterson, 1986, p.257).

The current study is guided by the model of teachers' thought processes and actions presented by Clark and Peterson (1986). As shown in Figure 2.2, the teachers' thought processes and actions model illustrates a bidirectional interactive relationship between teachers’ thought processes and their classroom practices. It also shows the effect of constraints and opportunities on this relationship. The domain of teachers’ thought processes consists of three major categories: (a) teacher planning (pre- and post-active thoughts), (b) teachers’ interactive thoughts and decisions, and (c) teachers’ theories and beliefs. This study focuses on the third category which is described as “the rich store of knowledge that teachers have” (Clark & Peterson, 1986, p.258). In this study, teachers’ conceptions of teaching and learning are considered as parts of teachers’ theories and beliefs. Based on this model, teachers’ theories and beliefs affect and are affected by their planning, their interactive thoughts and decisions, and their actions.

Teacher’s Conceptions of Teaching and Learning

Even though a large body of research on teachers' theories and beliefs exists, there is little agreement on the distinction of teacher’ knowledge, beliefs, and conceptions (Pajares, 1992). Based on conceptual change theory pointed of views, Hewson and Hewson (1989) used the terms “teachers’ conception of teaching” to describe knowledge and beliefs the teacher used in teaching. They defined teacher’s conceptions of teaching as

> The set of ideas, understandings, and interpretations of experience concerning the teacher and teaching, the nature and content of science, and the learners and learning that the teacher uses in making decisions about teaching, both in planning and execution. These include curricular decisions (the nature and form of the content) and instructional decisions (how the content related to the learners in the instructional setting). The structure of a conception may vary considerably from a relatively amorphous collection of ideas with no strong connections to one which is interrelated and possesses a large measure of internal consistency (p. 194).

This section reviews the definitions of two major terms related to teachers’ conceptions of teaching and learning in science education literature. These terms include (a) knowledge and (b) beliefs.

Definition of knowledge. Richardson (1996) pointed out that the difference between knowledge and beliefs is the “truth condition.” For her, knowledge is an idea or statement that is accepted to be true by people in a community. In other words, knowledge requires proofs and evidences to support its claims of truth in order to be accepted by a community of people. Alexander, Schallert, and Hare (1991) defined knowledge as one type of beliefs. They said “knowledge often refers to justified true beliefs and is reserved for universal, or absolute, truths” (p.3117).

Definition of beliefs. Pajares (1992) reviewed the research on teachers’ beliefs and highlighted the confusion and lack of an agreement with the definitions of the term beliefs in the literature. He noted that the term “beliefs” is “a messy construct" with various meanings and uses. In addition, he pointed out that beliefs are often disguised under various terms, including

> conceptions, conceptual systems, preconceptions, dispositions, implicit theories, explicit theories, personal theories, internal mental processes, action strategies, rules of practice, practical principles, perspectives, repertories of understanding, and social strategy, to name but a few that can be found in the literature (p. 309).

In contrast to knowledge, Richardson (1996) noted that the common characteristic of beliefs is the individual acceptance without a truth condition and community agreement. Based on this view, the term belief is used to describe an idea or statement which is personally accepted. For her, beliefs do not need to be validated by others. A person might believe thing to be true even though this person has never tested whether it is true or false. Beliefs are based on personal experiences and assumption while knowledge requires external verification. In other word, beliefs do not require any proof or real evidence to confirm the truth condition.

Many scholars also point out that beliefs contain affective and evaluative components (Abelson, 1979; Grossman, Wilson, & Shulman, 1989; Nespor, 1987;

Richardson 1996). People frequently insert their feelings, moods, and emotions into their personal acceptance of the belief. Richardson (1996) grouped attitudes and beliefs in the same subset. She said, “Attitudes and beliefs are a subset of a group of constructs that name, define, and describe the structure and content of mental states that are thought to drive person’s action” (p.102). Based on works by Ableson (1979), Nespor (1987) pointed out that beliefs can be separated from knowledge because beliefs contain four unique characteristics, including (a) existential presumption, (b) alternativity, (c) affective and evaluative aspects, and (d) episode storage. This author also emphasized that beliefs are influenced by personal preference and evaluation more than knowledge. For Pajares (1992), the most common distinction between beliefs and knowledge is that “Belief is based on evaluation and judgment; knowledge is based on the objective fact” (p.313).

In their review of research on science teaching and learning, Tobin, Tippins, and Gallard (1994) described beliefs as references used by the teacher to determine what they see, think, and do. These authors went on and noted that these references “act as organizers of teacher knowledge in the form of beliefs and images. They are useful in determining whether particular actions are legitimate in the culture of the science classrooms in which they operate” (p.55).

Since the distinction between teacher knowledge and beliefs is not clear in the literature, these two constructs are frequently mentioned in science education literature as inseparable components (Friedrichsen & Dana, 2003; Gess-Newsome & Lederman, 1999; Grossman, Wilson, & Shulman 1989, Kagan, 1990). Grossman et al. (1989)

suggested that maintaining the bur distinction between teacher knowledge and beliefs is one of the best ways to examine teachers' thought processes because teachers frequently treat their beliefs as knowledge and these two constructs mutually affect each other. Similarly, Kagan (1990) mentioned that knowledge about teaching and learning can be regarded as beliefs because it tends to be an opinion instead of fact. He also noted that teachers' knowledge is a form of beliefs situated in three places including context (it is related to a particular instructional setting), content (it is related to a particular subject to be taught), and person (it is embedded within teachers' individual belief system). This study follows this trend by merging both teacher knowledge and beliefs together and by using the term *teacher conception* representing teacher's idea about things based on both knowledge and beliefs. In addition, this study uses the terms "teachers' conceptions," "teachers' beliefs," "teachers' views," "teachers' perceptions," "teachers' thought processes," and "teachers' thinking" interchangeably.

Research on Teacher's Conceptions of Teaching and Learning and Classroom Practices

Many scholars have considered teachers as the key to the success of the current educational reform (Cuban, 1990; Prawat, 1992; Tobin et. al. 1994). There has been a growing body of research aiming to understand and improve teachers' classroom behaviors. Based on the assumption that research on teachers' thought processes will provide a better understanding of teacher classroom practices, many researchers have tried to examine the relationship between teachers' thought and actions in various aspects:

- Conception of (or, belief about) teaching and learning science (Brickhouse & Bodner, 1992; Bullough, 1991; Calderhead & Robson, 1991; Freire & Sanches, 1992; Haney et al., 2002; Hewson et al., 1995; King et al., 2001; Koballa et. al., 2000; Laplante, 1997; Lemberger et. al., 1999; Levitt, 2002; Mellado, 1998; Perry & Rog, 1992; Prosser et. al., 1994; Samuelowicz & Bain, 1992; Simmons et al, 1999; Tobin, 1990; Tobin & Fraser, 1990; Weinstein 1989);
- Orientation toward teaching and learning (Friedrichsen & Dana, 2003, 2005; Kagan & Tippins, 1991);
- Epistemological beliefs (Hashweh 1996; Kang, 2007; Kang & Wallace, 2005; Luft & Roehrig, 2007; Tsai, 2007);
- Constructivism (Beck, Czerniak, & Lumpe, 2000; Haney & McArthur, 2002; Haney, Czerniak, & Lumpe, 2003);
- Inquiry-based instruction (Brown et al., 2006; Crawford, 1999, 2000, 2007; Haefner & Zembal-Saul, 2004; Hayes, 2002; McDonald & Songer, 2008; Newman et al., 2004; Roehrig & Luft, 2004b; Rop 2002; Wallace & Kang, 2004; Windschitl, 2002, 2004);
- Nature of science (Abd-El-Khalick, Bell, & Lederman, 1998; Brickhouse, 1990; Lederman, 1995, 1999; Lederman & Zeidler, 1987; Mellado, 1997; Mellado et. al., 2008; Tobin & McRobbie, 1997; Trumbull et. al, 2006; Wang, 2001; Waters-Adams, 2006; Zimmerman & Gilbert, 1998);

- Education reform (Barak & Shakham, 2008; Davis, 2003; Haney et al., 1996; McRobbie & Tobin, 1995; Roehrig & Kruse 2005; Schneider, Krajcik, & Blumenfeld, 2005; Tobin & McRobbie, 1996);
- Subject matter knowledge (Gess-Newsome & Lederman, 1995; Hashweh, 1987);
- Pedagogical content knowledge (Avraamidou & Zembal-Saul, 2010; Barnett & Hodson, 2001; Faikhamta, Coll, & Roadrangka, V., 2009; Park et al., 2011);
- Knowledge and beliefs system (Bryan, 2003; Tsai, 2002); and
- Technology integration (Ertmer et. al., 1999; Lumpe, Haney, & Czerniak, 1998; Woodrow et al., 1996).

As expected, many research studies have reported the relationship between teachers' beliefs and practices (e.g., Haney, Czerniak, & Lumpe,1996; Haney, Lumpe, & Czerniak, 2002; Hashweh, 1996; Kang & Wallace, 2004; Roehrig & Kruse, 2005). For instance, Hashweh (1996) conducted a study to examine the relationship between 35 Palestinian science teachers' epistemological beliefs and classroom behaviors. Based on self-reported data from the questionnaire, he concluded that teachers' epistemological beliefs influenced their classroom practices. As he reported, teachers holding constructivist beliefs were likely to examine students' alternative conceptions, knew a lot of effective teaching strategies, and effectively implemented learning activities that promoted conceptual change, and frequently used more effective teaching strategies than teachers with empiricist beliefs.

Roehrig and Kruse (2005) conducted a study with 12 high school chemistry teachers to investigate the impact of a reform-based chemistry curriculum, *Living by Chemistry (LBC)*, on teachers' beliefs and classroom practices. Qualitative and quantitative data were collected with Teachers' Beliefs Interviews (TBI) and a modified Reformed Teaching Observation Protocol (RTOP). Based on participant's TBI responses and RTOP scores, they found a statistical relationship between teacher's beliefs about teaching and learning and their classroom practices. As they pointed out, teachers who held a high level of student-centered beliefs attempted to implement inquiry-based classroom instructional practices while teachers with traditional teacher-centered beliefs seemed to be resistant to change in practice. Similarly, McDonald and Songer (2008) reported two contrasting cases of fifth grade teachers enacting inquiry-based and technology-rich curriculum. They found that the teachers' enactment was significantly impacted by two factors: their conceptions of authenticity (authentic learning /authentic science) and their view of science (descriptive/inferential). Based on the result of this study, the teacher who focused on authentic learning and descriptive science tended to incorporated open-ended and student-directed inquiry while the other teacher who emphasized authentic and inferential science was committed to structured and guided inquiry.

In her study, Brickhouse (1990) examined three science teachers' views about the nature of science and the impact of these views on their classroom instruction. She found that the teachers' views of the nature of science were consistent with their views of how students should learn science as well as with their instructional practices. For example, the instructional activities of one teacher, Cathcart, who viewed science as a linear and rational process, emphasized memorization of factual information. On the other hand, Lawson who believed that science was a tool for problem solving had a tendency to ask his students to use scientific theories to explain observations and solve problems.

The literature has also shown that there were no simple links between teachers' classroom practices and their conceptions of teaching and learning. In addition, more recent studies have shown that teachers' practices were influenced by various sets of beliefs and these belief sets were interacting with each other (e.g., Lederman 1999; Tobin & McRobbie, 1997; Tsai, 2002; Wallace & Kang, 2004). Tobin and McRobbie (1997), for instance, conducted an interpretive case study of one male Australian high-school chemistry teacher. They found that even though the teacher viewed science as changing and involving scientists' interpretation, this teacher often promote the views of science as static and certain by emphasizing learning through memorization. They reported that teacher's instructional goals influenced his classroom actions more than did his views of the nature of science. These goals included (a) helping students pass tests and examinations, (b) preparing students for the next educational level, (c) indentifying content to be learned and memorized, and (d) maintaining the power of control. The authors reported that a teacher with these educational goals tended to use instruction promoting the positivist views of scientific knowledge. In a different paper on the same data, Tobin and McRobbie (1996) identified four cultural myths supporting the continuous use of traditional, teacher-centered instruction. These myths included (a) the transmission of knowledge, (b) being efficient, (c) maintaining the rigor of the curriculum, and (d) preparing students to be successful on examination.

Lederman (1999) conducted a multiple-case study to examine the relationship between five biology teachers' conceptions of the nature of science and their classroom practice. The results of his study revealed that teachers' conceptions of the nature of science did not necessarily transfer into classroom practice. In addition, he found that teachers' instructional practice was majorly influenced by other sets of belief such as making students feeling successful in science, developing students' positive attitudes toward science, making students feeling good about themselves, and helping students seeing the relationship between science and their daily lives.

In her study, Tsai (2002) interviewed 37 Taiwanese science teachers' views about teaching science, learning science, and the nature of science. She found that these three views were interrelated in a beliefs system, called "nested epistemologies." In addition, the results of her study showed that most of these teachers held a traditional view in all three dimensions: teaching science as knowledge transfer, learning science as knowledge acquisition or reproduction, and science as a set of well-established truths. She concluded beliefs related to practices were intertwined and nested with each other.

Two competing sets of teachers' beliefs about teaching and learning science were also found in Wallace and Kang's (2004) study. In addition, they conducted a multiple-case study of six experienced high school science teachers and found that these teachers exhibited two competing sets of beliefs when considering the implementation of inquiry-based instruction. On one hand, the teachers held a set of beliefs derived from school culture and centered on factors that impede the implementation of inquiry. Two examples of these cultural beliefs included (a) a belief that some students are too immature and lazy to complete inquiry tasks and (b) a belief that students should spend their time on preparation for high stake exams rather than on inquiry-based projects. On the other hand, these teachers exhibited a set of beliefs that support the implementation of inquiry-based instruction. For instance, they believed that inquiry-based instruction could be used to foster students' scientific problem solving skills and students' attitudes toward science. The researchers pointed out that the reconciliation between these two competing sets of beliefs led to different teachers' actions in the classroom. For example, one teacher in this study separated these two belief sets into two different courses: inquiry-based physics and teacher-centered chemistry. Other two teachers who emphasized the important of culturally-based learning goals spent most of the class time on teacher-centered activities. On the other hands, two other teachers who succeed in integrating these two belief sets implemented meaningful inquiry-based instruction in their classrooms.

In conclusion, the results of the literature review suggest that teachers' beliefs can be either congruent or incongruent with their classroom practices. While many studies have sought to determine teachers' knowledge and beliefs about teaching through one or more forms of student-centered instruction, few have directly explored their conceptions of the student-centered approach and comprehensively examined their conceptions across all three educational aspects: curriculum, instruction, and assessment. Moreover, the review of the research literature states that teachers can hold various belief sets and each belief set can either cooperate or compete with each other (e.g., Tsai, 2002; Wallace &

Kang, 2004). The review also reveals some possible groups of teacher knowledge and beliefs that could influence the implementation of teachers' conceptions of the student-centered approach. Examples of these possible groups included (a) a belief that some students are too immature and lazy, (b) a belief that students should spend their time on preparation for high stake exams, (c) a belief that instruction should focus on enhancing problem solving skills, and (d) a belief that instruction should focus on improving students' attitudes toward science (e.g., Lederman 1999; Tobin & McRobbie, 1996, 1997; Wallace & Kang, 2004).

Nevertheless, there is little research on how teachers' conceptions of the student-centered curriculum, instruction, and assessment relate to other belief sets and how this relationship influences their classroom practices. Therefore, the present study attempts to fill these gaps in the research literature. In order to capture a complete picture of teachers' conceptions of the student-centered approach, this study was designed to examine teachers' conceptions of the non-student-centered approach together with teachers' conceptions of the student-centered approach. Furthermore, in order to fully understand the influence of teachers' conceptions of the student-centered approach on their classroom practices, this study was designed to examine other sets of teachers' beliefs that could affect the implementation of the student-centered approach. It is anticipated that the results from this study would provide a better understanding of teachers' thought processes and their classroom behaviors.

CHAPTER THREE

METHODOLOGY

The purpose of the present study was to examine Thai high school physics teachers' conceptions of the student-centered approach as well as their perceptions of their classroom practices. This study aimed to answer following research questions:

1. What are Thai physics teachers' conceptions of the student-centered approach?
2. What are Thai physics teachers' perceptions of their classroom practices in relation to their conceptions of the student-centered approach?
3. What reasons do Thai physics teachers give for supporting or opposing the implementation of student-centered practices in their own classroom?
4. What are Thai Physics teachers' reflections on the student-centered educational reform movement in relation to their conceptions of the student-centered approach?

This chapter outlines the research methodology and method of the study. It contains eight main sections including (a) methodology, (b) research design, (c) participants, (d) researcher's roles, (e) data collection, (f) data analysis, (g) credibility, and (h) limitations and delimitations of the study.

Methodology

This study is a qualitative multiple-case study focusing on understanding physics teachers' conceptions of the student-centered approach in their natural contexts. Merriam (1998) has described qualitative research as "an umbrella concept covering several forms of inquiry that help us understand and explain the meaning of social phenomena with as little disruption of the natural setting as possible" (p.5). She has also noted that the purpose of qualitative study is to understand the meaning of "the phenomenon of interest from the participants' perspectives, not the researcher's" (p.6). This notion is resonant with the purpose of this study which intends to investigate the conceptions of the student-centered approach naturally, from teachers' perspectives.

Research Design

This study employed a holistic multiple-case study design to answer four main research questions mentioned earlier. Even though scholars have defined case study research in many different ways, their definitions have shared a number of common characteristics (Creswell, 2007; Merriam, 1998; Patton, 2002; Stake, 1995, 2006; Yin, 2003). In general, case study is defined as the systematic study of a phenomenon that has definable boundaries and cannot be fully understood without its context. Creswell (2007) has defined case study as "the study of an issue explored through one or more cases within a bounded system (i.e., a setting, a context)" (p.73). As noted by Merriam (1998), "[a] qualitative case study is an intensive, holistic description and analysis of a single instance, phenomenon, or social unit" (p. 27). Yin (2003) has defined a case study as "an empirical inquiry that investigates a contemporary phenomenon within its real-life context when the boundaries between phenomenon and context are not clearly evident" (p.13). Yin (2003) also believes that "the case studies are the preferred strategy when 'how' or 'why' questions are being posed, when the investigator has little control over events, and when the focus is on a contemporary phenomenon within some real-life contexts" (p.1).

There are at least three reasons why the case study fits with this research study. First, this study primarily focuses on answering "how" and "why" questions. In addition, this research study aims at examining how Thai physics teachers perceive their classroom practices in relation to their conceptions of the student-centered approach as well as why they teach as they do. Second, the researcher has little control over teachers' conceptions of the student-centered approach as well as their perceptions of their own classroom practices. Finally, the case study approach is relevant to this study because it is difficult to separate out teachers' conceptions from the contexts in which it operates.

Participants

This study consisted of four individual cases of Thai high school physics teachers in the Promotion of Science and Mathematics Talented Teachers (PSMT) program. All four cases were situated in different schools. The participants were purposefully selected. The participant selection process was based on the following criteria: (a) the participants were teaching high school PSMT physics in Buriram and Surin provinces, (b) they had two years of teaching experience and were promoted from "assistant teacher" to "tenured teacher," (c) they did not hold any science education degrees equal to or higher than the Master's degree, (d) they were willing to examine their own understanding and classroom practices, and (e) their school principals gave them permission to conduct this research study in their schools. The major goal of purposive sampling was to engage the physics teachers who felt comfortable to describe their thinking openly and to demonstrate their classroom practices freely. In addition, this study utilized the purposeful sampling method to maximize the opportunities for obtaining rich and in-depth data (Stake, 2006). As noted by Merriam (1998), “Purposeful sampling is based on the assumption that the investigator wants to discover, understand, and gain insight and therefore must select a sample from which the most can be learned” (p. 61). The recruitment occurred through various methods such as mailing an invitation letter, posting an announcement on the PSMT website, and using individual invitations. There were four PSMT teachers who met these criteria.

As all four participating teachers, Ploy, Mook, Gorn, and Yord, are in the PSMT program, they all had a Bachelor’s degree in Physics and a one-year graduate teaching certificate. In order to be eligible to apply to the PSMT scholarship, these teachers were required to have at least 2.80 high school overall cumulative GPA and at least 2.80 math and science cumulative GPA. Moreover, in order to maintain the PSMT scholarship, these teachers were required to maintain a cumulative GPA of at least 2.75 in a Bachelor’s degree program and of at least 3.00 in a graduate teaching certificate. Moreover, all of them knew one another and were the same age, 24-25 years old. Three of four teachers, Ploy, Mook, and Yord, graduated from the same university. Furthermore, during the time of study, Ploy and Mook were in the first year of their Master's Degree program in science education at the same university. These two teachers received financial support from IPST to attend the four-year summer Master’s degree program.

Role of Researcher

As a researcher for this study, I became an investigator employing the qualitative case study method to examine how teachers made sense of the term "student-centered," as well as how they perceived their classroom practices. My role as the investigator was to observe the classroom, to conduct interviews, to collect related documents and to analyze all collected data. In other words, I became the "primary instrument for data collection and analysis" (Merriam, 1998, p.7). As a result, the quality of this research study relied on my ability to gather and analyze the data. It was also dependent on my ability to be sensitive to the data. Strauss and Corbin (1990) have described this as theoretical sensitivity:

> Theoretical sensitivity refers to a personal quality of the researcher. It indicates an awareness of the subtleties of meaning of data. ... [It] refers to the attribute of having insight, the ability to give meaning to data, the capacity to understand, and capability to separate the pertinent from that which isn't (p. 42).

Based on Strauss and Corbin (1990), professional and personal experiences form one of the major sources that can enhance theoretical sensitivity. In this section, I provide the readers with a brief description of my professional and personal backgrounds in order to illustrate my sensitivity to the study.

During the data collection and analysis, I was a Ph.D. candidate in science education at the University of Minnesota. One of my interests has been to understand the current trends in teaching and learning science, especially physics. I have been awarded a full scholarship from IPST in order to pursue this degree. After graduating from the University of Minnesota, I will continue my work as an IPST officer to promote student-centered education and improve science education across my country, Thailand.

My sensitivity and credibility lies in both professional and educational experiences. I was one of the Thai students who participated in the PSMT program. I had a Bachelor's degree of science, majoring in physics. I also hold a Graduate Diploma, majoring in the teaching profession. I had a one-semester teaching experience as a student teacher. Before I enrolled at the University of Minnesota, I had worked as an IPST officer at the physics department for one year. I worked with other IPST officers to:

- Produce lessons, exercises, academic documents, equipment and media for the teaching and learning of high school physics;
- Set teacher training programs by distance education in collaboration with the Distance Learning Foundation and the Educational TV (ETV) for teachers throughout our country;
- Cooperate with networking the teachers' program for developing the equipment, materials and basic education curriculum; and
- Exhibit a science show on National Science Week 2005 at Impact Exhibition and Convention Center, Bangkok between 22nd and 28th August, 2005.

Working with IPST gave me a chance to meet, observe, and have discussions with many Thai physics teachers in their schools. I believe that these professional and educational experiences have enhanced my sensitivity to conduct a good quality research study on Thai physics teachers' conceptions of the student-centered approach and their perception of their classroom practices. I also believe that by applying both etic (or outsider's) and emic (insider's) perspectives as being one of the PSMT students and currently studying abroad, I would be able to make a wise decision on how to collect, analyze, and present the relevant data.

Building and maintaining trust is another task for a good qualitative researcher (Lincoln & Guba, 1985). In order to encourage the participants to share their ideas openly and honestly, the qualitative researcher has to gain trust from them. As a result, in this study, I used various strategies to develop trust with the participants. For instance, before the data collection began, I had carefully explained my research goals, methods, risks, and benefits of treatments to the participating teachers. I also informed them that this study was conducted under Institutional Review Board (IRB) protocols so their identity was protected and secured. During the data collection, I placed a special emphasis on developing friendship with the participants. I believed that my background as one of the PSMT teachers and being in the same age group with the participants allowed me to develop a friendly and supportive relationship with them. It is important to note that the IPST generally has had a positive relationship with participating science teachers. The major responsibility of IPST has been to provide teaching supports to science teachers rather than to evaluate their practices. In other words, the IPST does not get directly involved in the process of teacher evaluation for salary increases and promotions. As a result, I believe that my background as an IPST officer definitely strengthens the trust and friendship between the participants and myself.

Data Collection

The overall structure of data collection procedures for each teacher is presented in Figure 3.1. Data collection was conducted in two different schools at the same time. In addition, data collection was administered at Ploy's and Mook's school during the second half of the fall 2010 semester. Then, data from Gorn and Yord were collected during the first half of the winter 2010 semester.

This section describes three different data sources used in this study. These sources of data include interviews, classroom observations, and document review.

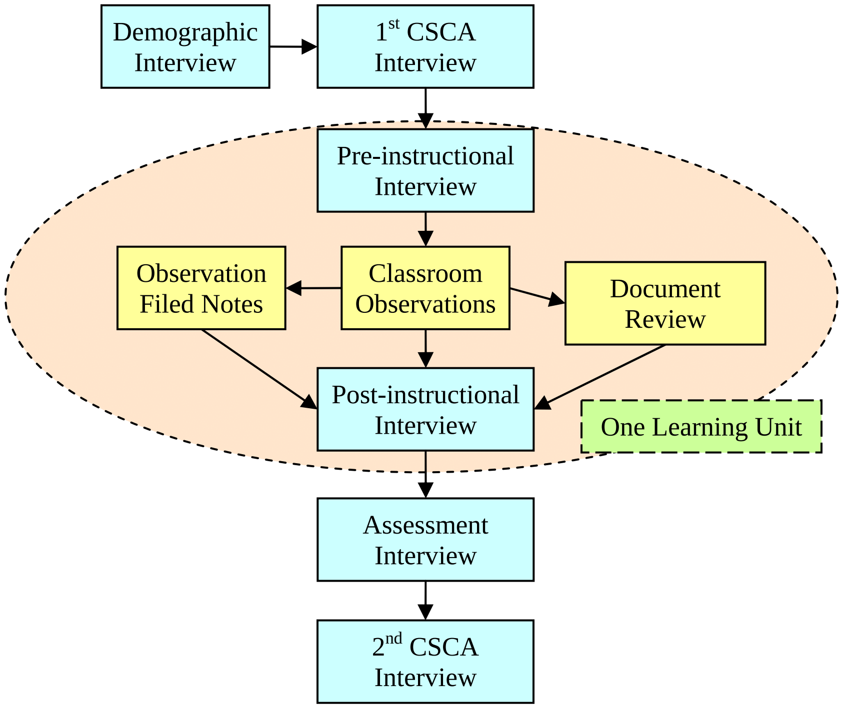


Figure 3.1. Data collection.

Interviews. The interview is considered one of the most important data sources for case study research. Merriam (1998) has noted that "interviewing is necessary when we cannot observe behavior, feelings, or how people interpret the world around them" (p. 72). Stake (1995) has pointed out that "the interview is the main road to multiple realities" (p.64). As mentioned earlier, this research study intended to capture teachers' conceptions of the student-centered approach and their interpretation of classroom practices while the researcher could not observe teachers' conceptions and interpretation directly. Therefore, the interview was chosen as the primary method for data collection in this study.

In this study, as shown in Figure 3.1, six different kinds of open-ended interviews were carried out. The first two interviews were conducted during the first week of data collection for each teacher. These interviews included the demographic interview and the Conceptions of Student-Centered Approach (CSCA) interview. The demographic interview was administered to determine teachers' personal information and perspectives about their everyday instruction (Appendix B). During the interview, teachers were asked to describe their perceptions of the PSMT program, their regular classroom practices, their school contexts, and the Thai educational system. Teachers' top three instructional goals were also investigated through the interview. In order to shorten the interview process, each teacher was asked to complete a short questionnaire asking about demographic background such as years of teaching experience, workloads, school responsibilities, and the number of students and teachers in the school. Each demographic interview lasted for 50-100 minutes.

In the CSCA interview, teachers' conceptions of the student-centered approach were examined (Appendix C). This interview intended to capture teachers' personal conceptions of the student-centered approach in an ideal context. Each teacher was asked to give new beginning teachers a description of what the student-centered approach (curriculum, instruction, and assessment) would look like. The characteristics of non-student-centered approaches were also examined in order to obtain a more complete picture of their conceptions of the student-centered approach. The teacher was also asked to illustrate the perceived strengths and weakness of both student-centered and non-student-centered approaches. At the end the interview, the teacher was asked to give their reflection on the student-centered reform movement. Furthermore, during the interview, explanations with examples, analogies, or metaphors were asked for more clarification. The first CSCA interview lasted for 40-80 minutes.

The third and fourth interviews were conducted during the classroom observation periods. These two interviews included the pre- and post-instructional interviews (Appendices D and E). The pre-instructional interview was administered before instruction began. Even though I asked all of the teachers to have a pre-instructional interview at least one day before instruction, they requested that I interview them on the same day that they delivered the lesson because they frequently decided what and how to teach the night before instruction. As a result, all pre-instructional interviews were conducted on the day of instruction. Each pre-instructional interview lasted for 10-30 minutes. There were two instructional days that the pre-instructional interview was canceled due to short-notice scheduling problems. The one was Ploy’s first lesson, and the other was Yord’s second lesson. The post-instructional interviews lasted for 20-60 minutes.

The main goal of both pre- and post-instructional interviews was to use learning activities from their lesson plans (or their classroom practices) as sources to probe their thought process as well as to elicit their reflections on each activity. The pre-instructional interview was used to capture how teachers made a plan to teach their students, how they perceived their lesson plan based on their conceptions of the student-centered approach, and what factors influenced their decisions in developing a lesson plan. Similarly, the post-instructional interview was conducted to examine how teachers actually taught their students, how they perceived their practices based on their conceptions of the student-centered approach, and what factors influenced their classroom practices.

Both pre- and post-instructional interviews were conducted using a similar structure. Before these two interviews began, I had asked each teacher to think and make a draft summary of their lesson plans (or actual practices). The decision whether or not to implement the plan was primarily dependent on them. In addition, if their lesson contained few lesson activities, these teachers usually refused to make any notes and preferred to start the interview right away. Yord was the only teacher who did not take any notes before the interviews started. Instead, he used the student's notebook as a reference source to recall what happened in the classroom. At the beginning of the interview, I asked each teacher to summarize key events illustrating what would happen (or had happened) in the classroom. In addition, they were asked to describe how they decided what and when to teach (curriculum), how to teach (instruction), and how to assess students' learning (assessment). Based on their explanations, they were asked to characterize both teacher's and students' actions in terms of being or not being student-centered ones. Their reasons for the characterization were also investigated. In order to obtain a better picture of their thought, these teachers were also asked to describe their ideas about how to make their lesson plans (or practices) more student-centered. The strengths, weaknesses, and factors influencing their lesson plans (or practices) were also examined through the interviews. Examples of interview questions include the followings:

1. What will/did your students learn? How/why do/did you decide to teach it?
2. What will happen/happened in the classroom?

3. Are/were there any assessment activities? What are/were they?
4. What of these activities can be described as being student-centered or non-student-centered? Why?
5. What are strengths/weaknesses of each activity?
6. If you want your lessons to be more student-centered ones, what will/should happen? Why will/would not you do that?

The fifth interview was an assessment interview (Appendix F). This interview focused on examining teachers' conceptions of student-centered assessment and their perceptions of their examinations at the end of the observed units. This interview was originally designed to be conducted two times: one interview before and one interview after the test at the end of the unit. However, after I discussed with each teacher, I decided to administer this interview once at the end of the examination because there was no difference between teachers' plans and actual practices. All four teachers evaluated students' understanding by using the written test with pre-defined correct answers. Similar to pre-and post-instructional interviews, in the assessment interview, each teacher was asked to summarize key features of their tests such as sources of test questions, types of test questions, and ways of completing the tests. After that, their perception of assessment, its strengths and weaknesses based on their conceptions of the student-centered approach was examined. The duration of the assessment interview ranged from 15-25 minutes.

The last interview is the second CSCA interview. It was administered at the end of the final data collection week. The goal of the interview is to examine whether teachers' conceptions of the student-centered approach have been changed as a result of the presence of this study or not. The interview was guided by questions similar to those in the CSCA interview. Additionally, during the interviews, teachers were encouraged to use examples from the observed classrooms as reference sources to illustrate their ideas.

All interviews mentioned above were semi-structured, flexible, and adaptive. In addition, even though I used the interview protocol of open-ended questions to guide the discussion, I might not have used all of the questions listed in the interview protocol and might have changed the wording of the questions in some cases. I also constructed new interview questions to probe the answers of the respondent for more in-depth clarification. The examples of these questions are "What do you mean when you say …?," "Could you tell me more about …. (what you have just said)?," and "Could you give me more examples to illustrate your ideas?"

It is important to note that all of the interviews were conducted in Thai, which is the first language of the researcher (interviewer) and teachers (interviewees). This language allowed me, as an interviewer, and the teachers, as interviewees, to communicate with each other fluently and effectively. The interview was audio-recorded with the permission of the teachers and took place in a quiet area at each teacher's school. During each interview, I took notes focusing on key ideas expressed by the teacher. These notes helped me to develop new questions as well as to recognize some ideas that might be overlooked. Moreover, after finishing each interview, I immediately wrote reflection notes summarizing my impressions and interpretations of the interview. Furthermore, all of the interviews were transcribed by me to ensure the accuracy of the transcription. Table 3.1 presents the total numbers and duration of the conducted interviews.

Table 3.1

The Total Numbers and Duration of the Interviews

Type of the interviews	Ploy		Mook		Gorn		Yord	
	No.	Length (min)	No.	Length (min)	No.	Length (min)	No.	Length (min)
Demographic	1	102.14	1	70.00	1	51.15	1	74.40
1st CSCA	1	55.45	1	50.00	1	74.20	1	44.16
Pre instructional	3	158.31	5	66.40	9	254.04	4	146.11
Post instructional	4	259.19	5	130.30	9	303.24	5	179.13
Assessment	1	24.59	1	14.49	1	22.00	1	20.23
2nd CSCA	1	55.45	1	43.12	1	32.38	1	43.47
Total	11	656.33	14	376.11	22	738.41	13	508.30

Classroom observations. Non-participant classroom observations were conducted in one of each teacher's classrooms. The observed classroom was chosen by the teacher based on their preference. In addition, before the data collection began, each participating teacher was asked to choose one of their class sessions they felt comfortable to be observed. The focus of the note taking was on key learning events and transitions between these events. In addition, I paid special attention to both teacher's and students' actions able to be used as sources for making sense of what the participant said during the interviews. One week before the first classroom observation began, both teacher and students had been informed of the goals, risks, and benefits of the study. This procedure was intended to assure them that their identities were fully protected.

Each participant's classroom was observed for one complete learning unit in order to cover all three educational aspects, including curriculum (what and when to teach), instruction (how to teach), and assessment (how to assess students' learning). Table 3.2 presents the summary of the observed classrooms. The data from classroom observations were used as a reference source for formulating the post-instruction interview questions, as well as for understanding the participants' answers to the post-instruction interview questions.

Table 3.2

Summary of the Observed Classrooms

Teacher	Class	Learning Unit	Number* of		Weekly schedule
			Week	Lesson**	
Ploy	M5/1 (Grade 11)	Heat	4	4	Tuesday and Friday (120 minutes/day)
Mook	M4/4 (Grade 10)	Force, Mass, and Laws of Motion	3	5	Wednesday and Thursday (90 minutes/day)
Gorn	M6/2 (Grade 12)	Electric and Magnetic Field II	8	9	Wednesday (50 minutes) and Thursday (100 minutes)
Yord	M4/2 (Grade 10)	Motion	3	5	Tuesday and Friday (100 minutes/day)

Note. * Number of observed instructional lessons and weeks does not include the exam period.
** Number of observed instructional lessons does not include the number of the canceled class.

As mentioned earlier, I observed Ploy's and Mook's instruction during the second half of the fall 2010 semester. Even though Ploy taught three high school physics courses, she recommended observing her M5/1 (Grade-11) class on the Heat unit. Ploy completed this unit in four weeks. Mook advised me to observe either her M4/2 or M4/4 (Grade-10) classes on the unit of Force, Mass, and Laws of Motion. Because of the time conflict, I observed her M4/4 class. Mook's observed unit consisted of five 90-minute lessons and she finished all of these lessons within three weeks.

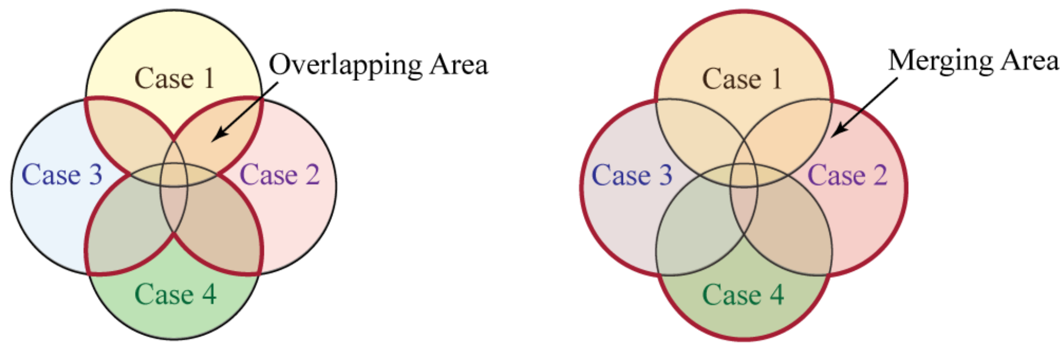
The observations of Gorn's and Yord's classrooms took place during the beginning of the winter 2010 semester. Both Gorn and Yord told me that I could observe any of their classes because they did not see any difference in their practices in each classroom. Gorn suggested I observe his M6/2 (Grade-12) class on Electric and Magnetic Field II. He had four 50-minute lessons on Wednesday and five 100-minute lessons on Thursday. Yord recommended observing him teaching about Motion with his M4/2 (Grade-10) students. For this observed unit, he gave five 100-minute lessons on Tuesday and Friday for three consecutive weeks. It is important to note here that the cancellation of classes is normal in Thailand. As a result, the total number of the observed lessons is less than the total number of the actual lessons because all four teachers canceled some of their classes during the observation period.

Documents. Besides classroom observations and interviews, documents such as teacher manuals, textbooks, lesson plans, student work, handouts, worksheets, presentations, notes on blackboards, and assessment tasks were gathered and used as supporting evidence. Several methods of data gathering were employed. Examples of these methods included making copies, taking digital pictures, and scanning images of the original documents. In the document collection process, the teacher was asked to help in identifying and prioritizing relevant documents. For instance, the teachers were asked to choose documents that could be used to illustrate their classroom practices and their conceptions of the student-centered approach. These teachers were also asked to choose three of the students' works to display what they wanted their students to do.

Data Analysis

In this study, data collection and data analysis took place simultaneously (Merriam, 1998). The analysis allowed me to make sense of the current data which then guided the subsequent data collection and analysis. All data from several sources of information such as interview transcripts, observation field notes, and documents were systematically analyzed to find out the answers to the research questions of this study. It is important to note here that the primary data source came from interviews while the classroom observation and document review were used as a supplementary tool to facilitate the interpretation of the interview data. Additionally, I used the NVivo 8.2 software to facilitate data analysis. There were at least four reasons why I chose to analyze the data by using NVivo Software. First, it allowed me to code, uncode, and manipulate the data without affecting the original sources. In addition, I imported and set up all interview transcriptions into the software as read-only files so that I would not accidentally change or erase some portions of the files during the analysis. Second, I could use the NVivo program to code and decode the data at nodes easily and to freely move between nodes and data sources. This program also allowed me to look effectively at all of the data coded in each node. Third, the NVivo allowed me to add highlights, annotations, and memos to the data source, all with ease. I used these tools to keep track of my ideas and reflections during the analysis. Finally, the NVivo program allowed me to use various supporting tools such as coding stripes, coding frequency, and tree node coding structures to utilize the analysis. For instance, I frequently used coding stripes to display all codes of a passage in order to ensure that the passage was coded at the right node. During the analysis, the constant comparative method was used to analyze the data and identify categories and themes. By using this method, I constantly compared and contrasted data to the emerging themes (or categories) for developing new themes (or categories) until all themes (or categories) were saturated (Creswell, 2007).

There were two levels of the analysis: within-case analysis and cross-case analysis. The within-case analysis focused on answering the four main research questions of this study based solely on data from each case. The cross-case analysis aimed to develop the comprehensive themes able to explain all four cases. It is important to note here that the cross-case analysis of this study was designed for a different purpose from that of most multiple-case studies. On one hand, most multiple-case studies frequently utilize cross-case analysis techniques to unearth similarities and differences among cases (see Figure 3.2A). On the other hand, instead of finding the overlapping ideas across four cases, the cross case analysis of the current study aimed to add up all of the data from each case to develop the models covering all aspects of teachers' beliefs as much as possible (see Figure 3.2B). This analysis was based on the assumption that each participating teacher might not be able to revel the whole set of their beliefs about the student-centered approach because of the time limitation and the diversity of the possible forms of the student-centered approach.



(A) The cross-case analysis of most multiple-case studies.

(B) The cross-case analysis of the current study.

Figure 3.2. Comparison between the cross-case analyses of most multiple-case studies (A) and the current study (B).

In order to facilitate both within-case and cross-case analyses, I adopted three coding strategies recommended by Strauss and Corbin (1998). These strategies included (a) open coding, (b) axial coding, and (c) selective coding. First of all, the purpose of open coding was to break the data apart and then identify concepts or codes representing each segment of the data (Corbin & Strauss, 2008; Strauss & Corbin 1998). Each emerged concept had its own properties and dimensions. In the open coding stage, I coded each concept as a free node. Then, I grouped the concepts with shared properties into the same category. In some categories, I developed subcategories for the lower-level concepts. I named each concept, category or subcategory by using a conceptual label reflecting my interpretation of concepts contained in it. In addition, I tried to label each concept, category, or subcategory by using an "In-vivo" or "Emic" term, which is an actual word or statement of the participant (Bazeley & Richards, 2000; Corbin & Strauss, 2008; Richard, 1999). This process was used to avoid over interpretation as well as to provide a better representation of the participant's ideas.

During the open coding process, I used various ways to extract the concepts from the data. For instance, I examined the transcripts, word by word, sentence by sentence, paragraph by paragraph, or the whole text to obtain all possible meanings. As recommended by Corbin and Strauss (2008), I read and reread the transcripts many times and asked myself if these interpretations were an accurate representation of the participants' responses. I also put a special emphasis on the word clues such as “never,” “always,” “at least,” and “I would say it differently from others” when I tried to make sense of what the participant said. Moreover, I looked for some irrelevant data and used these data to develop an alternative explanation in order to get a more complete dimension of a concept.

The axial coding aimed to relate and group the categories, subcategories, and concepts with each other in order to get a more complete explanation of the case (Corbin & Strauss, 2008). In this stage, I grouped all the emerging codes into relevant categories and subcategories. I also added some categories and subcategories if needed. Some codes and subcategories were relocated in order to refine the dimensions and properties of each category. All emerging categories, subcategories, and concepts were linked and organized into a tree-like hierarchical network or tree node. This process was guided primarily by the conceptual framework of the study. In addition, the data were analyzed, categorized, and organized within three aspects of education: curriculum, instruction, and assessment.

By this method, four main categories emerged from the data including (a) classroom practices, (b) conceptions of the student-centered approach, (c) perception of classroom practices and (d) reflection on the student-centered educational reform movement. First, the “classroom practices” category described teachers’ general perceptions of their classroom practices. It was mainly developed from the first part of pre- and post-instructional interviews focusing on how each teacher talked about their curriculum (how they decide what and when to teach), instruction (how to teach), and assessment (how to assess students’ learning). In order to gain a better understanding of how each teacher viewed their instructional practices, the instructional flowcharts were developed (Appendix G). Additionally, the flowchart was a summary of the teaching and learning process mentioned by each teacher. It illustrated each teacher’s perception of when and how they implemented each instructional activity in their classroom. I believed that their perception for their curriculum, instruction, or assessment activities could not be separated from when and how they actually used it.

The second category, “conceptions of the student-centered approach” category, contained the teachers’ views about the student-centered and the non-student-centered approach. It also consisted of three subcategories: (a) characteristics, (b) strengths and weaknesses, and (c) other factors. The “characteristics” subcategory focused on teacher’s reasons for characterizing each curriculum, instruction, or assessment activity whether it was student-centered or non-student-centered. These reasons were identified as the characteristics of student-centered and non-student-centered approaches. The “strengths and weaknesses” category aimed to describe the strengths and weaknesses of the student-centered and the non-student-centered approaches. The goal of the “other factors” categories was to capture other factors influencing or hindering the implementation of the student-centered and the non-student-centered approaches.

The third category was the “perception of classroom practices” category. It was developed to identify how teachers perceive their practices in relation to their conceptions of the student-centered approach. I constructed this category after I finished coding and grouping teachers’ passages based on their reasons for characterization such as “because students actively do it,” “because students study on their own,” and “because it is what they want to know.” In addition, by looking at teachers’ passages based on the type of activity such as “lecture,” “problem solving demonstration,” and “problem solving exercise”, I could obtain the better picture of their perceptions of their practices. Then, I went back to open coding stage and recoded the data based on the type of activities. After that, I categorized and grouped these new codes into two subcategories: implemented and unimplemented activities. The implemented activities referred to the ones that were implemented in an actual classroom. In contrast, the unimplemented activities referred to the ones that were not implemented in an actual classroom. The unimplemented activities were usually mentioned by the teacher as activities that could be used to make their practices more student-centered or non-student-centered.

The last category is the “reflection on student-centered reform” category. It aimed to identify how the teachers reflect on the student-centered educational reform movement. The main categories, categories, and subcategories from the axial coding stage are summarized in Table 3.3.

Table 3.3

Coding Categories

Main Category	Category	Subcategory1	Subcategory2	Subcategory3
1. Classroom practices	Curriculum	Strategies for choosing what and when to teach		
	Instruction	Instructional activities		
	Assessment	Assessment activities		
2. Conceptions of the SC approach	SC Curriculum	Characteristics	Strengths and weaknesses	Other factors
	NSC curriculum	Characteristics	Strengths and weaknesses	Other factors
	SC instruction	Characteristics	Strengths and weaknesses	Other factors
	NSC instruction	Characteristics	Strengths and weaknesses	Other factors
	SC assessment	Characteristics	Strengths and weaknesses	Other factors
	NSC assessment	Characteristics	Strengths and weaknesses	Other factors
3. Perception of practices	SC curriculum	Implemented activities	Unimplemented activities	
	NSC curriculum	Implemented activities	Unimplemented activities	
	SC instruction	Implemented activities	Unimplemented activities	
	NSC instruction	Implemented activities	Unimplemented activities	
	SC assessment	Implemented activities	Unimplemented activities	
	NSC assessment	Implemented activities	Unimplemented activities	
4. Reflections on the SC reform	Teacher’s reflections			

Note. SC: Student-centered, NSC: Non-student-centered.

In the final stage, selective coding was used. It was the process of selectively determining the core category and its relationship with other lower-level categories

(Strauss & Corbin, 1998). The goal of selective coding was to integrate all fragmented pieces from the previous coding stage into one unified storyline covering all analyzed data.

In this stage, I also utilized a frequency analysis by counting the sources and references of the codes. The number of sources referred to the number of interview transcripts that were coded in each category. The number of references indicated how many passages were coded in each category. The length of the reference could vary from one sentence to several paragraphs. One sentence could also contain one or many references. For the purpose of this study, the frequency refers to the amount of supporting statements mentioned by the participant rather than to the level of their beliefs or concerns. In other words, the concepts that were mentioned most often were the concepts that had the largest number of supporting statements. Moreover, the underlying assumption of the frequency analysis is that every concept expressed by the participant is meaningful to them in some way. Thus, the concept with higher frequency did not make more sense to the participant than the concept with lower frequency. In other words, I valued all emerged concepts equally regardless of how many sources and references they had. The frequency analysis became a useful tool to compare and contrast the amount of student-centered and non-student-centered activities that were implemented and unimplemented by the teacher. For instance, the frequency analysis showed that Ploy frequently implemented non-student-centered lecture-based activities (sources = 8, references = 21) while she rarely implemented a student-centered reading comprehension activity (source = 1, reference = 1) in the observed lessons.

Once the data of each case had been completely analyzed, themes and categories of individual cases were compared and contrasted by cross-case analysis. The focus of the cross-case analysis was to understand teachers' conceptions of the student-centered approach as a whole. In addition, the analysis aimed to understand the focused phenomenon, not only in general but also under various circumstances (Stake, 2006). During the analysis, I selectively looked for findings that seemed to provide the most useful understanding of each category in order to develop the cross-case themes. The tentative assertions were developed, edited, changed, and removed until all assertions could provide a complete understanding of all four cases. Table 3.4 summarizes the key research questions and the related categories and subcategories for the within- and cross-case analyses.

Table 3.4

Summary of Research Questions and Related Categories and Subcategories

Research Question	Main Category	Subcategory
1) What are Thai physics teachers' conceptions of the SC approach?	Conceptions of the SC approach (C, I, and A)	Characteristics
	Conceptions of the NSC approach (C, I, and A)	Characteristics
2) What are Thai physics teachers' perceptions of their classroom practices in relation to their conceptions of the SC approach?	Perceptions of classroom practices	Implemented and unimplemented SC activities (C, I, and A)
		Implemented and unimplemented NSC activities (C, I, and A)
3) What reasons do Thai physics teachers give for supporting or opposing the implementation of SC practices in their own classroom?	Conceptions of the SC approach (C, I, and A)	Strengths and weaknesses, of the SC approach (C, I, and A)
		Other factors influencing the implementation of the SC approach (C, I, and A)
	Conceptions of the NSC approach (C, I, and A)	Strengths and weaknesses, of the NSC approach (C, I, and A)
		Other factors influencing the implementation of the NSC approach (C, I, and A)
4) What are Thai Physics teachers' reflections on the SC educational reform movement in relation to their conceptions of the SC approach?	Reflections on the SC reform	Teacher's reflections

Note. SC = Student-centered, NSC = Non-student-centered, C = Curriculum, I = Instruction, A = Assessment.

Credibility of the Study

The goal of this study was to obtain a rich description of teachers' conceptions of the student-centered approach. It was important to note that this case study focuses on developing an understanding of the participants within their contexts (analytical generalization) rather than generalizing the findings to the population (statistical generalization) (Yin, 2003). As noted by Stake (2006), "Because the reader knows the situations to which the assertions might apply, the responsibility of making generalizations should be more the reader's than the writer's" (p. 90).

The credibility of this study consisted of three common elements: construct validity, external validity, and reliability. The first component, construct validity, was defined as "establishing correct operational measures for the concept being studied" (Yin, 2003, p. 34). The construct validity of this study was enhanced by using multiple sources of evidence. In addition, I employed the triangulation technique to strengthen the construct validity of both within each case and across all cases. Multiple data sources and measures were triangulated to ensure that the data measured were what they were intended to measure. Moreover, the construct validity was enhanced by the member-checking process. In addition, during the data analysis process, I frequently asked the participants to verify the results of the analysis in order to ensure that my interpretation of the data is valid.

The second element is external validity. It was referred to the property of ensuring that the findings of this study were "generalizable" (Yin, 2003, p.37). As mentioned earlier, this study focuses on establishing analytic generalization rather than statistical generalization. The analytic generalization of this study was enhanced by matching the results to the relating theories from the literature. The multiple-case analysis was also used to enhance external validity.

Finally, there were two strategies used by the researcher to increase the reliability of the study. These strategies included using a case protocol and maintaining a chain of evidence (Yin, 2003). These strategies were used to ensure that repeating data collection and analysis procedures of this study would generate the same results. It was important to note that this study did not emphasize an internal validity because the main purpose of this study was descriptive and exploratory rather than explanatory (Yin, 2003). In other word, this study did not employ an experimental or causal comparative design in which an internal validity was considered as very important.

Limitations and Delimitations of the Study

This study was limited by several inevitable factors. There were at least three major limitations of the study. The first limitation was a lack of generalizability. This study was based on and limited to the Thai high school physics teachers who were in the PSMT program and had two years of teaching experiences. Moreover, findings from this study were limited to one particular group of teachers as well as to a small number of participants. As a result, the purpose of this study was not to generalize the results to a broader teacher population. I believe that by presenting a rich and comprehensive description of contexts, readers might be able to apply the findings of the study to other similar settings.

Second, the data collection methods of the study also had limitations. The classroom observation was limited because the presence of the researcher in the classroom might affect the teacher's and students' classroom behaviors. This limitation was minimized by describing the goals and objectives of the research study to the teachers and students one week before classroom observation began. Observing various lessons and spending sufficient time in classroom were also used to minimize the researcher's presence. Based on my own experiences, the high school students became quickly familiar with the researcher's appearance in their classroom. Moreover, the interviews were also limited by two factors: time constraints and the amount of information chosen by teachers for discussion. Many interviews were conducted under time constraints. For instance, many pre-instructional interviews were conducted in a short period of time during the morning flag saluting ceremony because the observed lessons took place in the first period of the school day. Many post instructional interviews were also conducted under time constraints. I tried to limit the post instructional interview to no longer than sixty minutes to avoid participant fatigue. The self-report nature of the interviews was another limitation. The weakness of the pre-and post-instructional interviews was that the participants might have difficulty remembering and recalling the details of their lessons or their practices. This limitation was reduced by asking the participants to make a note summarizing what happened in the classroom before the interview or by asking them to use students' lecture notes as a reference during the interview. Conducting the pre- and post-instructional interviews on the day of instruction was another way to minimize the chance of missing data missing and distorted memories. Furthermore, several interviews were conducted to ensure that all relevant data were collected.

The third limitation is researcher bias. Even though my experiences as a physics student, science educator, and practicing science teacher helped me to make sense of the data, these experiences could become a bias affecting how I collected and analyzed the data. Thus, during the data collection and analysis, I had to be constantly aware of my bias and tried to understand the data from the participant's perspectives as much as possible. Moreover, I also employed both member checking and triangulation techniques to minimize the researcher bias and its impact on the study.

CHAPTER FOUR

FINDINGS FROM INDIVIDUAL CASES

This chapter presents findings from each of the four individual cases: Ploy, Mook, Gorn, and Yord. Each case consists of five main sections: (a) introduction to the case, (b) curriculum, (c) instruction, (d) assessment, and (f) reflection on the student-centered educational reform movement. The first section illustrates the context of the case. It describes the teacher's workloads and other school duties, the characteristics of the observed classroom, and the instructional schedule of the observed unit.

After the context of the case presented in the first section, the three following sections present each teacher's conceptions of the student-centered and non-student-centered approaches in three aspects: curriculum, instruction, and assessment. In order to provide a clear picture of each case, the presentation of these three sections is guided by the framework of the study and follows the same outline. In addition, it starts with giving an introduction of each section by summarizing teacher's classroom practices. After that, the teacher's conceptions of the student-centered and non-student-centered approaches are presented by focusing on the characteristics, strengths, and weaknesses of each approach. It is important to note that the presentation of each teacher's conceptions of the student-centered and non-student-centered approaches is not fixed and depended on which way will provides a better picture of the case. For instance, Ploy's conception of non-student-centered curriculum is presented before her conception of student-centered curriculum because she predominantly perceived her practices as being non-student-centered.

The last section presents each teacher's reflection on the student-centered educational reform movement in relation to their conceptions of the student-centered and non-student-centered approaches.

Case One: Ploy

Introduction

During the data collection period, Ploy taught in a medium-sized secondary school with 802 students in a rural area. She stated that most students in her school did not pay much attention to learning and that they did not have any plans for their future study since they were always guided by their teachers and parents. In the Background and Context Interview, she noted, "It's like the school has already planned what they have to study in each day, Monday study subject A, Tuesday study subject B. They always follow this path, systematically." She also pointed out that her school did not have enough laboratory equipment available for her to use. She added, "Most of them [the equipment] are broken. And, some of them that are still working aren't usable because the connection wires are lost."

Of the 35 teachers at Ploy's school, 5 of them were science teachers. As the only physics teacher in the school, Ploy had to teach all high school physics courses (M4 - M6: Grades 10-12). She also taught five other subjects including M1 (Grade 7) Health Science, M2 (Grade 8) Electronics, School Clubs, Girl Guides, and Homeroom. She commented on her teaching workload by saying, "Almost everyday, I have to teach at least one or two subjects since I have six classes and five subjects. That's a lot."

Ploy recommended observing the M5/1 (Grade 11) class, consisting of 43 students (17 males and 26 females). She described this class as “a class with not much problem.” She pointed out that she recommended observing this class because “[t]here are a small number of the students who are not willing to learn and exhibit agitated behaviors.”

The classroom observation was conducted on Ploy’s lessons during the Heat unit. The instructional schedule of the Heat unit is shown in Table 4.1. She taught this unit for four consecutive weeks and administered the post-instructional test the following week. During these four instructional weeks, Ploy taught a lesson each Tuesday for two hours and had a one-hour extra lesson on one Thursday. Though this class was scheduled to meet each Friday during these four weeks, Ploy was required to cancel class every Friday due to extra-curricular activities, including sports day, science camp, teacher field trip, and the preparation for teachers and principal retirement party. The total time of instruction for the Heat unit was nine hours which was less than half the total time of instruction prescribed in the course description.

Table 4.1

Ploy's Instructional Schedule of the Heat Unit

Week	Date	Lesson
1	Tue, Aug 31	Lesson 1: Heat, Temperature, and Heat Capacity (2 hours)
	Fri, Sep 3	No instruction: Sport day
2	Tue, Sep 7	Lesson 2: Matter and Latent Heat (2 hours)
	Fri, Sep 10	No instruction: Science camp
3	Tue, Sep 14	Lesson 3: Ideal Gas and The Gas Laws (2 hours)
	Thu, Sep 16	Extra Lesson: Kinetic Theory of Gases (1 hour)
	Fri, Sep 17	No instruction: Teachers Field Trip
4	Tue, Sep 21	Lesson 4: Internal energy and Laws of Thermodynamics (2 hours)
	Fri, Sep 24	No instruction: Preparation for the Teacher Retirement Party
5	Tue, Sep 28	No instruction: Ploy was on duty outside the school
	Fri, Sep 31	Posttest

Curriculum

When Ploy gave her reasons for deciding what and when to teach, she mentioned three major instructional goals of the Heat unit. The first goal was to "know" scientific concepts relating to Heat. According to her, there were three reasons why she wanted her students to know these concepts: these concepts were (a) written in the IPST physics textbook, (b) fundamental knowledge for later study, and (c) useful in students' everyday life. The second goal was to be able to solve physics problems. In addition, she stressed that the primary focus of her curriculum was on problem solving because it was one of the major difficulties for her students and because it was emphasized in physics. The final goal was to learn other academic skills including thinking, analyzing, and summarizing.

Characteristics of Non-Student-Centered Curriculum

Ploy viewed her current curriculum as non-student-centered because it was based on "the teacher" and "the IPST textbook." She also mentioned that her curriculum was non-student-centered because when she decided what to teach, she did “not think about her students.”

Strengths of Non-Student-Centered Curriculum

When Ploy talked about the strengths of non-student-centered curriculum, she frequently mentioned that it was “very easy,” “uncomplicated,” and “fast” to construct. She also mentioned that she preferred using curriculum based on the IPST textbook because it would cover all subject matter for the national examination. She said, “At least, when they [students] take the national examination, it will consist of these topics” (Post Lesson3). She also pointed out, “I believe that what IPST has written should be good and suitable for my students” (Post Lesson4).

Weaknesses of Non-Student-Centered Curriculum

Ploy also showed awareness about the weaknesses of non-student-centered curriculum. She was concerned that her students might not be able to make sense of non-student-centered curriculum because “they might think differently from their teachers” (Pre-lesson3). Moreover, she noted that her students might feel “bored and [not] want to learn” from non-student-centered curriculum. Furthermore, she stated that using non-student-centered curriculum could “limit” students’ opportunity to learn; she said, “It’s like we fix the content to learn. Instead of learning other content, we fix and tell them that this is enough” (Post Lesson3).

Characteristics of Student-Centered Curriculum

Ploy pointed out that her curriculum could be more student-centered if her students had a chance to “participate in deciding what to learn.” She explained why asking the students to decide what to learn is the characteristic of student-centered curriculum by saying, “we put students’ needs as the first priority” (1st CSCA), “At least we listen to students’ voice” (Post Lesson2), and “At least, the students could share their ideas” (Post Lesson 4).

Strengths of Student-Centered Curriculum

When Ploy talked about her idea of student-centered curriculum, she stated that it had three strengths. First, for her, the strength of student-centered curriculum was that the students would “want to learn” and feel “interested in learning” and “proud of” the content they choose. Second, she pointed out that her students would be able to understand the structure of student-centered curriculum. For example, she said, “If they finish learning this, they will know what they should know and what they are going to learn next” (1st CSCA). Finally, she stated that by asking students’ ideas, the teacher would know more about what these students want and then be able to address those needs.

Weaknesses of Student-Centered Curriculum

Even though Ploy recognized the strengths of student-centered curriculum, she stated that she could not construct and implement student-centered curriculum in her practices. In addition, she reported that she did not want to construct student-centered curriculum because it was hard for her to construct curriculum to meet all students’ and teachers’ needs. For instance, she noted, “If we ask students to participate in this process, it will make thing more complicated. It will be hard to find a common agreement” (1st CSCA). She also mentioned that making student-centered curriculum would “consume a lot of time." For example, she said, "If we wait until the construction of student-centered curriculum is completed, we won't have any time for instruction" (2nd CSCA). Moreover, she pointed out that teachers' workloads would be increased if they had to construct student-centered curriculum. She was worried that the teachers who have already had their own curriculum need to "take apart" and "rewrite" their current curriculum (1st CSCA). Furthermore, she confessed that she won't ask her students to help her choose what to learn because "they don't know what they should learn." She added, "It is impossible to ask my students who know nothing" (Post Lesson4). She also noted, "People who write and construct [curriculum] should be teachers. They should understand and know more about what students should learn" (2nd CSCA).

Instruction

Ploy employed various activities to start her instruction of the Heat unit. These activities included administering pre-test, checking students' handouts, asking students to present their homework solutions, and carrying out a reading comprehension activity. During these activities, if her students were either tired or out of control, she frequently asked her students to participate in a relaxation activity where students sang a song, stretched arms and legs, and clapped their hands.

A lecture with PowerPoint presentations was the most common teaching method used by Ploy to deliver key concepts of the Heat unit. While she was lecturing, students learned by listening, taking notes, and reading the presentation handouts. She also used a teacher-led discussion technique or what she called "lecture with answering teacher's questions" to facilitate the students' learning process.

After the lecture, Ploy frequently gave her students a demonstration of how to solve exercise problems. However, in Lesson 3 where the instruction of the Temperature Unit Conversion took place, she skipped giving a problem solving demonstration and asked her students to solve exercise problems themselves.

After finishing the lecture and problem solving demonstration, Ploy asked her students to apply their knowledge by solving exercise problems. Most of the exercise problems were assigned by Ploy. However, she once asked one of her students to construct one problem of the Temperature Unit Conversion as the exercise problem. During problem-solving activities, Ploy kept walking around the classroom to help her students solve the assigned problems.

When the exercise was completed, Ploy finished her instruction by asking her students to present their solutions in front of the class. The solution was usually written on the blackboard by a volunteer student and then was explained by Ploy. She also ended her instruction by assigning homework, in which students were asked to either solve more exercise problems or complete the reading assignments.

Characteristics of Student-Centered Instruction

Ploy stated that she had implemented various student-centered instructional activities in her actual classroom. These activities include reading comprehension, problem solving exercises, students' exercise solution presentations, peer coaching, and homework. In addition to these activities, she reported that she had implemented a student-centered activity in which her students solved exercise problems without her demonstration. She also viewed the activity in which her students constructed an exercise question as being student-centered.

Furthermore, Ploy mentioned various activities that could be used to make her lessons more student-centered. These activities included self-studying, learning from worksheets, making mind maps, presenting homework solutions, and analyzing various kinds of the “State of Matters” graphs. Moreover, she noted that in student-centered instruction, students should be the ones who gave real-world examples of the discussed topics instead of the teacher.

Ploy gave five reasons why activities mentioned above were student-centered. First, she believed that student-centered instruction would allow students to “study on their own.” In addition to the term “study on their own,” she frequently talked about student-centered instruction by using the following terms: “studying by themselves,” “searching and finding by themselves,” “reviewing on their own,” “analyzing on their own,” and “concluding by themselves.” Even though she used the term “searching for information by themselves” to describe student-centered activities, she frequently related this term to an activity where students search for information in a worksheet or the textbook rather than to an activity where students gather information from various sources. For instance, she talked about a reading comprehension activity by saying, “Students had to study and search for the information by themselves. Each student studied by reading the textbook to see what it [the concept of ideal gas] is. This point is student-centered” (Post Lesson3).

Second, Ploy mentioned that in student-centered instruction, students would actively "do" or "make" things by themselves. According to her, learning activities with this characteristic included the followings: "constructing exercise problems," "solving exercise problems," "presenting exercise solutions," "completing homework assignments," "making PowerPoint presentations," "making mind maps," and "conducting scientific experiments." For instance, she said, "Homework is absolutely student-centered because students do it by themselves" (Post Lesson2).

Third, Ploy believed that students' discussion was student-centered because it encouraged her students to "think." For example, when she gave the reason why the discussion activity was student-centered, she said, "It promotes students to think, to use their own thought processes" (Post Lesson1).

Fourth, Ploy characterized a peer coaching activity where her students taught each other about how to solve exercise problems as being student-centered because the students "help one another." In addition, she noted, "It put an emphasis on the students. Students help one another on their own. They explain to one another" (Post Lesson1).

Finally, when she talked about student-centered learning activities, she frequently emphasized that the teacher was not with the students while they participated in learning activities. In addition, according to her, the absence of teacher involvement referred to situations where students learned on their own. For example, she talked about the problem solving exercise without teacher's demonstration as follows:

> It was the process of letting the students solve problems their own to see whether they can do it or not. I won't teach them how to do it. I want to see whether they can do it or not. This means it is centered on students first, students do it first (Post Lesson1).

For Ploy, the reading activity when the teacher was not in the classroom was another example of student-centered instruction. She explained,

> The heat transfer [activity] in which I ask the students to read the textbook on Friday is student-centered, because the teacher isn't in the classroom at all. The teacher lets students do it on their own in the classroom. They will study on their own and discuss on their own (Post Lesson2).

She also explained why homework was student-centered by saying, "Because they calculate, they find, and they do by themselves. When they go outside where there is no teacher watching them, everything is based on them" (Post Lesson3).

Strengths of Student-Centered Instruction

Ploy believed that student-centered instruction has five strengths. First, she mentioned that it promotes several academic skills, including "cognitive", "problem solving", "information searching", and "social" skills. Second, she said that in student-centered instruction, the students would gain "enduring knowledge." In addition, she explained that if her students studied and received information on their own, they would remember "clearly," "accurately," and that the knowledge received by them would be "long lasting." Third, she pointed out that when her students were active, they felt "happy", "excited", and "interested" in learning. Fourth, she noted that student-centered learning activities such as "doing homework," "making mind maps," and "solving problems" gave her students a chance to "review" what they have just learned. Finally, she believed that student-centered instruction allowed her students to examine their own understanding and to address their own curiosity. For instance, she talked about a reading comprehension activity by saying,

> If students study on their own, they will know what thing they don't understand. They will come to me and ask me to explain to them. If I just feed them, I won't know whether they understand or not. They also won't know themselves. It's like they seem to understand, but actually don't understand' (Pre Lesson2).

She believed that students would have a better understanding when they learned from a reading comprehension activity than from a lecture.

Ploy also reported two factors facilitating the implementation of student-centered instruction in her classroom. First, she mentioned that she decided to implement some of the student-centered learning activities because it was good for her students. For example, she talked about a reading comprehension activity by saying, "It took time but it would help my students to know how to think, analyze, and summarize" (Pre Lesson2). Second, she stated that she preferred using student-centered instruction when her students had to learn things they can learn or do by themselves, such as the topics that her students already learned from another class and the topics that did not involve "computation." For instance, when she gave her reason why she let her students solve problems relating to Gas Laws without her demonstration, she said, "I want them to do it by themselves because they already learned from the Chemistry class" (Pre Lesson3).

Weaknesses of Student-Centered Instruction

In addition to the strengths of student-centered instruction, Ploy mentioned that student-centered instruction has four weaknesses. The first weakness was time management. She noted that student-centered instruction "consumes" and "wastes" a lot of instructional time. She also stated that she "can't control" instructional time when she used student-centered instruction. The second was that student-centered instruction did "not work" with the students who had "low learning capability." She also noted that she did not want to implement student-centered instruction in the observed classroom because some of her students tended to "wait for wait for copying" their friends' works or "wait for being fed" information by their teacher. She also pointed out that many of her students were unable to complete the assigned task on their own. According to her, the third weakness of student-centered instruction was that she, as a teacher, could not take care of all students at the same time. For instance, she talked about the weakness of reading comprehension as follows:

> I couldn't focus on each student to see whether their conclusion is right or wrong. I just randomly assessed them. If I didn't ask the students who can't complete the assigned task, I wouldn't be able to help them. So the weakness is that I didn't know how well all of the students understand when they read on their own (Post Lesson3).

Finally, Ploy mentioned that student-centered instruction could increase teacher's workload. Additionally, she pointed out that if she asked her students to analyze various kinds of the "State of Matters" graphs, she needed to spend more time to find those graphs. She went on and complained, "I have to prepare more learning materials. I will have heavier workloads" (Post Lesson2).

Characteristics of Non-Student-Centered Instruction

Ploy reported that all of the observed lessons consisted of non-student-centered learning activities. Lecture was most frequently used and viewed by Ploy as a non-student-centered learning activity. Other non-student-centered activities, implemented in her classroom, included activities where she demonstrated how to solve problems, checked students' handouts, and coached her students to solve exercise problems.

Ploy mentioned that these activities were non-student-centered because they were the followings: “just standard lecture[s],” activities where “teacher leads and students follow,” and activities where “teacher gives and students receive information.” She also described herself during the exercise activity as a non-student-centered teacher. She said, “It is a standard lecture. But this time, it is a lecture at the students’ desk” (Post Lesson1).

Moreover, she mentioned that the learning activities mentioned above were non-student-centered because the teacher had “already prepared” information for the students to learn. For instance, she explained why her lecture was not student-centered by saying, “Because my students don’t have to search for any information. Their only job is just reading [the handout]” (Post Lesson3).

When Ploy talked about non-student-centered instruction, she used the term “teacher-centered” and “non-student-centered” interchangeably. For instance, she talked about her lecture by saying, “This is not student-centered because it is teacher-centered, centered on the whiteboard, the marker, and the teacher” (Pre Lesson4). Additionally, she noted that lecture was non-student-centered “because the teacher becomes the center for the students to follow” (Pre Lesson3).

Furthermore, Ploy said that the checking learning materials activity was non-student-centered because this activity aimed to address her needs. She said,

> It is non-student-centered because if it is student-centered, whether [the students] bring [the handouts] to the class or not is up to them. But, this, in which I ask, is my need. ‘I want you to bring it. You have to bring it.’ This is teacher’s need. The teacher wants them to use it because it helps them in their learning (Post Lesson2).

Strengths of Non-Student-Centered Instruction

Ploy reported seven strengths of non-student-centered instruction. First, in contrast to student-centered instruction, she viewed time management as a strength of non-student-centered instruction. In addition, she mentioned that it was very “fast” and “easy” for her to “use,” and to “control” the instructional time. According to her, the second strength of non-student-centered instruction was that it allowed her to teach as planned. Third, she believed that both lecture and teacher’s demonstration are two of the “good” ways for her students to learn “step-by-step” problem solving. Fourth, she pointed out that her lecture would make her students think the way she planned. For instance, she said, “When the teacher asks and the students answer, they will know what teacher talks about and then make their own understanding” (Pre Lesson4). Fifth, she reported that in non-student-centered instruction, she could address students’ questions immediately because she was “close to” her students. For instance, she said as follows:

> In the classroom, the teacher can walk around to take a look at each student in their group. The teacher can go to see which point they can or can’t do. If they can’t do at this point, the teacher will show how to do it (Pre Lesson1).

She stressed that non-student-centered activities allowed the teacher and students “get close to each others” because there was an “interaction” between them (Post Lesson1).

When Ploy talked about the last two strengths of non-student-centered instruction, she pointed out that she preferred using it because “at least” it helped her students to know key topics for studying on their own as well as to have a chance to hear about the learning concepts. She confessed that her lecture might not be a good way for her students to learn but “at least, they have ever heard from teacher’s mouth” (Post Lesson4).

Furthermore, Ploy gave three reasons why she preferred using non-student-centered instruction in her classroom. The first reason was that she did “not have enough time to teach.” The examples of her statements included the followings: “I need to teach as fast as possible” (Post Lesson1), “Instruction is running behind the schedule” (Pre Lesson3), and “There are so many extra school activities” (Pre Lesson4). The second reason was that she perceived non-student-centered instruction as “a good way” to teach problem solving skills. She stressed, “Computation would be better explained via lecture” (Post Lesson1). Finally, she gave the reason why she checked students’ handouts that she wanted her students to “value” the handouts she gave to them. She said, “I ask them because I want them to know that I still care about my handouts” (Post Lesson2).

Weaknesses of Non-Student-Centered Instruction

According to Ploy, non-student-centered instruction had five weaknesses. First, she was concerned that by using non-student-centered instruction, her students would “stop thinking” and then “wait for being fed” by the teacher. For instance, she said, “Students will wait until the teacher feeds them. They would not try to think on their own. They will think that no matter what they do, the teacher will tell and explain to them in the end for sure” (Post Lesson1). Second, she mentioned that the lecture from the teacher could give students “incomplete” information. She confessed that her lecture did not cover everything her students needed to know. Third, she was concerned that her students might not perceive the “value” of information she presented through her lecture.

For example, she said, “They won’t feel interested because it is something they easily get, because the teacher just gives and they just passively receive. It isn’t valuable to them because the teacher just gives them without any of their requests” (1st CSCA). Fourth, she believed that non-student-centered instruction could “limit,” “fix,” and “restrict” students’ thinking. She realized, “The students have a lot of ideas” (Post Lesson1) and “Their ideas are so broad” (Pre Lesson2). So, in order to teach according to her plan, she had to limit those ideas and tell them, “It is enough, this is enough” (Pre Lesson2). Finally, she noted that knowledge gained by the students through non-student-centered instruction was “not enduring.” For instance, she stressed, “When [students] get out of the class, it [students’ understanding] disappears” (Pre Lesson3).

Not Applied to both Student-Centered and Non-Student-Centered Instructions

There was one activity Ploy characterized as not being both student-centered and non-student-centered. This activity was what she called a “preparation” or “relaxation” activity. She used this activity to increase students’ “attention” and “enjoyment” in learning by asking students to sing a song, clap their hands, or stretch their muscle. She pointed out that this activity did not apply to both student-centered and non-student-centered instructions because it was “just regular play” (Post Lesson1).

Assessment

For the observed unit, Ploy administered two identical tests: pretest at the beginning of the unit, and posttest at the end of the unit. These tests consisted of seven multiple-choice questions and three open-ended questions. Since students’ scores of both tests were very low (means of pretest and posttest is 1.84 and 2.67 out of 10 maximum score), Ploy decided to use the average of the pretest and posttest scores as students' in-class scores. She pointed out that this method would increase the in-class score of the students who obtained a high score on the pretest and a low score on the posttest.

Beside these two tests, Ploy also assessed students' learning from problem solving exercises and homework. She reported that she employed the "helping score" evaluation strategy to grade students' works. The helping score strategy referred to an evaluation based on the completion instead of the work performance. By this strategy, the students who submitted the assignments on time would receive a full mark even if their work was incorrect. In addition, Ploy also characterized the average score of pretest and posttest as one of the helping score strategies. She pointed out that the average of the pretest and posttest scores was the helping score evaluation because it aimed to help students who "could not do the posttest but made a good guess on the pretest" (Assessment).

Ploy's ideas about student-centered and non-student-centered assessments could be separated into two groups. The first group was a group of her ideas related to the characteristics of assessment activities. The second group focused on the evaluation techniques. In this section, these two groups are presented separately.

Characteristics of Student-Centered Assessment Activities

In the Heat unit, Ploy believed that she administered various student-centered assessment activities to assess students' learning. These activities included pretest and posttest, problem solving exercise, and homework. She pointed out that these activities were student-centered because these activities aimed to assess student's understanding and capability "individually." For example, she explained why the assessment of students' homework was student-centered by saying, "I look at each student whether they can do or can't do. It's like the first student can't, the second can, and the third can't…the focus is on each student" (Pre Lesson2). She also mentioned that both pretest and posttest were student-centered because her students used "the understanding they have" as well as "their own ability" to complete the assigned task. She stated, "They complete the test individually rather than as a group or a pair, so they used their own understanding to answer each test question" (Assessment).

Weaknesses of Student-Centered Assessment Activities

Ploy reported that she faced some difficulties with evaluating students' real understanding by using student-centered assessment activities. She pointed out that she could not trust the results of the evaluation. In addition, she mentioned that when evaluating students' homework, she could not tell whether her students did it on their own, looked at the textbook, or copied other's work (Post Lesson3). She also talked about the weakness of the pretest and posttest that the test questions were too "broad" and could not examine students' understanding "in depth" and "in details" (Assessment).

Characteristics of Non-Student-Centered Evaluation Technique

When Ploy looked at how she evaluated students' work, she perceived that her evaluation technique was non-student-centered because she used what she called the "helping scores" approach. She characterized this evaluation technique as being non-student-centered because she focused on "students' responsibility rather than their understanding." For instance, she gave the reason why helping score was non-student-centered by saying, "The teacher does not look at whether they [students] do it on their own, think on their own, or copy others' work. Not even look at whether they do it right or wrong" (Pre Lesson4).

Strengths of Non-Student-Centered Evaluation Technique

According to Ploy, the main goal of the helping score approach was to give students marks as high as possible in order to prevent them failing the class. She pointed out that by using this evaluation strategy, students would get a "good grade" and "high scores." She also noted that this technique made her students have "positive feelings" toward learning physics.

Weaknesses of Non-Student-Centered Evaluation Technique

Ploy was concerned that by using the helping score evaluation technique, the assessment results might not represent students' real understanding. She mentioned that most of her students "couldn't accept the results" of the national examination (Assessment). She explained,

> When they [students] compete with other schools or are directly assessed by the central agency, assuming that the total score is ten, they will get only one. When they see their score, they will feel depressed, they can't accept the results because in their school, from the total of ten, they get eight (Assessment).

She also noted that her students wouldn't work hard when she graded students' work by using the helping score technique. According to her, this evaluation strategy made her students think, "No matter what I do, I will receive a good mark. No matter what I do, I won't get zero mark." She went on and mentioned, "This will make students feel lazier and don't work harder" (Assessment).

Characteristics of Student-Centered Evaluation Technique

In order to make her evaluation more student-centered, Ploy reported that she should evaluate students' work based on their "performance." She called this evaluation technique as "an authentic evaluation" or "a real score evaluation." In addition, she described the term "real score" by saying that it was an assessment in which the teacher "look[s] at students' work and assess [it] based on that [work]" (Pre Lesson4).

Ploy pointed out that the real score evaluation approach was student-centered because it was based on "students' work performance" or "what students show." For instance, she said, "For grading students' work, what they do is what they get. This is student-centeredness because I do not give them additional score. It is not an assessment where they get a full score if they submit their work" (Pre Lesson3). Moreover, when she talked about making the pretest and posttest become more student-centered, she mentioned that she should evaluate the students by using the posttest score rather than the average of pre- and post-test scores. She said,

> Telling the truth that if it is student-centered, I would better use the posttest score because, in the pretest, many of my students do not learned anything yet. When they take the test, even though they can really get a high score, they might be lucky to guess the right answers… But, for the authentic score, I would like to use the posttest score because it tells that after they have learned, how well they understand, how well thinking skills they have acquired (Assessment).

However, in order to increase students' in-class scores, Ploy decided to use the average of pre- and post-test scores.

Strengths of Student-Centered Evaluation Technique

Ploy mentioned that the real score evaluation allowed her to know the level of students' understanding. She emphasized that assessing students based on their performance was “the right way of solving the problem” (Assessment). In addition, she mentioned that by using the real score evaluation technique, she could improve her instruction because she knew the actual level of her students’ understanding. Furthermore, she pointed out that by using this technique, her students would feel “proud” of the score they got. She said, “If they get it [score] on their own without any help, they will feel very proud of themselves, they will feel much better than knowing that the score they receive comes from my [teacher’s] help” (Post Lesson4).

Weaknesses of Student-Centered Evaluation Technique

Ploy admitted that she could not implement the real score evaluation technique in her actual classroom. In addition, she reported two weaknesses of this technique. First, she mentioned that by using this technique, many students would have a “low score” and “fail.” She added that when her students had low score and failed, they would feel negatively toward learning physics. For example, she said, “It will make my students think they can’t learn. It will make they feel discourage and don’t want to take science courses anymore” (1st CSCA). Moreover, she noted that her school administrators would not pleased if there were many students failing in her class. She revealed that at her first year of teaching, she had been told by the school administrators to find the way to increase students’ scores such as “changing the method of evaluation”, and “giving additional points from the extra assignment” (2nd CSCA).

According to Ploy, the second weakness of the real score evaluation was that it did not take students’ diligence and effort into account. She said,

> Some students study very hard in the classroom. They never skip the class, always study in the class, pay attention in learning, never chit-chat. But they still get a

> low score from the test. These diligence and hardworking behaviors should be taken into account (Pre Lesson4).

She believed that it was not fair for hard-working students to receive low in-class scores.

Ploy's Reflection on the Student-Centered Educational Reform Movement

When Ploy talked about the student-centered educational reform movement in Thailand, she noted that she supported the implementation of the student-centered approach in the actual science classroom. In addition, she mentioned two advantages of the student-centered approach. First, she believed that the student-centered approach would teach her students how to solve real world problems on their own. She said that the student-centered approach taught her students to "be able solve problems on their own, think on their own without panicking, with consciousness." She added, "This will help them to be able to live in the social world happily" (1st CSCA).

Second, Ploy mentioned that teacher workloads would be minimized because students would acquire the essential skills to learn on their own. In addition, She said, "It will reduce teacher workloads because at least when students can center on themselves. They will study in advance. Thus, it will be easier for the teacher to teach them" (2nd CSCA).

Case Two: Mook

Introduction

Mook's school was an extra-large school serving 3,228 middle school students, located in an urban area of a north-eastern province of Thailand. There were 112 teachers and Mook was 1 of 5 physics teachers in this school. She pointed out that there was a "positive learning atmosphere" in the school. She explained, "The competition between students is high." She mentioned, most students in her school studied hard and wanted to attend well-known universities. However, she stressed that many students were not attentive and eager to learn in the classroom. She went on and said, "They pay less attention to learn in the class but wait for special tutoring, after-school programs."

During the data collection period, Mook taught two grades: four classes of M4 (Grade 10) physics and one class of M1 (Grade 7) science. Mook's total teaching workloads was 16 hours. In addition to teaching, she also worked as a secretary of academic affairs who took care of school paperwork, such as transcripts, enrollment forms, and academics documents from outside sources.

Mook's M4/4 physics class was observed. There were 45 total students including 6 males and 39 females in this class. Mook described that most students in this class were "inert" and "inactive" students who "wait their teacher to feed information to them." In addition, she characterized this class as a "normal class needing to be fed."

The classroom observation was conducted in Mook's unit of Force, Mass, and Laws of Motion. As shown in Table 4.2, this unit took three weeks to complete all five lessons. In addition, it consisted of five 90-minute lessons. The total instructional time of the observed unit was 8 hours and 15 minutes while the total instructional time specified in the course description was 15 hours. At the beginning of the last lesson, Lesson 5, Mook notified her students that the final examination would be held in the next three weeks which was two weeks faster than the original plan. As a result, Mook taught the next learning unit, Motion, for only two weeks to cover all concepts of projectile, circular, and simple harmonic motions. During the data collection period, Mook frequently complained that she had to execute her instruction of these two units very fast because she did not have enough instructional time. At the end of the Motion unit, Mook administered the test of both Force, Mass, and Laws of Motion unit and Motion unit together.

Table 4.2

Mook's Instructional Schedule of Force, Mass, and Laws of Motion Unit

Week	Date	Lesson
1	Mon, Aug 23	Lesson 1: Mass and Force (90 minutes)
	Thu, Aug 26	Lesson 2: 1st and 2nd laws of Newton (90 minutes)
2	Mon, Aug 30	Lesson 3: 3rd law of Newton and Eight cases of motion (90 minutes)
	Thu, Sep 2	Lesson 4: The application of Newton's laws (45 minutes) and the test of the previous unit (45 minutes).
3	Mon, Sep 7	No instruction: Mook was on duty outside the school
	Thu, Sep 9	Lesson 5: Friction and Gravitation forces (90 minutes)
4	Mon, Sep 13	No instruction: Mook was on duty outside the school
	Thu, Sep 16	(Motion units – not observed)
5	Mon, Sep 20	(Motion units – not observed)
	Thu, Sep 23	Test of the Force, Mass, and Laws of Motion unit; and Motion unit

Curriculum

At the beginning of the 1st CSCA interview, Mook mentioned that she did not know much about curriculum. She also noted that her current physics curriculum was based on both school and standard curriculum which were developed by "others." During the pre-and post-instructional interviews, Mook mentioned three instructional goals of the observed unit. The first goal was to help her students to know and understand key concepts such as "force is vector quantity," and "how to calculate net force." The second goal of her curriculum was to teach her students how to "apply" knowledge they learned to solve physics problems. The third goal was to enable her students to see the "connections" between what they learned and everyday phenomena.

Mook gave three reasons explaining how she decided what and when to teach. First, she pointed out that she used her "own reason" and "personal experience" to decide what to teach. She mentioned that this way would help her students to gain a "clearer" understanding and be able to solve related problems. Second, she pointed out that the reason why her lessons placed special emphasis on students' problem solving skills was because national examinations focused on these skills. Finally, she mentioned that she selected the learning content as they were designated and contained in the school curriculum.

Characteristics of Non-Student-Centered Curriculum

When she talked about how she decided what to teach, Mook frequently mentioned that her current curriculum was non-student-centered. She gave two reasons supporting her argument. The first reason was that when deciding what would be in curriculum, she, as a teacher, was a "decision maker" while her students were "followers." Moreover, when she talked about non-student-centered curriculum, she frequently used the term "teacher-centered" to illustrate her idea. For example, she said,

> About choosing learning topics, the teacher is the one who selects all learn topics. So, I classify this method as being teacher-centered because the teacher thinks that it will help students to understand. The teacher is the one who makes all decisions (Pre lesson4).

She also noted that in non-student-centered curriculum, "[s]tudents' duty was to follow teacher's order only, without any argument" (1st CACA).

The second reason given by Mook was because her current curriculum was designed by "others." Additionally, Mook pointed out her current curriculum was non-student-centered curriculum because she and her students did not have any power to decide what and when to teach and learn. She mentioned that her current physics curriculum had already been constructed by either other teachers in the school (1st CSCA) or educators from the Office of Basic Education Commission (2nd CSCA). For example, she said, "The current curriculum has already been made by others. My students are just the followers and I, as their teacher, is just a leader who feeds them information" (1st CSCA). She also explained why her current curriculum was non-student-centered that she had to teach according to the school curriculum without caring about her students. She stressed, "No matter whether you [students] understand or not, I will move on to the next topic. I have to compress all learning content in order to complete the school curriculum" (1st CSCA).

Strengths of Non-Student-Centered Curriculum

During the interviews, Mook mentioned three strengths of non-student-centered curriculum. First of all, she mentioned that non-student-centered curriculum was "easy to make and use." In addition, she explained that non-student-centered curriculum could be constructed "easily" and at "low cost" by asking "someone from the ministry f education" assign what to teach at each level (2nd CSCA). She also noted, "Because the description of curriculum has already been specified, it is easy for the teacher to use" (2nd CSCA).The second strength was that the arrangement of the learning content by the teacher would promote students' learning. For example, she said, "The teacher thinks that arranging exercise problems in this step-by-step sequence will enable students to understand" (Pre Lesson4). The third strength of non-student-centered curriculum was that it allowed students to learn all of the content. She said, "The strength is that the learning content is completed. They [the students] will learn all of what the teacher wants them to learn" (1st CSCA).

Weaknesses of Non-Student-Centered Curriculum

For Mook, there were three weaknesses of non-student-centered curriculum. First, she mentioned that even though she expected her students to be able to understand the content in a non-student-centered curriculum, she was "not sure" whether her students were able to understand and do as expected. Second, she pointed out that her students might "not open their mind" to learn the content in non-student-centered curriculum. She stressed, "The more we [teachers] force students, the more they stay away, they don't want to know and don't want to hear" (1st CSCA). In addition, she gave an analogy of wearing shoes to illustrate her idea by saying, "It's like 'I don't want to wear these shoes. Why do you force me to wear them?' This causes the opposition and refusal" (1st CSCA).

According to Mook, the third weakness of non-student-centered curriculum was that it was hard for her students to follow the change of curriculum. In addition, she once commented on the curriculum designated by the ministry of education as follows:

> The weakness of teacher-centered is that whatever they [educators] want students to learn, they just designate. They designate without considering whether the followers can do or not. Now, students have a spinning head because there are so many projects… For example, my students are assigned to learn the 2544 curriculum for a moment and then they have to learn the 2551 curriculum. These students are overwhelmed already. And, every change causes more subjects for them to learn (2nd CSCA).

She also illustrated her idea by giving the example of "the world class curriculum" in which students who "cannot speak English at all" had to study in English. She commented, "Instead of making more improvement in the new curriculum, they [educators] add more subjects and works for the students to do" (2nd CSCA).

Characteristics of Student-Centered Curriculum

When she described her ideas of student-centered curriculum, she mentioned that in the student-centered approach, students should have a chance to "participate in" deciding what and when to learn. She recommended that in order to make student-centered curriculum, the teacher should ask their students in front of the class or set up "a student forum" to gather students' ideas about what they want to learn. Moreover, she pointed out that student-centered curriculum allowed the students to decide whether to move on to the next topic. She explained,

> "They [students] should be able tell the teacher that 'I still do not have a clear understanding. Why do we have to move on to the next topic so quickly? I want to have a clear understanding about this concept first.' So, students should have a chance to participate in making a decision on what to learn (1st CSCA).

When Mook explained why asking for students' ideas was student-centered, she illustrated her idea by making the consumer analogy. She said,

> If it is student-centered, we have to center on them. Students has to be the most important thing, has to be the first priority. It's like the center is on consumers. If our product doesn't sell well, we have to modify based on the consumers. So, the child-centeredness should be centered on the child. We have to ask them what they want to learn (2nd CSCA).

She believed that student-centered curriculum should be in line with students' needs.

Strengths of Student-Centered Curriculum

According to Mook, student-centered curriculum consists of two strengths. The first strength was that by using the student-centered approach, students would have an "open mind" to learn. In addition, she believed that students would feel "happy" and "interested" in learning and "want" to learn the content they choose. Mook illustrated her idea by giving an example of the Korea fever in which her students were able to sing the songs of Girl Generation (Korean girl-group singers) "in each and every single sentence and word" (1st CSCA). Mook commented, "Because these are the things students want to know and like, they will have an open mind to learn" (1st CSCA).

Second, according to Mook, students would be able to make sense of student-centered curriculum. For example, when she talked about three laws of Newton, she said as follows:

> If it is child-centered, the students will know about what key ideas of the current lesson are about, why they have to learn, what is the relationship between these Newton's laws and 'Work and Energy' of the next unit (Pre Lesson3).

Mook also mentioned that if her students constructed their own curriculum, they would have a "step-by-step" plan about what to learn in each semester (Post Lesson4).

Weaknesses of Student-Centered Curriculum

During the interviews, Mook also talked about two weaknesses of student-centered curriculum. First, she frequently mentioned that it was "complicated" to construct student-centered curriculum. She gave three reasons to support her argument. The first reason was that the construction of students-centered curriculum could "consume a lot of time" (1st CSCA), be "slow" (Pre Lesson3), and be a "waste of time"

(2nd CSCA). The second reason was that it was hard to settle an agreement among the students. She also noted that the argumentation between students “will never end” (1st CSCS). Mook went on and said, “These students want this while those students want that. It is too hard to meet all of their needs” (1st CSCA). The final reason given by Mook was that the construction of student-centered curriculum cost “a lot of expense.” Mook added that it would take a lot of money in collecting students’ ideas and getting students from different places altogether (2nd CSCA).

The second weakness of student-centered curriculum mentioned by Mook was that the students who completed student-centered curriculum might not meet the national science standards. For instance, she said, “The content that students have learned will be incomplete for sure. The teacher cannot let the students learn just what they want. Students won’t learn all of what the standard-setters want” (1st CSCA). She also emphasized that “[i]t is impossible” to make and use student-centered curriculum because the Office of the Basic Education Commission (OBEC) has “already specified” what to learn in each semester and at each grade level. She went on and stressed, “It is not optional. So, the teacher cannot teach students other topics” (2nd CSCA).

Instruction

Since Mook’s instructional time was very limited, she taught her lessons of Force, Mass, and Laws of Motion unit very fast. She regularly began her lesson by using what she called an “engagement” activity. During this activity, she asked her students to discuss with their peers about the topics related to what students were going to learn such as the discussion of why the heavy persons run slower than the slim ones (Post Lesson2).

Sometimes, she started her lesson by asking her students to review what they learned from the previous one.

After Mook finished the engagement activity, she normally used lecture and worksheets to deliver key concepts and ideas to her students. She also used some real world examples to clarify and explain her statements. Mook pointed out that during her lecture, her students learned by listening and taking notes.

After the lecture, Mook demonstrated how to solve problems by using equations and formulas given during the lecture. In this process, she solved some example problems and described each step of problem solving out loud in front of the class. Mook and her students had a “common agreement” on solving the problem through three steps, including (a) reading the question and then drawing the diagram, (b) listing all of the given and unknown parameters, and (c) matching the formulas with all parameters to get the answer. Sometimes, she asked her students to help her solving demonstrated problems by identifying parameters, computing numerical values, and correcting her solutions.

The next activity was a problem solving exercise in which the students solved exercise problems at their desk. Once in the observed unit, Mook implemented a “peer-coaching” strategy in which students shared, exchanged, and coached their peers how to solve exercise problems. After finishing each exercise problem, she asked her students to voluntarily write their solution on the whiteboard in front of the class. Then, Mook provided some explanations and feedback. In some lessons, Mook assigned additional exercise problems for her students to do as their homework.

Characteristics of Student-Centered Instruction

Based on the interviews, Mook perceived that she had implemented six student-centered activities in the observed unit. These activities included "problem solving exercise," "examples given by students," "students' solution presentation," "review," "student-and teacher problem solving demonstration," "collaborative work", and "peer coaching." Moreover, she repeatedly stated that if she wanted to make the observed lessons more student-centered, she would ask her students to "conduct a scientific experiment" and "do a self-study task."

There were seven reasons given by Mook to explain why the above activities were student-centered. First, she believed that student-centered instruction would allow her students to "think on their own." For example, she pointed out that she categorized problem solving exercises as being student-centered "because students think on their own." She added, "Students look at the example given by the teacher and then manipulate all information on their own" (Pre Lesson4). Experimentation was another activity of which students thought. For instance, she explained that the experimentation would make her instruction more student-centered "[b]ecause students think. They think about how to conduct an experiment, make a conclusion, and discuss why the results are like this because each group might not yield the same results" (Post Lesson5).

Second, Mook described activities in which students "search for new knowledge and information" and "construct" their own understanding as being student-centered. She pointed out that the student-centered teacher would ask their students to search for information on the assigned topics from various sources such as “textbooks” “worksheets”, and “the internet.”

Third, Mook believed that the experimentation made her instruction more student-centered because it allowed her students to have “a direct experience” and then construct knowledge on their own. She stressed that instruction was student-centered “whenever there is an experiment.” She went on and said, “Because students actively take an action. They have used their skills to generate their own knowledge to be able to understand the first and second laws of Newton” (Post Lesson2).

Fourth, student-centered instruction would, according to her, encourage students to “help and train each other” to solve exercise problems and present their solutions in front of the class. She stressed, “Friends-help-friends is student-centered” (Post Lesson4).

Fifth, in addition to the peer coaching activity, she believed that student-centered instruction included activity in which students helped their teacher to demonstrate how to solve example problems and verify the correctness of teacher’s solutions. For instance, she talked about the problem solving demonstration by saying “While I was writing at the whiteboard, I asked them ‘Is this correct?’ They might response ‘It is incorrect. The correct one should be like this.’ This is child-centered” (Post Lesson5).

The sixth characteristic of student-centered instruction was that it encouraged the students to recall the knowledge “they already had.” For example, Mook stated that the review activity was student-centered “[b]ecause what students have said comes from things they already known and learned” (Post Lesson3). She also described student discussion about the importance of the tire’s tread and shoe’s tread as being student-centered. She gave her reason supporting her idea by saying, “Because it is students’ own understanding. They just present it to let me [the teacher] know” (Post Lesson5).

Finally, Mook frequently emphasized that in student-centered instruction, teacher’s roles were minimized. During the interviews, she repeatedly used the term “just” to illustrate this minimization. She pointed out that the teacher’s roles were minimized from doing everything to be an “introducer,” “trainer,” “facilitator,” “preparer,” or “summarizer” while “students are the ones who actively do it.”

Strengths of Student-Centered Instruction

Based on the interviews, Mook mentioned four strengths of student-centered instruction. First, Mook believed that student-centered instruction would help her students to have “a real understanding.” For instance, she said,

> If it is child-centered, it’s like what I always say, the students will construct their own understanding. They will have an enduring knowledge. They will know the concept more than recitation in which they students are able to recite but cannot apply to the real world situations (Pre Lesson3).

She once mentioned that the peer coaching activity she implemented was successful in helping her students to learn how to solve the exercise problem. She said,

> It is successful. Based on my evaluation, at the beginning, there are only five students who understand. Then, after I ask them to teach and help their peers, it turns out that they are more open to share and discuss with their peers than the teacher. This helps them to make their own understanding (Post Lesson4).

Second, in addition to obtaining a real understanding, Mook believed that the knowledge students learned from student-centered activities was “enduring.” For instance, she said,

> The strength of student-centered instruction where there is students’ participation is that students will have knowledge that they can remember. Actually, they don’t

> need to remember but it will root in their brain because they construct this knowledge on their own. This knowledge is enduring. It does not come from recitation (2nd CSCA).

She believed that when her students gain knowledge on their own, they would have a real understanding and long-term memorization.

Third, Mook pointed out that the students who conducted a scientific experiment would have "a clear picture" of what was in the textbook. She also mentioned that if she had more instructional time, she would ask her students to conduct an experiment. She went on and said, "At least, they have ever done it and get to know what it is" (Pre Lesson2).

Finally, Mook believed that her students could practice various skills when designing an experiment. She said, "Whenever students have a chance to design the experiment on their own, they will use a lot more skills and a lot more thought" She went on and mentioned, "The students have to think about which lab equipment they have to use, how to use it, and what they need to know more about" (2nd CSCA).

In addition to the strengths of student-centered activities, Mook also mentioned three reasons why she preferred using student-centered instruction. First, she pointed out that she asked her students to complete problem solving exercises because she wanted her students to learn and practice how to solve problems from "direct experience." Second, she pointed out that she tended to use a student-centered activity if it helped her students "understand more" about the learning concept. In addition, she mentioned that she asked her students to discuss why the heavy person run slower than the thin one because this example help students to "understand more about the concept of force and mass" (Pre

Lesson1) and “have a clear picture of the relationship between mass and force” (Post Lesson1). Finally, she mentioned that she would implement student-centered instruction to teach topics in which students can read on their own. Examples of these topics include “Light,” “Nuclear Physics,” and “Astronomy.”

Weaknesses of Student-Centered Instruction

Mook reported three weaknesses of student-centered instruction. First, she pointed out that student-centered instruction “consumes a lot of time.” For instance, she mentioned that even if the peer instruction activity was successful, this activity did “consume a lot of time.” She continued, “Normally, we should solve many more problems than this. Today, we have solved only two problems” (Post Lesson4). Second, she believed that student-centered instruction went on “very slow” and “endless.” Finally, she was concerned that in the student-centered classroom, both “inactive” and “low-capability” students would not learn anything. For instance, Mook talked about the experimentation as follows:

> The weakness of this method is that if students do, they will get it. But, if they don’t, they won’t get it. However, almost 80 percent of the students in this class are the ones who just wait for being fed (Post Lesson5).

She also mentioned that student-centered instruction was ineffective with the students who did not want to complete the learning task as well as with the students who were unable complete the assigned work on their own. For instance, she said,

> For low-ability students, the child-centeredness is not working for sure because some students are not willing to do anything. Even I force them, they still won’t do. Even using the score to motivate them, they are still inactive (2nd CSCA).

Mook confessed that she still did not know how to motivate these students to learn.

Furthermore, Mook gave two reasons why she did not want to implement student-centered instruction in her classroom. The first reason was the lack of instructional time. In many interviews, she indicated that she did not have enough time to implement student-centered instruction. For example, she said, “If I have more instructional time than this, I can implement student-centered instruction. With this time limitation, I have to use teacher-centered instruction in order to finish all lessons on time” (Pre Lesson1).

The second reason was her past negative experiences with student-centered instruction. When Mook was asked whether she would like to let her students to conduct the Force experiment, she answered, “Is it ok if my answer is ‘not going to use’? Because I have used it before. The students still cannot process all information. They still don’t understand” (Pre Lesson1). She also mentioned that she “was once disappointed” with her students when she taught a Science Project course in her first year of teaching. She noted that it did not go so well as her expectation. She explained, “I distribute papers to them to read, but they don’t read. I tell them to do, but they don’t do either. I feel very disappointed from that experience” (Assessment).

Characteristics of Non-Student-Centered Instruction

Mook reported that she had implemented four non-student-centered learning activities in the observed unit. These activities included “lecture,” “problem solving demonstration by the teacher,” “science project” and “real world examples given by the teacher.”

During the interviews, Mook frequently used the term “teacher-centered” and “non-student-centered” interchangeably. In addition, she described four characteristics of teacher-centered instruction. First, according to Mook, in the teacher-centered classroom, the teacher was the one who did everything. Mook described learning activities such as “problem solving demonstration,” “science project,” and “lecture” as non-student-centered activities in which the teacher would “do everything” while “students don’t have to do anything at all” For example, when she gave the reason why teacher’s demonstration was non-student-centered, she said, “The teacher is the one who solves the problem” while the students’ duty was to “watch” what their teacher did (Post lesson 5).

Second, Mook described non-students-centered instruction involved a one-way communication in which the teacher was a “producer” (1st CSCA), “feeder” (Pre Lesson2), or “giver” (Post Lesson5) and students were “consumers” (1st CSCA) or “receivers,” (Post Lesson5).

Third, in contrast to student-centered instruction in which students would “think,” Mook noted that in non-student-centered instruction, the teacher was the one who would “think” for students. For example, she talked about the discussion of an example given by the teacher as follows:

> It is teacher-centered because the teacher is the one who thinks. If it is student-centered, the teacher has to ask students to give an example. They should be the ones who describe how action is equal to reaction. But, the teacher is the one who raises the issue of the fight between students. The teacher is the one who thinks for them (Post Lesson3).

Mook also noted that while many people frequently categorized student science projects as being student-centered, she saw them as being non-student-centered. She mentioned that student science projects were actually the “teacher projects because the teacher is the one who thinks.” She went on and talked about the science project fair by saying “The teacher is the one who prepares and makes everything even a report and photos for posting on a board. The only duty students have is to remember a presentation script (1st CSCA).

Finally, according to Mook, non-student-centered instruction included an activity in which the teacher gave an order to students. For example, she pointed out that students' presentation of exercise solutions was "teacher-centered because the teacher specified that they [students] had to do this, they had to present their solution to the teacher" (Post Lesson4). She also described homework assignment as a non-student-centered activity in which the teacher gave an order to students. She noted, "It is teacher-centered because the teacher orders and the students just perform as what the teacher has said" (Post Lesson5).

Strengths of Non-Student-Centered Instruction

Mook pointed out that non-student-centered instruction has three strengths. First, she believed that it was "fast" to use and "easy" to finish the lesson "on time." For example, she mentioned that the "fastest" way to learn problem solving is to watch teacher demonstration (Pre Lesson3). She also said that lecture was "a fast way" to teach because "students' don't have to think much" (Post Lesson3).

Second, regardless of the quality of students' understanding, Mook mentioned that the strength of non-student-centered instruction was that it allowed students to receive all knowledge that the teacher wanted them to have. She also pointed out that in non-student-centered instruction, students would learn "all of the content" stated in the standards (2nd CSCA).

Finally, Mook mentioned that instead of not learning anything in student-centered instruction, students were “forced” to learn something in non-student-centered instruction. For example, she said,

> The strength [of non-student-centeredness] is opposite to child-centeredness. For the students who can’t do anything, the teacher has to force and compel them to do. ‘You have to do this and you have to do that.’ So, they do even if they don’t want to do. But, they still get some knowledge. The strength is that when the teacher feeds, they might receive some things (1st CSCA).

Mook also mentioned four reasons why she implemented non-student-centered instruction. First, she pointed out that she had to use non-student-centered instruction because she had limited time to teach. For example, when she gave the reason why she used lecture in her classroom, she said as follows:

> I might not be able to finish this course according to the schedule. I have to use this method to give the students all information as much as possible. This method is faster and the students could get more knowledge than any other methods (Pre Lesson1).

Second, she pointed out that there were some topics that should be taught by non-student-centered learning activities. The example of these topics was Quantum in Modern physics. She explained, “This content is hard. Students don’t have enough background and this content is new for them. So, the students cannot construct their own understanding” (1st CSCA). Furthermore, she believed that she had to use non-student-centered instruction to teach the computational content. For example, she noted that she preferred using non-student-centered instruction to teach the computational concepts of motion. She said,

> Because students still don’t know when to use the formula ‘$v = u + at$’, when to use ‘$s = ut+½at^2$,’ this is the case where the teacher has to help. The teacher has to explain that this is a distance, and that is a velocity (2nd CSCA).

Third, as mentioned by Mook, she had to use non-student-centered instruction because a student-centered learning activity did not work as expected. For example, when she talked about the problem solving exercise activity of the Newton's laws, she said,

> I, as the teacher, have tried to encourage students' participation in solving the problems on their own. This part is expected to be child-centered. But it is impossible because my students still don't understand the concept. So, I have to help them. Thus, it becomes teacher-centered (Post Lesson3).

Finally, when Mook talked about the reason why she did not want her students to conduct the 'Net Force' experiment, she mentioned that her students could receive an understanding from listening her lecture as "same" as from conducting a real experiment. She went on and mentioned, "Because if I teach this way, the students will understand the same thing and it saves a lot of instructional time" (Post Lesson1).

Weaknesses of Non-Student-Centered Instruction

When Mook talked about non-student-centered instruction, she mentioned that it had three weaknesses. First, she was concerned that students who learned from non-student-centered instruction might not have a real understanding of what they learned. She noted, "They know but cannot apply." She added that by rote recitation, students "still cannot use that [knowledge] to solve the problems" (Pre Lesson3).

Second, Mook pointed out that students might not want what the teacher gave. For example, she talked about the weakness of lecture by saying, "It seems like we had given something. They may take, ignore, or even leave it there" (Pre Lesson3). She also mentioned that students' willingness affected the amount of information they received.

She said, “Giving them [students] 80, they might get only 20 because they don't want that much” (Post Lesson5).

Finally, Mook mentioned that the knowledge gained by students was “not enduring” (1st CSCA). Mook illustrated her idea by giving an example of the recitation for the exam by saying, “When they get out of the exam hall, they will forget everything right away” (2nd CSCA). She also stressed, “After the exam, they do not even remember what things they already learned” (1st CSCA).

Not Applied to both Student-Centered and Non-Student-Centered Instructions

During the interview, Mook mentioned two instructional activities that were neither student-centered nor non-student-centered instruction. The first activity was the experimentation. In addition, she believed that the experimentation could be mixed between 70% for student-centered part and 30% for non-student-centered part. She mentioned that the 70% represented the part where “students actively do and conduct an experiment, make a conclusion, answer questions, and make a presentation in front of the class.” She added that the 30% could be non-student-centered if there was “teacher’s participation” in explaining the students how to setup an experiment and preparing lab equipment for them. Mook said the 70/30 experimentation was more practical than the 100% student-centered one because it was ‘faster’ and worked well with inactive students, like most of her students who always wait for teacher’s direction.

The second activity was the notification activity where Mook notified her students that the final examination week was rescheduled to be two weeks earlier than expectation. She noted that she did not want to classify this activity because it was “not related to learning" (Post Lesson5). She added that she just wanted her students to know that instruction would be moving at a fast pace.

Assessment

For the observed class, 90 percents of students' score came directly from the paper-pencil tests, including 20 percent from mid-term exams, 30 percent from final exams, and 40 percent from tests at the end of all four learning units. Another 10 percent allocated as an affective score which was evaluated from students' responsibility, classroom participation, and self-management. Mook combined and administered the test of two learning units, (a) Force, Mass, and Laws of Motion and (b) Motion, together. The test consisted of twenty questions and there were ten questions of the observed unit. All questions of the observed unit focused on computation or problem solving. The mean score for the observed unit was 4.26 out of 10 total score. There were 16 students from 26 students who passed this part of the test. In addition to the summative assessment, Mook mentioned that she evaluated students' understanding through exercise and homework.

Characteristics of Non-Student-Centered Assessment

Mook frequently mentioned that she had administered four non-student-centered assessment activities in the observed classroom. These activities include "problem solving exercises," "the test at the end of the classroom," "affective score" and "the report of the test score." There were three reasons given by Mook to explain why these activities were non-student-centered or teacher-centered. First, Mook viewed that she, as the teacher, was the one who made a decision about assessment. For example, she described the assessment on students' presentation of exercise solutions as being "teacher-centered because the teacher chooses a student and specifies what students have to solve, asks students to do, and then checks it. It is the assessment of the teacher" (Post Lesson4).

Second, Mook believed that in non-student-centered assessment, the teacher used their own judgment on assessment. For example, she pointed out that the construction of the test of the observed unit was "totally teacher-centered" because it was based on how she "wants to check students' understanding" (Assessment). She also believed that the affective score was "teacher-centered" because "It is based on teacher's feeling and favoritism" (Post Lesson5).

Finally, she noted that her assessment was teacher-centered because she was "the only one who used the results of assessment to improve instruction." She went on and said, "My students are not interested in these results. If they know the results, they won't do anything for their improvement" (2nd CSCA).

Strength of Non-Student-Centered Assessment

Mook's reason of using non-student-centered assessment was that it was "easy," "fast," and "comfortable" to use. In addition, she talked about the strength of the multiple-choice test by saying, "I just place the stencil key over students' answer sheet and count the correct answers. Then, I can obtain each student's score and put this score on the academic record instantly" (2nd CSCA).

Weaknesses of Non-Student-Centered Assessment

Even though non-student-centered assessment was easy to administer, Mook was concerned that results from this assessment did not represent students' "authentic understanding." In addition, she believed that the paper-pencil test at the end of the unit was not a good way to evaluate students' understanding. For example, she said, "My questions might not match with students' expectation. Sometimes, even if they have a well preparation for the test, I might ask things they don't know. So, this assessment might not be able to determine students' understanding" (2nd CSCA).

Characteristics of Student-Centered Assessment

In addition to the implementation of non-student-centered assessment, Mook reported that she implemented two student-centered assessment activities in her classroom. These activities included "problem solving exercises" and "presentation of students' exercise solution." She believed that these two activities were student-centered because the students did "think on their own."

In addition to these two implemented activities, Mook also pointed out that if she wanted her assessment to be more student-centered, she would ask her students to "present their understanding" through multiple assessment tasks such as making a presentation in front of the class, writing reports, and constructing mind maps. According to her, the student-centered teacher would use these tasks to assess students' understanding rather than using only the paper-pencil exam at the end of the unit. She called the use of multiple assessment tasks by using the term "authentic assessment" (1st CSCA).

Mook also pointed out that student-centered assessment would allow her students to "participate in" assessing peers' work. She said, "Child-centered should have a characteristic of students' participation, such as making a presentation in front of the class and then assessing other's work, by using an evaluation form or questionnaire" (Post Lesson5). However, she did not implement this activity in the observed classroom.

Strengths of Student-Centered Assessment

Mook mentioned four strengths of student-centered assessment. First, she mentioned that student-centered assessment allowed the teacher to examine students' understanding and then give students some "feedback" right away. For example, she said, "I frequently ask my students to solve exercise problems in front of the class and then give them feedback instantly" (Pre Lesson3). Second, she believed that by using multiple assessment tasks, her students would always gain a "good score." She illustrated her idea by saying, "Even when students do [the work] incorrectly, they will get some marks." She added, "The teacher will tell them what's wrong and then give it back to fix it" (2nd CSCA). Third, Mook once mentioned that if her students did "participate in" assessing their peers, next time they would think about "how to make a good work and get good marks" (Post Lesson5). Finally, Mook pointed out that using multiple assessment tasks would allow the teacher to examine students' understanding "authentically." She stated, "I will know them authentically. It's like I know that today, what the students know and what the students are able to do" (1st CSCA).

Weaknesses of Student-Centered Assessment

In addition to the strengths of student-centered assessment, Mook reported four weaknesses of this assessment. First, she mentioned that student-centered assessment was "difficult" and "uncomfortable" for the teacher to implement. During the interviews, Mook mentioned that she would face many difficulties with the implementation of student-centered assessment. Examples of these difficulties included constructing a "rubric" for assessment (1st CSCA), listening students' presentations (Assessment), and reading students' reports (Assessment). Second, she pointed out that student-centered assessment "consumes a lot of time." In addition, she noted that it would take a lot of time for the teacher to listen to the presentation of all students as well as to read all students' reports. Third, she believed that student-centered assessment was ineffective with non-collaborative students. She stressed, "If the students do not do, I cannot assess them" (1st CSCA). Moreover, when she talked about a group work assignment, she mentioned that there were some students who did not want to do anything and were willing to pay all the expense. Finally, Mook pointed out that student-centered assessment was not suitable for a large-scale assessment such as "national assessment" and "school assessment." She stressed that it was too "hard" and "complicated" to assess student's understanding at these large size groups (1st CSCA).

Mook's Reflection on the Student-Centered Educational Reform Movement

Mook talked about the reform of education toward the student-centered approach by expressing that, "It is good, if it has been promoted in the right way." She went on and mentioned that many teachers still did not have "a clear picture" of what student-centeredness was. Mook used her own experience in the teaching professional program to support her argument that at that time, she was forced to apply the 5-E learning model to every single lesson. She went on and mentioned that even though some content was not appropriate for the 5-E, she still had been forced to write the lesson plan by applying the 5-E model. She said, "I don't understand why it has to be 5-E all the time?" (1st CSCA).

Case Three: Gorn

Introduction

The school where Gorn taught was a secondary school located in a rural area. During the time of the study, the total number of the students in the school was 498, including 251 middle school students and 247 high school students. Gorn described his school as a medium-size school. During the demographic interview, Gorn raised three concerns about the students in his school. First, he mentioned that some of the students were not interested in learning because they did not want to pursue further study after completing their high school education. The second concern was that many students had family problems. He pointed out that forty percent of the students in this school came from divorced families where their parents were separated, remarried, or left them behind with their grandparents. The last concern was students' illiteracy. He pointed out that about one-third of the students did "not have background knowledge, could not read and write." He highlighted, "The only thing they can write is their name."

In Gorn's school, there were 25 teachers, including 5 science teachers. Gorn was the only one physics teacher in this school. As the only physics teacher in the school, Gorn taught all three levels of high school physics (M4 - M6; Grades 10-12). In addition to these courses, he taught other courses including boy scouts, school clubs, and tutorial courses. Other than teaching, Gorn had two school duties: (a) the head of registration and assessment, and (b) the head of science department.

The observed classroom was M6/2 (Grade 12) class. There were 34 students in this class. 22 of them were females and 12 were males. When Gorn described the students in this classroom, he noted that there were a variety of students in this class. On one hand, as he mentioned, this class had some “hardworking” and “attentive” students who could get a “full or almost full” score from the test. On the other hand, many students in this class had “a low level of enthusiasm about learning and do not have much responsibility.” He went on and said, “There will be some students skipping the class, some students sleeping in the class, and, some students sitting and doing nothing.”

Gorn pointed out that his practices were not different in any of the other classrooms. His reason for choosing this class to be observed was because the instruction of the class was in the middle of the week. In addition, he noted that the other classes he taught were on either Monday or Friday on which the school was frequently closed for a national holiday.

The observed unit was Electric and Magnetic Field II. It was the first unit of the second semester. The lessons of this unit ran for 50 minutes on Wednesday and 100 minutes on Thursday. Gorn took nine weeks to complete nine lessons of this unit. Within these nine weeks, there were seven days on which Gorn had to cancel the class. The schedule of the observed lessons and class cancellation was illustrated in table 4.3.

Table 4.3

Gorn's Instructional Schedule of Electric and Magnetic Field II Unit

Week	Date	Lesson
1	Wed, Oct27	No instruction: Cleaning day
	Thu, Oct28	Lesson1: Motor
2	Wed, Nov3	Lesson2: Generator
	Thu, Nov4	Lesson3: Transformer, and power lost
3	Wed, Nov10	Lesson4: Transformer computation
	Thu, Nov11	Lesson5: Transformer computation (con.(, household appliances, and electrical safety
4	Wed, Nov17	Lesson6: Household appliances test
	Thu, Nov18	Lesson7: Household appliances (con.), and alternating current
5	Wed, Nov24	No instruction: Preparation for a Vajiravudh's (Thai National Scout) day ceremony
	Thu, Nov25	No instruction: The Vajiravudh's day ceremony
6	-	No instruction: He was on a leave of absence for taking care of his mother who has a cancer surgery
7	Wed, Dec8	Lesson8: Alternating current (con.)
	Thu, Dec9	Lesson9: RCL (Resistance/Capacitor/Inductance) circuits
8	Wed, Dec15	No instruction: Buddhist seminar
	Thu, Dec16	No instruction: Boy Scout camping
9	Wed, Dec22	No instruction: Gorn had to help other teachers making the copies of midterm exams.
	Thu, Dec23	Posttest

Curriculum

During the interviews, Gorn mentioned three goals of the Electric and Magnetic Field II unit. The first goal was to help his students understand the concepts and ideas relating to electric and magnetic fields. He pointed out that his students should have known these concepts because they were "important" and "related" to students' everyday life. For instance, when he talked about his lesson on the calculation of wire resistance and voltage drop, he mentioned that the learning concept was "applicable to the students who might run their own business such as farming." He added, "They have to apply this knowledge to make a wire connection to the animal shelters." Second, he pointed out that the observed unit aimed to develop students' academic skills such as problem solving skills, reading comprehension skills, searching information skills and note taking skills. The last goal mentioned by him was to teach his students to be able to do the National Test in order to gain access to a university.

Characteristics of Non-Student-Centered Curriculum

Gorn frequently mentioned that his current curriculum was non-student-centered. He gave four reasons to support his idea. First, he perceived his curriculum as being non-student-centered because he was the one who "chooses" and "organizes" what to learn. For example, he pointed out that his curriculum was not based on "student-centered principles" but it was based on the principle that it contained "the knowledge background in which the students should know before they study further" (Post Lesson1).

Second, Gorn pointed out that his current curriculum was non-student-centered because the structure of the curriculum was based on either the "national standards" or "the IPST textbook." For example, he said, "Choosing the learning content is not student-centered because it is based on the structure of the standard content in which the IPST has written in the textbook" (Pre Lesson3). He also pointed out that he was one of the non-student-centered teachers because he taught some content regardless students' readiness to learn. For instance, he said,

> The current curriculum is non-student-centered because the content I teach is mainly based on the IPST textbook. Sometimes, my students might not be ready for learning this content. But, they need to learn all of this content within this semester. So, I have to teach this content to them (1st CSCA).

For Gorn, another characteristic of non-student-centered curriculum was that his students had to learn what they did "not want to learn." For example, he talked about the topic of the alternating current by saying "In reality, if I let students decide whether they want to learn this topic or not, they will choose not to. But, I need to teach them in order to meet the standards. Thus, [my curriculum] is non-student-centered." (Post Lesson7).

Finally, Gorn viewed the learning content on the calculation of transformers and appliance voltage as being non-student-centered because this concept was "not necessary" for the students to learn. For instance, he talked about learning how to select an appropriate voltage for the appliances by saying, "These days, most of the electric appliances are made to be used at the same voltage level, 220V. Thus, the learning topic on how to select an appropriate voltage for the appliances is not necessary any more" (Post Lesson8).

Strengths of Non-Student-Centered Curriculum

During the interview, Gorn mentioned four strengths of non-student-centered curriculum. First, he believed that things students learned from non-student-centered curriculum were "comprehensive" and "met the standards." He stressed that he had to choose what to teach "based on the national curriculum as much as possible," because he wanted to make sure that his students "complete the curriculum designated by the Ministry of Education" (1st CSCA). He also pointed out that by using curriculum based on the IPST textbook, his students would have enough background knowledge to do the national examination (2nd CSCA).

Second, Gorn believed that non-student-centered curriculum allowed his students to learn at an "appropriate" pace "from easy to hard." In addition, he mentioned that both teacher and IPST should make a good decision about what and when to learn. He also explained that since he planned to teach at "a very slow speed," his students would learn "little by little" so they did "not have to force themselves too much" (Pre Lesson 4).

Third, Gorn stated that using the IPST textbook as a reference was an "easy" way for him to decide what to teach. He mentioned that this method was convenient for a teacher like him, who had "little time to prepare what to teach" and a lot of "teaching and school duties" to do (1^{st} CSCA).

Finally, Gorn pointed out that the use of standard curriculum would allow his students to be able to learn from other students in other schools. In addition, he said that since every student learned the same content, they would be able to "exchange and learn" from other students who lived in a same village but studied in a different school (2^{nd} CSCA).

Weaknesses of Non-Student-Centered Curriculum

Gorn pointed out that non-student-centered curriculum has three weaknesses. First, he mentioned that students would not want to learn the content in non-student-centered curriculum. He also mentioned that when students did not want to learn, they would exhibit misbehaviors such as "sleeping", "chit-chatting" (Post Lesson1) and "making annoying noises" (2^{nd} CSCA). He commented that since he had to devote some instructional time to address these behaviors, "This would minimize the opportunity of their peers to learn" (2^{nd} CSCA).

The Second weakness was that the learning content chosen by the teacher could be “too hard” for the students to learn. Gorn also pointed out that his students might not have enough background knowledge to learn the content in a non-student-centered curriculum. He stressed that this issue had “negative” effects on his students such as feeling bored, disliking physics, and decreasing their achievement (1st CSCA).

Finally, Gorn pointed out that by using non-student-centered curriculum, students would get used to “the habits of waiting for receiving information from the teacher.” He added, “Students will not try to study on their own and wait for hearing the learning topics from the teacher. It’s like the teacher tell them to stop thinking. They won’t try to search for information on their own” (Pre Lesson3).

Characteristics of Student-Centered Curriculum

Even though Gorn frequently described his current curriculum as being non-student-centered, he perceived his curriculum as being student-centered as well. In addition, he perceived that many learning topics he taught were student-centered because his students still did “not already know” and they did “need to know” about these topics. For example, when he gave the reason why the transformer lesson was student-centered, he said, “I see that students still don’t have a chance to know about this concept and it has a direct effect on them when they use this device” (Pre Lesson4). Similarly, when he talked about the computation of the transformer, he said, “I think that if they know this concept, they will be safer. My thought is based on bringing the highest benefit to the students. That’s why it is student-centered” (Pre Lesson5). In order to make his curriculum more student-centered, he recommended administering an examination to measure what students did "not know" and then teaching accordingly (Pre Lesson1).

When Gorn was asked to describe how to make his curriculum to be more student-centered, he also mentioned that students should have had a chance to tell their teacher about "what they want to learn." He empathized, "If it is student-centered, it should come from students' desire to learn" (1st CSCA). He also said, "If it is student-centered, there should be a survey asking the students what they want to learn, what they already know, and what questions they have" (Post Lesson1).

Strengths of Student-Centered Curriculum

According to Gorn, student-centered curriculum had four strengths. The first strength was that students would have positive feelings toward learning. He believed that asking students to choose what to learn would make them feel "happy," "attentive," and "eager" to learn. He also mentioned that by using student-centered curriculum, the teacher can run instruction "progressively" without wasting the time and efforts on addressing "students' misbehaviors" (2nd CSCA).

Second, Gorn pointed out that student-centered curriculum allowed him to save some instructional time for teaching other content. For instance, he stressed that if curriculum was designed to be based on students' prior knowledge, the teacher would be able to avoid "teaching things students already know." He went on and stressed, "So, the teacher has more time to teach other concepts in a deeper level" (Post Lesson2).

The other two strengths of student-centered curriculum included (a) it gave students "a chance to learn what they want and what they don't know" (Post Lesson2);

and (b) it encouraged students to make a preparation before instruction "without waiting for the teacher" (Pre Lesson3).

Weaknesses of Student-Centered Curriculum

In addition to the strengths of student-centered curriculum, Gorn pointed out five weaknesses of student-centered curriculum. First, he believed that the learning content chosen by students was either too "easy" or too "hard" to learn. For instance, he said, "Most of the students want to do an easy task and learn an easy thing without thinking of the benefits they are going to have in the future" (Post Lesson1).

Second, Gorn pointed out that it was hard to administer an examination assessing students' prior knowledge. He confessed that he could not conduct the examination because he had "a limited time" (Pre Lesson1). He also mentioned that the examination examining students' prior knowledge was "ineffective because in reality the students do not have anything" to complete the examination (2nd CSCA).

Third, he mentioned that it was difficult to decide what to teach based on students' ideas. He argued, "The students who have well-prepared background knowledge will want to study in a hard level, while the students who have minimal background knowledge will want to learn an easy concept first" (1st CSCA).

The other two weaknesses were associated with Gorn's two concerns about the implementation of student-centered curriculum. His first concern was that his students might not have enough knowledge to do the national examination if they learned things based solely on what they want. The second concern was that there were no supportive learning sources available for his students to use as references when they designed curriculum. Examples of these resources included the internet and textbooks in the school.

Instruction

During the classroom observation period, Gorn frequently started his lesson by checking students' attendance and learning materials. The following learning activities of the observed unit can be categorized into two trends. The first trend was focused on reading comprehension activities. In this trend, the students were asked to read and summarize the information from the IPST textbook. He used various strategies to guide students' learning such as posting reading questions, administering pre- and post-reading tests, and informing his students that there would be the test at the end of the reading activity. He frequently finished the reading activity by discussing with his students to find the answers to reading questions.

The second trend aimed to develop students' conceptual understanding and problem solving skills. In this trend, he employed a lecture method for delivering knowledge and improving students' conceptual understanding. After he finished the lecture, he demonstrated how to solve example problems related to the learning topic. Then, he asked his students to do problem-solving exercises. Since the instructional time was limited, most of the exercises were assigned as homework. In the following lesson, he usually asked some of his students to write their homework solutions in front of the class. After that, he gave the explanation and clarification of students' solutions. In addition to ask students to present their homework solutions in the following lesson, he also asked his students to submit their homework at his office desk to be evaluated. Most of the exercise questions were constructed by Gorn. He once asked his students to construct their own exercise problems and solve these problems as homework assignments. However, in the following lesson, he decided to give his students additional exercise problems that were more difficult and complex than students' ones.

Characteristics of Student-Centered Instruction

Gorn perceived that he had implemented various student-centered instructional strategies in the observed unit. The top three student-centered activities most frequently mentioned by Gorn included the followings: "reading comprehension," "problem solving exercise," and "reading and exercise questions posted by the students." In addition to these activities, he also implemented other student-centered activities including "obtaining students' alternative ideas," "giving additional exercise problems in which students try to avoid," "asking students to present their exercise solutions," "answering students' questions," "giving real world examples related to students' experiences," "asking students to address misbehavior on their own," and "demonstrating how to solve example problems." Furthermore, he mentioned that he would carry out a "self-study" and "experimentation" in order to make his practices more student-centered.

During the interviews, Gorn mentioned ten characteristics of student-centered instruction. The first characteristic was that student-centered instruction allowed students to "study" and "search" for knowledge on their own. He pointed out that, in the student-centered classroom, students had to search for information from various sources rather than directly obtaining from the teacher. These sources included "the internet," "the IPST textbooks," and "collections of entrance examinations."

The second characteristic was that student-centered instruction encouraged students to “learn,” “generate,” “share,” and “exchange” variety of ideas with others. In addition, Gorn believed that students should learn a “variety of ideas” from both the teacher and the other students rather than learn limited information exclusively from the teacher.

The third characteristic was that in the student-centered classroom, students should be the ones “who want to know.” He believed that the student-centered teacher would encourage students find answers to the questions arisen from their curiosity, needs, and interests. For instance, when he gave the reason why reading questions constructed by the students was student-centered, he said, “The questions they have constructed represent what they want” (Pre Lesson2). Moreover, when he talked about an activity in which one of his students asked him during the lecture why there was a noise in a household transformer, he said that it was student-centered “[b]ecause this is the thing the students want to know. It arises from their observation. This knowledge is what they really want to have” (Post Lesson3).

Active participation was another characteristic of student-centered instruction mentioned by Gorn. He pointed out that the student-centered teacher would encourage students to “actively” conduct scientific experiments, solve exercise problems, and construct exercise and reading questions. For example, he talked about the experimentation by saying, “If the students actively do and learn from learning materials they can touch and feel, it is the learning process called ‘students is the most important’” (1st CSCS).

Fifth, Gorn believed that student-centered instruction was an activity in which the teacher taught things that students “still don’t know” or “try to avoid learning it.” For example, when he talked about his demonstration of how to calculate the voltage of the transformer, he said, “Since I have a background knowledge that my students still don’t know about this topic, this demonstration is student-centered because it is focused on the thing they don’t know and don’t understand” (Post Lesson4). Additionally, when he talked about the activity in which he gave his students additional exercise problems, in case that the problems constructed by his students were too easy, he said, “It is also student-centered because the main point is that the students still don’t have these skills and they avoid practicing. So, they need someone to force them to do” (Post Lesson5).

There were five other reasons given by Gorn to explain why he characterized his practices as being student-centered. First, he pointed out that giving examples relating to students’ everyday experiences was student-centered because it aimed to facilitate students’ learning. Second, he pointed out that the review was student-centered because it aimed to examine what students “already know” (Post Lesson7). Third, he described that he viewed the activity in which he checked students’ notebook at the beginning of his class as being student-centered because it was beneficial for his students to learn by taking notes on their own notebook. He said, “It is student-centered if we look at the benefit to the students” (Post Lesson8). Fourth, according to Gorn, asking students who exhibited misbehavior to calm themselves down outside the classroom was student-centered because “they address their behaviors on their own” (Post Lesson4). Finally, he suggested that students should be categorized as of their learning capability in order to allow the teacher to teach accordingly. He noted, “Each student has different level of learning capability and development, so the appropriate learning method for each student should be different.” He also mentioned that because all of his classes had students with mixed levels of learning capability, it is hard for him to implement the student-centered approach. He went on and stressed, “Mixing students is not student-centered because waiting for all students to understand the learning topic before moving on to the next one will hold the advanced students back” (1st CSCA).

Strengths of Student-Centered Instruction

When Gorn talked about student-centered instruction, he mentioned that it had ten strengths. The first strength was that it promoted several technical skills, including “information searching,” “public speaking,” “reading comprehension,” “problem solving,” “answering the question”, and “listening” skills.

Gorn talked about the second strength of student-centered instruction by saying that students could learn various things from conducting an experiment. In addition, he mentioned that during the experimentation, his students could learn “how to solve problems from their mistakes,” “lab equipment usage and safety management skills,” and “experimenting skills.” He also mentioned that his students could use the results of the experiment to verify the correctness of the scientific theory. He said, “If they conduct an experiment and find the results that are consistent with the theory, they will feel confident that the theory they learned is true. So, they can accept it” (1st CSCA).

The third strength of student-centered instruction was that the students could remember what they learned “very well” for “a very long time.” For example, Gorn talked about the strength of the student discussion by saying, “If the students express their own thought, knowledge they obtained will come from their own reasonable consideration. This will make this knowledge stay with them for a long time period” (Post Lesson1).

The fourth strength was that activities where students shared and exchanged ideas with others would provide these students a chance to “broaden” their understanding. In addition, he pointed out that student-centered instruction allowed students to learn from “different perspectives of other students” (Post Lesson8).

The fifth strength was that student-centered instruction encouraged students to think “creatively,” “differently,” and “openly.” For instance, he pointed out that the reading homework assignment about household appliances would encourage his students to use their own “imagination” and “creativity” to make the connection between what in the textbook and what in their house (Pre Lesson5).

He talked about the sixth strength by pointing out that the teacher could use a reading comprehension activity to “save instructional time.” In addition, he noted that he preferred asking students to learn descriptive concepts by reading the textbook to giving them a lecture. He mentioned that by reading the textbook, students took a short time to receive all information of descriptive concepts.

When he talked about the seventh strength, he mentioned that his students would feel “challenged” to complete the assignments that were consistent with their learning capability. He said as follows:

> The strength is that if they are assigned to work on the things that challenge their capability, they will have a willing to complete this work rather than seeing that it

> is very easy to do it any other time. It becomes the work they have to finish as soon as possible in order to know more. For the students in the low-ability group, the work they have to do should be assigned from the easiest level. This will be beneficial for them, too. The students in the low-ability group will feel interested in learning in stead of playing at the back of the classroom. They will want to do the assigned work because they can do it and it is not too hard for them to do (1st CSCA).

He believed that the student-centered assignment should be in line with students' learning capability.

Finally, Gorn once mentioned that his students were happy when they discussed with their peer. He noted, "It appears that students are happy. There is a sound of student laughing in the classroom" (Post Lesson3).

In addition to the strengths of student-centered instruction, Gorn reported four reasons why he chose to implement student-centered instruction in his classroom. First, he mentioned that he had to demonstrate how to solve the problem because the students could not complete the problem-solving exercise without his demonstration. Second, he believed that reading was a good way of learning descriptive content with no computation. Examples of this content included the content of "how generator works" (Pre Lesson2), and "how a fuse and cut-out work" (Pre Lesson5). Third, Gorn mentioned that he preferred using a reading comprehension activity because it was easy to implement and only required the IPST textbook. Finally, Gorn mentioned that he had to assign the students to solve the difficult exercise problems because he wanted his students to learn to "try" rather than "giving up" without any attempt (Pre Lesson5).

Weaknesses of Student-Centered Instruction

During the interviews, Gorn reported eight weaknesses of student-centered instruction. First, when Gorn talked about the weakness of student-centered instruction, he frequently pointed out that there were some students who did not want to do the assigned work. He was concerned that many students in the observed classroom had "little" or "lack of" eagerness to learn. He noted that in stead of completing the assigned works, these students just waited for "listening to the teacher" (Pre Lesson2), "being fed by the teacher" (Post Lesson2), "copying their peer's works" (Post Lesson2), or "paying the workgroup expense" (Pre Lesson8). He stressed that these students would "not have any benefit from" student-centered instruction (Post Lesson5).

The second weakness mentioned by Gorn was that his students might exhibit unexpected misbehaviors. For example, when he talked about the experimentation, he mentioned that some students might throw magnets at others' heads or pull the connected wires from the lab equipment until they break off (Pre Lesson1). He also pointed out that during the discussion activity, some students would try to interrupt the discussion by saying something "irrelevant" (Post Lesson4) or "annoying" (Pre Lesson6).

As mentioned by Gorn, the third weakness of student-centered instruction was that many students still did not have enough reading skills to study on their own. He stressed that student-centered instruction could become "the two-edged sword that can hurt" the students (Post Lesson1). He explained that the teacher might move on to the next learning activity without noticing the students who still did not complete the reading activity. He also pointed out that the students could make a “misinterpretation” of the text they read (Pre Lesson4).

According to Gorn, the fourth weakness was that students might construct exercise problems that were very easy to be solved. He noted that students’ problems were likely to be “similar to the examples given by the teacher” (Pre Lesson9). As a result, he once commented that asking students to construct exercise problems “might not be much beneficial for them” (Pre Lesson1).

When he talked about the fifth weakness, Gorn mentioned that the students who did not want to complete the assigned task on their own would try to copy their friends’ works. He noted, “They will get used to the copying behavior” (Pre Lesson5). The sixth weakness of student-centered instruction mentioned by Gorn was time. He stated that both experimentation and reading comprehension activities could “consume a lot of instructional time.”

Gorn talked about the seventh weakness by saying that he faced a lot of difficulties in teaching the class with mixed-ability students. As he mentioned, if he focused on high-ability students, the assignment would be too hard for both medium and low-ability students. In contrast, if he focused on the low-ability students, the high-ability students would not feel challenged in completing the assignment. He also talked about the difficulty with assigning students to work as a group. He noted that students with different learning capability did not want to work together. On one hand, the low-ability students did not want to work as a group with high-ability students because they were frequently complained by high-ability students as being useless. On the other hand, the students with high achievement did not want the inactive students to join their group because they did not want to obtain the low scores on collaboration of the group.

Finally, Gorn talked about the weakness of the homework assignment by saying that many of his students did not have enough time to complete the assignment at home because it was “the harvesting season” and his students had to spend the after school time “to help their family” (Pre Lesson7).

Characteristics of Non-Student-Centered Instruction

Gorn pointed out that he implemented four kinds of non-student-centered learning activities in his classroom. For him, three of these activities included “lecture,” “answers to reading questions given by the teacher,” and “reading and exercise questions posted by the teacher.” He once pointed out that the problem-solving exercise activity he implemented became student-centered when one of his students refused to do the task by saying, “Why don’t you [Gorn] think [solve the problem] on your own?”

For Gorn, non-student-centered instruction had five characteristics. First, non-student-centered instruction was a lecture in which the teacher directly “gives” or “feeds” knowledge to the students. He stressed, in the non-student-centered classroom, the teacher was a “lecturer” who “explains everything” while students were “note-takers”. Second, he believed that students had “very little participation” in non-student-centered instruction. For example, he gave his reason why his lecture was non-student-centered by saying, “The teacher is the only one who administers instruction whereas the students’ participation is very little” (Post Lesson8).

Third, Gorn frequently pointed out that students' interests and needs were not taken into account in non-student-centered instruction. For example, he said that reading and exercise questions posted by the teacher were non-student-centered because these questions did not represent students' interests and needs. Moreover, when he talked about the student's response of "Why don't you [Gorn] think [solve the problem] on your own?," he said as follows:

> This question reflects that the student does not want to learn at all. It likes, 'If the teacher want to know, why the teacher doesn't compute on his own.' Actually, this situation should not happen because in the student-centered activity, learning process should start from students' needs and what they want to know (Post Lesson3).

He believed that this question should not appear in the student-centered classroom.

Another reason given by Gorn for characterizing his lecture as being non-student-centered was that the discussed ideas were "limited" and "not diverse." He once explained why his practice was non-student-centered by saying, "It's like the teacher explains everything. The students do not express their idea at all. There is no diversity of the ideas. There is no knowledge expansion" (Post Lesson8).

Finally, in contrast to asking students to address their misbehaviors on their own, Gorn described that the non-student-centered teacher might solve students' misbehaviors by "punishment." He added that the non-student-centered teacher might use "impolite statements" and separate misbehaving students from their friends (Post Lesson4).

Strengths of Non-Student-Centered Instruction

According to Gorn, non-student-centered instruction had seven strengths. First, he believed that by using non-student-centered instruction, he could save some instructional time for giving an explanation or focusing on computation. In addition, he believed that the teacher was able to speed up students' learning process by giving a lecture or guiding questions. The second strength of non-student-centered instruction mentioned by Gorn was that students were guided to learn. He also mentioned that in a reading comprehension activity, students would be able to "meet the standards" guided by teacher's questions "more easily" than a reading activity without these questions.

The third strength of the lecture mentioned by Gorn was that the teacher could immediately help students when problems arise. For instance, he said, "During the lecture, if the students have any questions, they can suddenly ask the teacher and the teacher can answer immediately" (Post Lesson8). Fourth, Gorn pointed out that by receiving the same information from the teacher, all students would have the "same interpretation" and "understanding." He gave the "two-door" analogy to illustrate his idea of having "the same interpretation." He explained, in the student-centered classroom, students were allowed to use any of these two doors to enter and exit the room while, in the non-student-centered classroom, students received a clear direction from their teacher about how to use these two doors (1st CSCA).

The fifth strength was that teachers' explanation could help students to understand difficult concepts. During the discussion of the sine function, Gorn said, "It is hard for the students to make sense of this concept on their own. So, in order to make this difficult concept more easily to understand, I, as the teacher, have to explain this concept" (Pre Lesson7).

Sixth, Gorn once stated that his lecture was beneficial for the students who want to find out “more additional information.” He further explained, “The person who gets the most benefit from the lecture is the one who takes this knowledge and search for more additional information. The person who loses the benefit is the one who just listens and stops right there” (Post Lesson1).

When Gorn talked about the eighth strength of non-student-centered activities in which the teacher directly gave correct answers to the reading questions, he noted that this activity allowed the students who were afraid of asking the questions to know. He stressed, “If I use this method, it will help the students who are shy and afraid of asking the question to lean and understand the concepts they should know” (Post Lesson3).

Finally, Gorn mentioned that he had to use non-student-centered instruction because the student-centered learning activities did not work the way he planned. There were two learning activities that were unsuccessfully implemented to be student-centered. In the first activity, he asked students to solve the problem in front of the classroom but one of his students rejected and said, “Why don’t you [Gorn] think [solve the problem] on your own?” As a result, his instruction became non-student-centered. The second activity was the activity where the students were unable to answer the reading questions. He said, “At the beginning, I plan to make it student-centered but it turns out to be the activity in which the teacher explains everything. So, it is not student-centered” (Post Lesson9).

Weaknesses of Non-Student-Centered Instruction

Gorn reported four weaknesses of non-student-centered instruction. First, he stated that using lecture might “limit students’ creative thinking”. For example, he stressed, “The weakness of an activity in which the teacher makes a conclusion for the students is that the teacher might inhibit students’ thinking that might be different and diverse” (Pre Lesson4).

As mentioned by Gorn, the second weakness was that students did not want to find the answers to teacher’s questions. He noted, “The students do not feel interested in finding the answers to my questions because these questions are not the things they want to know, and do not come from their own motivation” (Post Lesson1).

When Gorn talked about the third weakness of non-student-centered instruction, he noted that students would learn to wait for knowledge from the teacher and stop studying on their own. He also mentioned that students might learn misconceptions from the teacher. He stressed, “Teacher’s knowledge is not always true because the teacher obtained this knowledge long time ago…It can be lost or incorrect. So, the students might learn incorrect information if they do not check and search for more information” (Post Lesson3).

Finally, he confessed that his explanation might not be easy to understand by his students as he thought. He said, “In stead of making students understand, they might get more confused” (Post Lesson8).

Assessment

Gorn used various assessment strategies to examine students' understanding. In addition, he pointed out that he evaluated students' understanding by looking at students' answers to discussed questions, reading questions, and exercise questions. He also administered two tests for accumulative scores. The first test was a written test focusing on the reading topic of "Household Appliances." Since students' score on this test conducted in the first time on Wednesday, November 17, 2010 was very low (mean is 2.30 out of 6 maximum score), he decided to administer this test again on Thursday, November 18, 2010. After completing the retest, he employed a peer assessment technique by asking his students to evaluate their peer's answers to the test questions. There were 25 students from 29 total students who received the score higher than 3. The mean score of the retest was 3.16. The second test for accumulative scores was conducted at the end of the observed unit. It was a written test consisting of one conceptual question and five computational questions. Students' test score was low with the mean of 2.35 from the 8 total score. There were only seven of twenty-four students obtained the scores higher than 4, determined as passing.

Characteristics of Student-Centered Assessment

Gorn believed that he implemented various student-centered assessment strategies in the observed classroom. These strategies included "answers to reading questions," "questions constructed by the students," "retest," a remedial exam," "peer evaluation," "score report," and "individual assessment." He also mentioned that in order to make his assessment more student-centered, the test questions at the end of the observed unit should be “open-ended” and his students should be allowed to complete the test freely without the time constraint.

Based on the interviews, Gorn mentioned nine reasons explaining why the assessment strategies mentioned above were student-centered. First, he pointed out that in the student-centered approach, students should be the “administrators” constructing and developing assessment. He mentioned that all assessment tools such as the scope and type of the assessment questions, and the evaluation of the students’ answers, should be done by students. He also pointed out that in order to make the test on Household Appliances more student-centered, the time for completing test should not have been limited by the teacher.

Second, he believed that the discussion about the answers to both reading and test questions were student-centered because these two activities gave his students a chance to express and share their “knowledge” and “ideas” to others. Third, he mentioned that the individual evaluation was student-centered because it focused on assessing individual differences. For instance, he viewed the evaluation of the problem-solving exercise as being student-centered because “[i]t evaluates each individual student whether they are able to solve the problems or not” (Pre Lesson3). Moreover, he characterized the separation of the students during the exam as being student-centered because “They [the students] have to answer the questions on their own without others’ help” (Assessment).

Fourth, he pointed out that the retest was student-centered because it aimed to assess students’ “real understanding.” He explained that since the students did not prepare and were not ready for the first test, “The results of the test can represent a deviation." He went on and stressed, the retest was the "real assessment" that could "evaluate how hard they worked, how much efforts they put in, and how much knowledge each student had" (Post Lesson7).

Fifth, he believed that the score report was student-centered because it gave students a chance to know the level of their understanding. He noted, "I see it as being student-centered because I tell my students the test results in order to let them know which level they are in. So, they can make an improvement from the level at which they currently are" (Assessment).

Sixth, he believed that examining students' understanding through problem-solving exercises was student-centered because the teacher could use the results of assessment to give students "additional learning supports." Seventh, he mentioned that using open-ended test questions would make the test at the end of the observed unit more student-centered because these questions would encourage his students to "use the high level of thought and consideration" (Assessment). Eighth, he pointed out that a remedial exam for students who failed the test was student-centered assessment because it gave the students a chance to "edit" and "improve" themselves (1st CSCA). Finally, he once mentioned that the student-centered teacher would evaluate students as of their learning capability. In addition, he illustrated his idea by using the case of a student with learning disability or "special child." He said as follows.

> The way I see it as being student-centered is because I look at the learning capability of the student. He has developed. This level of the development is very hard for him to do but he is able to do it. So, he deserves this score. But, for the students who have already had sufficient learning capability but do not force themselves to learn, I give them the zero score because they do not develop at all (1st CSCA).

He believed that the student-centered teacher should focus on assessing students' development.

Strengths of Student-Centered Assessment

According to Gorn, there were six strengths of student-centered assessment. First, he noted that the retest was "good for the students" because they could learn more when they made a preparation for the test. He also pointed out that by using retest results, his students would have a better accumulative score. Second, when he talked about the strength of the activity in which his students construct reading and exercise questions, he stated that it allowed his students to express their "curiosity" as well as to ask for his advices about how to address their issues (Pre Lesson6). Third, he noted that open-ended test questions would allow his students to "openly "express their latent ability." He added, "The students might have different ideas" and the open-ended questions could be used as "stimulators" to motivate students to think and share their ideas (Assessment).

In addition, the other three strengths of student-centered assessment were related to a peer assessment. First, he mentioned that the peer assessment could be used to save his time on evaluating students' answers. Second, he believed that the peer assessment would encourage his students to ask their peer for evaluating their works before submission. The last strength of the peer assessment was that the students should be more able to understand other students' answers than the teacher. He stressed that by this method, "[t]he results of assessment are more accurate" (Post Lesson7).

Weaknesses of Student-Centered Assessment

Gorn pointed out that there were five weaknesses of student-centered assessment. First, he mentioned that students' cheating behavior during a peer evaluation could cause negative effects such as obtaining "high level of inaccuracy" of the test results, (1st CSCA), minimizing students' chance to know their understanding level (Post Lesson7), and learning to "take advantage from others" (2nd CSCA). Second, he was concerned that peer evaluation was "not standardized" (Post Lesson5). He also noted, "Sometimes the assessment results were not consistent with student's understanding because students might assess and interpret their peers' answers incorrectly" (1st CSCA). Third, he pointed out that the test questions constructed by his students were "too easy" and did "not cover" all key concepts. Fourth, he mentioned that if he let his students complete the test at home, the results of the test might not represent students' real understanding. He added that students' answers might come from the textbook rather than from their current understanding. Finally, when he talked about the case of a "special child" assessment, he mentioned that some students might not see the fairness of assessment. He pointed out that these students might have the question why they receive a lower grade than the special child who knew less than themselves.

Characteristics of Non-Student-Centered Assessment

According to Gorn, non-student-centered assessment consisted of three characteristics. The first characteristic was that the teacher was the one who designed assessment tools. In addition, he frequently pointed out that in non-student-centered assessment, all key characteristics of assessment such as the assessment questions, the way to answers to the assessment questions, the way to grade students' answers, and the duration of assessment were completely determined by the teacher. For instance, he talked about the test at the end of the observed unit by saying, "The teacher has constructed the test questions already" while "the students have to guess which topics the teacher wants to assess" (1st CSCA).

The second characteristic was that the teacher rated all test questions with the same value without consideration of their difficulty level. In addition, Gorn explained that this strategy was non-student-centered because it was not "worthwhile" for the students who were able to solve difficult test problems (Assessment).

Finally, Gorn mentioned that non-student-centered assessment involved activities in which students can do "whatever they wanted" during assessment, such as copying peers' answers and searching answers from the textbook. He pointed out that this assessment was non-student-centered because it could not be used to assess students' understanding (Assessment).

Strengths of Non-Student-Centered Assessment

There were four strengths of non-student-centered assessment mentioned by Gorn. First, he pointed out that if he evaluated students' works by himself, he could give his students some comments and feedback. Second, in contrast to student-centered assessment, he pointed out that the reading and test questions constructed by the teacher would be more "comprehensive" and "meet the standards." Third, he mentioned that the strength of the evaluation made by the teacher was that the evaluation criterion was "clear and the same for everyone." Finally, he mentioned that he restricted the test time because he wanted his students to learn to solve problems within the limited amount of time.

Weaknesses of Non-Student-Centered Assessment

During the interviews, Gorn pointed out that non-student-centered assessment had four weaknesses. First, he confessed that he might misinterpret students' written answers to the test questions. He noted, "Students' handwriting is an obstacle in understanding and evaluating students' answers" (2^{nd} CSCA). He also mentioned that his students could not communicate with him through writing because of students' lack of written communication skills (Post Lesson6). Second, Gorn once mentioned that if his students were evaluated as being wrong, their confidence could be minimized. Third, he confessed that his evaluation could be "too strict." For instance, he pointed out that if he made an evaluation, his students would "lost the score from making a tiny mistake" such as not drawing a dividing line between the numerator and denominator of a fraction (Post Lesson5). Finally, he mentioned that close-ended test questions did not stimulate students to make further thought because they were "easy to answer."

Gorn's Reflection on the Student-Centered Educational Reform Movement

Gorn pointed out that he supported the student-centered educational reform because the student-centered approach taught students to think creatively in "different" and "correct" ways (2^{nd} CSCA). He also mentioned that he agreed to the learning principle of the student-centered approach emphasizing "the development of each student at their full potential." He added, "Everyone is born with different levels of ability. So, making all of them able to do the same thing within the same period of time is impossible" (1^{st} CSCA).

However, Gorn said that it was "too early" to promote the implementation of the student-centered approach. He argued, "Because the students still have a lack of motivation and willingness to learn." He went on and said, "Nowadays, the students still do not want to learn so student-centered instruction is ineffective" (1^{st} CSCA).

Case Four: Yord

Introduction

During the data collection period, Yord was a physics teacher teaching in a small rural school with 346 students (224 middle school students and 122 high school students). He pointed out that in accordance with the results of the Ordinary National Educational Test (O-Net)- the students in his school were categorized in the low achievement group. He also mentioned that there was a shortage of learning resources such as textbooks and lab equipment.

The total number of teachers in Yord's school was 25, including 5 science teachers. Yord was 1 of the 2 physics teachers in the school. He taught two high school physics courses, including M4 (Grade 10) and M5 (Grade 11) physics courses. Since there was no biology teacher in his school, he was assigned to teach two high school biology courses, including M4 (Grade 10) and M5 (Grade 11) biology courses. In addition to teaching, he worked as the head of registration and assessment to set up the data base and documents for admitting and transferring students, issue students' transcripts, and gather students' grade data from all teachers in the school.

When he was asked to select one of his classes to be observed, Yord's first response was, "There is no difference among them." After that, he chose his 4/1 physics classroom to be observed. He said that the students in this class were "more responsible" than the students in the other classes. There were 22 students (7 males and 15 females) in the observed classroom. He described these students by saying, "They are normal and have a high level of attention in learning. Since they are not smart if I teach them a 100, they might be able to obtain only 20 – 30."

Yord's five 100-minute lessons of the Motion unit were observed. The instructional schedule of this unit was shown in Table 4.4. He finished teaching this unit within one month. There was no instruction in the observed class during the first two weeks of the second semester. At that time, he tried to figure out what to teach because his school had adopted the new science curriculum. Once his decision was made, he pointed out that he had to teach his students the concepts of Motion again, but in less detail. He explained that the observed Motion unit was adapted from basic science curriculum while the Motion unit taught in the previous semester was based on high school physics curriculum which focused much more in-depth on conceptual details and problem solving applications. He pointed out that he had to reteach the concepts of motion because he wanted his students to meet both basic science and high school physics curricula.

Table 4.4

Yord's Instructional Schedule of Motion Unit

Week	Date	Lesson and activity
1	Tue, Oct26	No instruction
	Fri, Oct29	No instruction
2	Tue, Nov2	No instruction
	Fri, Nov5	No instruction
3	Tue, Nov9	Lesson1: Linear Motion
	Fri, Nov12	Lesson2: Speed experiment
4	Tue, Nov16	No instruction: Yord was on duty outside the school.
	Fri, Nov19	Lesson3: Acceleration
5	Tue, Nov23	Lesson4: Projectile motion and circular motion
	Fri, Nov26	Lesson5: Simple harmonic and answers to questions at the end of the IPST textbook chapter
6	Tue, Nov30	Test of the Motion unit

Curriculum

During the interviews, Yord pointed out that his curriculum for the Motion unit was "based on the IPST textbook." The two main goals of his current curriculum were (a) to help the students to "meet the science standards", and (b) to be able to "compete with other students" in the national examination. In addition, he frequently noted that he wanted his students to "know" key concepts, ideas, and formulae as well as to be able to "solve physics problems". He also mentioned that he wanted his students to know some learning concepts such as acceleration and projectile motions because these concepts were "related to students' everyday living." Developing experimenting skills was another goal of the observed unit. In addition, he pointed out that he wanted his students to learn how to use lab equipment and to make precise measurements.

Yord's gave two criteria of how to characterize whether his curriculum was student-centered or non-student-centered. His first criterion was the characterization based on the type of instruction. The focus of his second criterion was on the reference sources he used to decide what and when to teach. These two criteria were presented in this section separately. It was important to note that Yord did not mention both strengths and weaknesses of both student-centered and non-student-centered curricula when he looked at the first criterion, the type of instruction.

Characteristics of Student-Centered and Non-Student-Centered Curricula (Based on the type of Instruction)

In the interviews, Yord frequently categorized whether his curriculum was student-centered or non-student-centered by looking at the type of instruction. In addition, he categorized his current curriculum as being student-centered if it allowed him to employ student-centered instruction. In contrast, he categorized his current curriculum as non-student-centeredness if he used non-student-centered instruction in his classroom. As a result, he perceived his current curriculum as being "both student-centered and non-student-centered" (Pre Lesson3). For instance, he said,

> The content I select allows the students to have a chance to participate in answering the questions and having an interaction with other students. But in some content, there is no students' participation because the teacher has to explain the concepts to the students. So, this part is not [student-centered] (Post Lesson1).

He believed that when his way of deciding what to teach allowed him to implement a student-centered learning activity, his curriculum became student-centered.

Characteristic of Non-Student-Centered Curriculum (Based on the Reference Sources)

When Yord looked at the reference sources he used to decide what to teach, he repeatedly described his current curriculum as being non-student-centered. He explained that it was non-student-centered because it was based on the national standard curriculum or the IPST textbook. He emphasized that these two sources were constructed by "the experts" from the Ministry of Education not by the students (1st CSCA). He also mentioned that non-student-centered curriculum did not take students' needs into account. For example, he talked about his current curriculum as follows:

> It was not student-centered because I saw that the students did not choose what to learn by themselves. I did not focus on their needs or what they want to learn. But, I focused on what's contained in the [national] curriculum (Post Lesson1).

He believed that non-student-centered teachers did not take students' needs into account when designing curriculum.

Strengths of Non-Student-Centered Curriculum (Based on the Reference Sources)

Yord stated that the strength of the curriculum based on the national curriculum and the IPST textbook was its standardization and comprehensiveness. He also mentioned that non-student-centered curriculum allowed students to be able to compete with others. For instance, he said, "The strength of non-student-centered curriculum is that students will meet the same standards. They can use the knowledge they learn to complete the national examination with fairness" (1st CSCA). He also pointed out that non-student-centered curriculum allowed his students to learn all topics "they need to learn" (Pre Lesson4).

Weakness of Non-Student-Centered Curriculum (Based on the Reference Sources)

When he talked about the weakness of non-student-centered curriculum, he mentioned that the students "might not try to do well in learning" because they did not want to learn what in curriculum. Moreover, sometimes, when he was asked about the weakness of non-student-centered curriculum, he noted that it had "no weakness."

Characteristic of Student-Centered Curriculum (Based on the Reference Sources)

When he gave an idea about how to make his current curriculum more student-centered, Yod pointed out that the content of student-centered curriculum should be "chosen by the students" in order to address their "needs" and "preferences." He explained that it was student-centered "because the students have a chance to learn based on their own interests" (Pre lesson5). He also stressed, "Student-centered curriculum put an emphasis on letting the students to choose what to learn based on what they want" (1st CSCA).

Strength of Student-Centered Curriculum (Based on the Reference Sources)

Yord pointed out that if his students had a chance to learn what they wanted, they would pay attention in learning and then would obtain a good grade. For example, he said, "Since student-centered curriculum is based on students' preference, I believe that they will pay their attention in learning. As a result, they will have a good score from a test" (1st CSCA).

Weakness of Student-Centered Curriculum (Based on the Reference Sources)

According to Yord, the weakness of student-centered curriculum, in which students chose what to learn, was that it was not standardized. He also pointed out that his students would not be able to compete with students from other schools if they learned from the different curriculum. For example, he said as follows:

> Normally, I do not let the students choose because they will not learn the same things. The learning content will not be standardized all over the country. It should be based on the same standards so as to allow the students to compete with students from other schools during the national examination (2nd CSCA).

He went on and mentioned, “It is unfair if the examination asks about the topic they do not learn in the classroom. The examination should be fair to every student (2nd CSCA).

Instruction

Yord started the first lesson of the Motion unit by asking his students to write the course syllabus on their notebook. In addition to the course syllabus activity, most of his lessons, except the Lesson Two and Lesson Five, followed the following trend. He began his lesson with telling the students about the definition of the key learning concepts such as linear motion, acceleration, projectile motion, circular motion, and simple harmonic motion. After that, he used some real world examples to illustrate the definition he gave. During these two activities, students passively listened and took notes. Then, he asked his students to discuss and present some real world examples. Next, he introduced the computational formulas related to the learning concept and demonstrated how to apply these formulas to solve the problems. During these two activities, he told his students to take notes and highlight key ideas by underlining the key ideas as well as drawing rectangular frames around the key ideas. Subsequently, he asked his students to solve exercise problems and submitted their solutions to him at the end of the lesson.

In the Lesson Two, Yord asked his students to conduct an experiment measuring the speed of a cart by using a ticker timer. However, he could not find the carbon paper for the ticker timer. As a result, he asked his students to learn how to use and operate the ticker timer and then analyzed the results from the IPST textbook.

In the second half of the Lesson Five, Yord asked his students to discuss and find the answers to the questions at the end of IPST textbook chapter. However, most of the answers to these questions were given by him rather than the students.

Characteristics of Student-Centered Instruction

During the interviews, Yord pointed out that his lessons consisted of various student-centered activities, including “writing course syllabus,” “speed measurement made by the students,” “problem solving exercise,” “note taking,” “listening,” “answers to teacher’s questions,” “examples given by the students,” “highlighting key ideas,” and “experimentation.” He also mentioned that his lessons could be more student-centered if he asked his students to do the followings: “take active actions” (e.g., riding a bike, throwing a ball), “construct exercise questions,” and “conduct a research study to find new knowledge.”

Yord gave seven reasons explaining why the above activities were student-centered. First, he believed that in the student-centered classroom, students actively “participate in” learning activities. During the interviews, he frequently used the word “students’ participation” or “participate” to describe the characteristic of student-centered instruction. He defined the term “students’ participation” as an activity in which students take actions such as “listen”, “think”, “read”, “write”, “discuss”, “conduct an experiment”, and “solve an exercise problem”. He stressed, “Whenever there is students’ participation, it is student-centered” (Pre Lesson1). For example, he said, “Student-centered instruction is the part where students construct an experiment, answer questions, take notes, and discuss with the teacher and their peers. These are four main activities I described as being student-centered" (2nd CSCA). Furthermore, he also categorized the lecture as being student-centered because students participated in taking an action. As he pointed out, "The part they [the students] listen and take notes is the part that is centered on them. It is student-centered because the students participate in listening and taking notes" (Post Lesson3).

Second, Yord pointed out that student-centered instruction encouraged students to "gain knowledge by themselves." In addition, he believed that in the student-centered classroom, the students would design and conduct an experiment to "find knowledge on their own." He stressed, "Student-centered instruction put an emphasis more on the experimentation because it should have the process of acquiring knowledge" (1st CSCA). He also talked about the experimentation by saying, "The best way to do is not to let them read the textbook." He described this approach as being "authentically student-centered." He further explained,

> It means knowledge comes from their own thought. Some people might say that giving them worksheets or handouts is student-centered. Yes, it is also student-centered. But if it is authentically student-centered, they shouldn't have anything except the lab equipment and questions (Pre Lesson 4).

He believed that the students should conduct an experiment without any references.

Third, he noted that problem solving exercise was student-centered because the solutions to exercise problems were based on students' understanding. In addition, he pointed out that in the student-centered classroom, the students solved problems "by themselves" without "any help" from the teacher. For example, he said, "The exercise is student-centered because the students have done it by themselves. Whether it is right or wrong it is depended on them" (Pre Lesson4).

Fourth, Yord believed that when students shared their ideas, the learning activity became student-centered. In addition, he saw the discussion activity in which students gave some real world examples as being student-centered because the ideas originally came "from the students." For instance, he said as follows:

> When I ask 'Are there any examples of linear motion?' If it is question-answer discussion like this, it is student-centered because they [the students] think their own and they are free to think outside of the box, outside of the examples given in the textbook (Post Lesson1).

Fifth, when Yord talked about how his students obtained the time interval of the ticker timer, he mentioned that the student-centered teacher should ask the students to measure the time interval on their own rather than to read the lab equipment label. However, he pointed out that it is "impossible" to the measure the time interval by the students because "It needs to be measured by a special equipment, in which [he] don't know." He went on and mentioned that the measurement of ticker-timer's time interval could not be student-centered (Post Lesson2).

Sixth, when Yord talked about the activity in which he told his students to highlight key concepts, he mentioned that this activity can be more student-centered by letting the students highlight the key concepts on their own. He said, "If it is student-centered, the students should highlight on their own." He went on and said, "They have to be able to see which parts are the keywords of those topics" (Post Lesson4).

When Yord talked about the last characteristic of student-centered instruction, he commented that his definition of student-centered instruction was different from the "theoretical" and "promoted" definition of student-centered instruction. In addition, based on his view, student-centered instruction should include an activity aiming at helping students learn. For example, he pointed out that using various instructional activities was student-centered because it helped students to learn more than using only one type of instructional activity. Many times during the interviews, Yord expressed the confusion between these two definitions.

> Yord: Based on my view, student-centered instruction is an activity that aims at placing an emphasis on students' participation in learning and at helping the students gain more knowledge and understanding. That's why I can't specify whether making them have more knowledge and understanding is student-centered or non-student-centered because I do not sure about the definition of it [student-centered instruction].
>
> Researcher: Based on your view, what do you think?
>
> Yord: I will say it is student-centered because I make students' knowledge and understanding increase (1st CSCA).

In the same interview, he also stressed that there was a distinction between his and theoretical definitions of student-centered instruction.

> Yord: My definition of student-centered instruction is to make students gain knowledge and understanding as much as possible. So, my instruction is student-centered. But, the theory says it is not. That's why I have to say it is non-student-centered.
>
> Researcher: Why?
>
> Yord: Based on the theory, it is non-student-centered because the students do not find the knowledge on their own (1st CSCA).

He also mentioned that even a punishment by hitting a student is student-centered. He explained, "Because it makes them know that their behavior is wrong. If they do wrong, then they are hit. They will know that they do wrong. So, they won't do it again and will do the right thing" (1st CSCA).

Strengths of Student-Centered Instruction

There were eight strengths of student-centered instruction mentioned by Yord. First, he pointed out that his students could learn and practice various educational skills from student-centered learning activities. These skills included “problem solving,” “observational,” and “experimental” skills. Second, in addition to experimental skills, he stated that experimentation made his students feel “confident” in conducting an experiment. He also said, “It made them [the students] more confident when they conduct an experiment in the future. They would do it more proficiently” (Post Lesson2). Third, he pointed out that the students would feel “proud” of knowledge they obtained on their own. Fourth, he mentioned that he could use student-centered activities to check students’ understanding. For example, he talked about an activity in which he asked his students to give some real world examples of the projectile motion by saying, “If the students are able to answer, I will feel confident that they understand about the concept of projectile motion” (Post Lesson4). Fifth, he mentioned that the discussion activity helps his students to develop “a reasonable understanding.” For instance, he said, “I believe that knowledge should not be presented directly. Students should think, share, and discuss to find the reason why it is as it is. This will make students understand more. When there is a reason, there is an understanding” (2nd CSCA).

Sixth, Yord mentioned that the strength of the student-centered learning activity in which students conduct their own research was that it gave the students a chance to “learn” and “do” for “their own interests.” Seventh, he mentioned that student-centered instruction offered students with a variety of information. In addition, he talked about an activity where he asked his students to give some real world examples by saying, “It helps students to gain more understanding. Learning should not be stuck with one or the other thing. They should look into many different ways. I don’t want them to entirely stick with what I told them” (Post Lesson5). Finally, when he talked about the strength of note-taking, he said, “The reason I ask them to take note is that they will write and make sense of what they write simultaneously. Writing things down is always better than mere listening” (1st CSCA).

Weaknesses of Student-Centered Instruction

During the interviews, Yord reported six weaknesses of student-centered instruction. First, he was concerned that the student-centered activities such as students’ discussion and reading activities could instill the students with misconceptions. For example, he talked about the weakness of the discussion among the students by saying, “The weakness is that if they understand it in a wrong way, they will hold that misunderstanding. It will turn out to be an activity that makes they learn the wrong thing” (1st CSCA).

Second, in addition to producing misunderstanding, Yord pointed out that in the student-centered classroom, students might miss a chance to know the correct ideas. For instance, he stressed, “Sometimes, they didn’t know whether they understood correctly or not because there was no one telling them which ideas were right or wrong” (2nd CSCA).

Third, Yord pointed out that student-centered instruction did not work with the students who waited for copying others’ work or were unwilling to learn. For instance, he talked about problem solving exercises as follows:

> The weakness is that the students who still don't understand or are unable to complete the task will wait for copying their peers' work. So, they are still unable to do it. Sometimes, I can't find out whether they copy others' work or not because they work in group not individually (Pre Lesson1).

According to Yord, the fourth weakness of non-student-centered instruction was that students might not be able to make sense of the examples presented by their peers. He confessed that he preferred asking his students to discuss about his example to students' example. He said, "If I let the students select an example to be discussed, other students might not be able to make sense. It will become the weak point even though there is students' participation" (Post Lesson4). He also gave the reason why he did not want to ask his students to give the real world examples of projectile motion by saying, "I believe that if they think on their own, they might come up with the wrong idea. That's why I won't let them think on their own" (Pre Lesson4).

Fifth, the weakness of letting students study by themselves was that the learning outcomes would not meet what they were expected to know. For example, he said,

> I believe that in every school, the teacher won't allow the students to study on their own because if they study on their own, how can we sure that these students will do as we expected. It's like learning under controlled versus uncontrolled conditions" (Pre Lesson5).

Finally, he pointed out that students might cause damage to the lab equipment when they conducted an experiment. He said, "The weakness is that if students are careless, reckless, and frivolous, they won't learn anything and the lab equipment may be damaged" (1st CSCA). He also pointed out that many teachers had to "make a lot of consideration whether they should let students do the experiment or not." He went on and explained, "Because when they have ever done that, they will know that their students might cause damage to the lab equipment, might not follow what they say, and might break the rules” (Pre Lesson4).

In addition to the six weaknesses of student-centered instruction, Yord gave five reasons why he decided not to implement student-centered instruction in his classroom. The first reason was that it was “unnecessary” to implement some student-centered activities such as kicking a ball, shooting a basket ball, and riding a bike. He explained, “The students already experiences in their everyday life so it is not necessary for them to actually do it” (Pre Lesson3).

Second, Yord pointed out that it was not “worthwhile” to let students study on their own. For example, when he gave the reason why he did not ask his students to conduct the acceleration experiment, he said, ‘Not worthwhile’ means I have to give them two periods to search for knowledge in which I do not sure whether they will understand what they have found or not. That’s why it is not worthwhile for the students to spend the time doing that” (Post Lesson 3).

Yord’s third reason was that he did not have enough time to implement student-centered instruction. For example, he talked about the weakness of experimentation by saying, “The weakness is that I have limited instructional time. Even though I focus on teaching them to understand all concepts and learn all required content, I still do not have enough time to do so” (Pre lessson3).

Fourth, he mentioned that he had to give the students some helps because they could not do it on their own. For him, the activities with this characteristic included constructing exercise problems, highlighting key ideas, and answering end-of-chapter questions. For instance, he talked about the highlighting activity as follows:

> If I let them highlight on their own, I think they cannot highlight the right one. Based on their experience and maturity, they are still unable to do it. Sometimes, they even don't understand why some passages are highlighted and some passages aren't. To be able to highlight the right one, they have to be able to identify which part is really important. (Post lesson4).

Finally, he pointed out that there were not enough learning resources to support the implementation of student-centered instruction. He mentioned that his school did not have enough computers with internet connection, lab equipment, and textbooks available for his students to use when they participated in student-centered instruction.

Characteristics of Non-Student-Centered Instruction

In addition to the student-centered activities, Yord mentioned that he implemented some non-student-centered activities in his classroom. The lecture was most frequently mentioned by Yord as an implemented non-student-centered activity. Other activities included "examples given by the teacher," "problem solving demonstration," "experimental results from the textbook," "exercise questions from the teacher," and "teacher's answers to the questions at the end of the book chapter."

According to Yord, there were five reasons to explain why he perceived these activities as being non-student-centered. First, he categorized the lecture as a non-student-centered learning activity because the knowledge was "already found" by others or "stated in the textbook." In addition, he described knowledge students learned from his lecture as "stable knowledge" (Post Lesson1), "fundamental knowledge" (Pre Lesson3), “knowledge in the textbook” (Post Lesson 5) and “not new knowledge” (2nd CSCA). For example, when he talked about his lecture on acceleration, he said as follows:

> This part is the fundamental knowledge. As I said, the fundamental knowledge is non-student-centered because the fundamental knowledge comes from stable knowledge in the textbook. They [the students] do not construct a new one (Pre Lesson3).

He also differentiated between student-centered and non-student-centered instructions by the sources of knowledge. He said,

> Because it has the characteristic that knowledge does not come from the students. The teacher feeds it to them. Lecture is the activity where the teacher tells the students directly. They do not think on their own. So, according to my view, student-centered instruction is the instruction in which they listen, think, read, write ‘and’ gain knowledge on their own. Since it has the ‘and’, the lecture is non-student-centered (2nd CSCA).

He believed that in the non-student-centered classroom, students learned things that had already been found by others.

Second, in addition to the sources of knowledge, Yord noted that the lecture was non-student-centered because knowledge was transferred directly from the teacher to the students. Examples of his statements included the followings: “Because the teacher tells the students directly while they do not construct on their own” (Post Lesson2), “Because the teacher just give the knowledge” (Post Lesson3), and “Because knowledge isn’t found by them but the teacher feeds it to them” (2nd CSCA). He pointed out that lecture was ‘always’ non-student-centered. He said,

> If the lecture has students’ participation, I think it shouldn’t be called ‘lecture’. It should be called another name. So, I am certainly sure that the lecture is non-student-centered. If the lecture involves students’ action, it should be called discussion where the teacher asks questions for the students to answer (2nd CSCA).

Third, during the interviews, Yord frequently said that teacher's problem-solving demonstration was 'always' non-student-centered because the teacher was the one who demonstrated how to solve the example problems. For example, he stressed, "Since it is called 'an example,' I have to show them how to do it" (Post Lesson3). In addition, he differentiated between teacher's example and a problem solving exercise by saying,

> I call it as 'the example'. It is always non-student-centered because it is the part in which the teacher demonstrates how to do it. On the other hand, the 'exercise' is student-centered because it is the part where the students do it on their own (2nd CSCA).

Fourth, he mentioned that his instruction was non-student-centered because exercise questions, experiment results, real world examples, or answers to the discussed questions did "not come from the students." For instance, he gave the reason why exercise problems were non-student-centered by saying, "Because the teacher is the one who selects the problem and the students do not construct the problems based on their curiosity" (Post Lesson3). He also pointed out that the experiment of the ticker timer was non-student-centered because his students obtained the results from the textbook rather than from the real experiment (Post Lesson2).

Finally, Yord pointed out that non-student-centered instruction included an activity where the teacher did not teach students who wanted to learn. He said,

> The students want to learn but they do not have a chance to learn. Actually, the students do not want anything more than just being taught by the teacher. They feel happy even having just like that. Then, I simply see that if the teacher teaches, it is student-centered (1st CSCA).

He believed that the student-centered teacher should be in the classroom with his/her students.

Strengths of Non-Student-Centered Instruction

Based on the interviews, Yord believed that there were five strengths of non-student-centered instruction. First, he mentioned that lecture was the “best,” “fastest,” and “easiest” way of instruction. For example, he noted that he preferred using lecture, “Because lecture is the fastest way of knowledge transfer within a limited instructional time” (Pre Lesson4).

Second, in contrast to student-centered instruction, Yord believed that the lecture gave students a chance to know “correct ideas.” He also pointed out that students would feel so “confident” that their understanding was true if they obtained this knowledge from their teacher. He emphasized, “Telling them directly is better because they will accept what they learn. They will know that it is correct because the teacher has already verified it. They will believe that it is correct” (2nd CSCA). Third, Yord mentioned that through lecture, students can develop reasonable understanding. For instance, he said, “The strength of the lecture is that it provides students with well-arranged reasons so as to help them understand” (Pre Lesson5).

According to Yord, the fourth strength of the lecture was that the teacher could control students’ learning process and choose an example that could attract students’ attention and interest. For instance, he talked about his example of a motor rider in uniform circular motion by saying, “Because some students still do not know about it, they will feel interested in learning about it” (Post Lesson 4).

Fifth, Yord mentioned that he decided to use lecture because it allowed his students to learn all concepts within the limited time. In addition, he said, “Because the time is limited and I want them to learn all concepts, I have to tell them directly." He went on and noted, "When all teachers decide how to teach, they have to think about which teaching strategies should be used in order to make students know all of the things they need to know" (Post lesson3). Sixth, Yord believed that the lecture can be used to force students to think. He said, "Sometimes, when I let them think on their own, they don't even try to think. So, I have to prevent this by leading them to think" (Pre Lesson1).

Finally, Yord mentioned that even though his students did not have an experience in conducting scientific experiment from his non-student-centered lessons, they still had enough knowledge and skills to take the national examination. He said, "At least, the students gain knowledge and problem-solving skills for taking the national tests. It is the way to address the current situation. At least, they have to know all of these and have to know the same things as other students" (Post Lesson2).

Yord also mentioned two reasons why he implemented non-student-centered instruction in his classroom. The first reason was because his students did not have enough background knowledge to study on their own. He emphasized, "Because their background knowledge is not enough to center on them" (Post Lesson2). He also said, "Because their background knowledge is weak, I have to teach them first. They have to gain enough knowledge and understanding first. Then, they can learn on their own at the higher level" (2nd CSCA).

The second reason for Yord to demonstrate how to solve the example problems was because his students could not solve exercise problems on their own without his demonstration. For example, he said, “If I do not show them how to do it, they won’t be able to do it. So, I have to do it” (2nd CSCA). He also mentioned,

> It is not necessary to be student-centered all the time. It is not like that. If I center on them, they might do it in a wrong way. So, they have to learn how to do it step-by-step. That’s why I have to show them how to do it first (Post Lesson3).

He believed that he needed to give a problem solving demonstration even though it was a non-student-centered learning activity.

Weakness of Non-Student-Centered Instruction

When he talked about the weakness of non-student-centered instruction, Yord confessed that his students might not be able to follow his lecture. For example, he said, “The weakness is that if they do not think, they won’t understand” However, he pointed out that he addressed this situation by asking his students to take notes. He explained,

> If they do not think, at least I have to make them take notes. So, during the exam period, they will have something to read and review. I believe that at least, they have learned something. This is why they have to write everything I have said (Pre Lesson5).

He believed that students would think later after reading their lecture notes.

Applied to both Student-Centered and Non-Student-Centered Instructions

In many interviews, Yord described various activities as being both student-centered and non-student-centered at the same time. On one hand, he mentioned that his instruction was student-centered because the students took an action in learning. On the other hand, his instruction was non-student-centered because the teacher was involved in students’ learning. For example, he talked about the activity in which the teacher gave a lecture and the students took notes as follows:

> In the part I tell them what acceleration is, it is not centered on them because the teacher tells or gives a lecture directly. But, in the part the students listen and take notes, it is centered on them because the students participate in listening and note taking. I see it as being student-centered (Post Lesson3).

Discussion was another activity described by Yord as being both student-centered and non-student-centered. He said, “It is the discussion. The discussion means ‘thinking together’. So, it could be seen as being both student-centered and non-student-centered.” He went on and mentioned, “The part in which students discuss is student-centered and the part in which the teacher discusses is non-student-centered” (Post Lesson5).

Assessment

Yord’s physics course had 70-30 grade system. In addition, 70 percent of the final grade included tests of all four learning units (10 percent), midterm exam (30 percent), and student’s lecture notes and exercises (30 percent). The other 30 percent of the final grade came from the final exam. He pointed out that he gave more weight on the scores from student’s notes and exercises because he wanted to help the students who obtained low score from the tests to have more chance to receive a higher grade.

The test at the end of the observed unit consisted of 20 multiple-choice questions. Six of these twenty questions were problem solving test questions while the rests focused on conceptual understanding. The mean score of the test was 10.21 from the total scores of 20 and students' test scores ranged from 4 to 15. Yord pointed out that the test results were “unsatisfied” because he expected to see some students “obtain[ing] the full score.” He further explained that the test was “easy” and students had already learned some parts of the test in the previous semester (Assessment). He added, “Mainly, they could not do the test because they did not prepare for the test. If they have read, they should have been able to do it" (Assessment).

Characteristics of Student-Centered Assessment

Yord pointed out that he saw how he administered in-class assessment through the lecture notes and exercises as being student-centered. He explained that it was student-centered because it assessed things resulted from a task of which students are "participated in." For example, he talked about the evaluation of the students' notebooks by saying, "The students participate in completing the work by taking notes, completing the exercise, and submitting their work. They participate in every part of the process, from the first moment of instruction until submitting their work" (Post Lesson1). He mentioned that the way of how he evaluated students' work was student-centered because it was based on students' performance and responsibility. He talked about the evaluation of students' assignments that as follows:

> This part is student-centered because the score they got came from what they did. The teacher did not specify that even though this student did the same, the teacher would give the different scores. It was not like that. That was if they did the same, they would get the same score (Pre Lesson4).

According to Yord, another characteristic of student-centered assessment was "students' acceptance" of the assessment results. He pointed out that his evaluation was student-centered because his students accepted the results of assessment. For instance, when he gave the reason why his evaluation was student-centered, he said, "There is no one makes any argument about the score. Everyone agreed to it. They accepted what they got" (Post Lesson3).

When he talked about the test at the end of the observed unit, Yord pointed out that it was student-centered because all of the test questions asked about what the students have learned in the classroom. For example, he said, “It is student-centered because what I teach is what I ask in the test. That is I construct the test questions based on students’ notes.” When he was asked to gave an idea of how to make the test more student-centered, he argued, “Constructing the questions based on students’ notes is the best I can do. I don’t know how to make it more than this. What I ask is what I teach. It is the highest form of student-centered assessment” (Assessment).

When he talked about his grading system, he mentioned that his current grading system, 70-30 proportion, was more student-centered than the grade based on 60-40 proportion because “[i]t is based on students’ capability.” He further explained that most of his students had low learning capability so 70-30 grading basis with the more weight on in-class scores would “increase a chance for them to get a higher grade” (Post Lesson3).

Moreover, when Yord gave an idea about how to make the 70-30 system more student-centered, he stated that the students had to “specify” the proportion between in-class scores and the final exam scores on their own. He pointed out that it was student-centered because the students were the ones who “set up the proportion on their own” (Assessment).

Yord also pointed out that student-centered assessment was an assessment in which the level of test difficulty was consistent with students’ learning capability. In addition, he noted that the tests with an advanced level of application were student-centered for the “high-ability” students while it was non-student-centered for his students. He went on and mentioned as follows:

> The students in this school are slower while the students in the urban areas are smarter. These two groups can not be assessed by the same test. The level of test difficulty has to be based on students’ learning capability. We cannot use the same assessment tool with these two groups because they have different expectation. If we use the easy test on the smart students, they will not feel proud of the grade they get. We have to construct the test that is appropriate to each group of the students (Assessment).

He mentioned that the test of the observed unit was student-centered because the test was not too easy and too difficult for his students to do.

Furthermore, Yord gave an idea of how to make a student-centered assessment by saying that the teacher should let “the students assess themselves.” He added that the teacher might ask the students to assess their own work by saying, “Based on what you did, what score would you give to yourself?” (2nd CSCA).

Strength of Student-Centered Assessment

Yord pointed out the strength of the assessment activity in which he evaluated students’ works at the end of every lesson was that it could be used to reinforce the students to learn. For instance, he noted, “It makes the students, who don’t want to take notes and do anything, willing to participate in learning activity more” (Pre Lesson1). He also said, “It allows the students to know whether they do it right or wrong. So, it makes them interested in learning and do not come to school without anything” (Post Lesson3).

Weakness of Student-Centered Assessment

During the interviews, Yord mentioned two weaknesses of student-centered assessment. First, he stated that if he let students set the proportion of the grading system on their own, they would not make a proper proportion. He went on and pointed out that the students would not see "the value of the grade" they obtained if it was too easy to get a high grade. Second, he mentioned that the results of the self-assessment were not trustworthy. For example, he talked about the weakness of self-assessment by saying, "If I let them evaluate themselves, they will give them the four [A] grade." He commented, "Assessment is the thing that cannot be done on one's own. Even though it can be done that way, it is not the right way to do so. It should be done by others" (1st CSCA). When asked if he was willing to employ the self-assessment activity, Yord responded, "I won't do it because it has no reliability. I believe no one does that" (Pre Lesson5).

Characteristics of Non-Student-Centered Assessment

Yord pointed out that his current evaluation strategy was non-student-centered because the evaluation was made by others, such as the teacher and students' peers. He mentioned that in non-student-centered assessment, the teacher became the "evaluator," "judge", and "person who makes an evaluation." Moreover, when he talked about a peer assessment, he said, "It is not [student-centered] because other persons are the ones who make an evaluation. They do not evaluate themselves" (Pre Lesson5).

Yord also mentioned that the test at the end of the chapter had the characteristic of non-student-centered assessment because he had tried to prevent his students cheating during the exam. He said, "It is not student-centered. It is teacher-centered because the teacher doesn't want the students to cheat by copying other answers." He went on and said, "There is no student-centered test. During the test, the students have to follow the regulations. So, the test cannot be student-centered" (Assessment).

In contrast to student-centered assessment in which students participate in completing the assessment tasks, Yord believed that in the non-student-centered classroom, the teacher would not assign students any assessment tasks such as "homework," "exercise," and "tests." He pointed out that the teacher should give students a grade based on his/her preference. For instance, he said as follows:

> I think there are no non-student-centered assessments because every test has to be student-centered. If it is non-student-centered, there will be no test. It will center on the teacher that 'This students has this level of attentiveness and this level of responsibility so they should get this grade.' In the real world, some people use this method. It's like grading students based on their name and their face. 'This face gets the four [A] grade. This face is rarely seen so it gets zero [F] grade' (2nd CSCA).

He saw the evaluation based on teacher's preferences as being non-student-centered.

When he talked about the grading system, Yord mentioned that non-student-centered assessment was not based on students' learning capability. In addition, he categorized the grade with 60-40 proportion as being non-student-centered. He explained, "If it is non-student-centered, I will use the 60-40 proportion, which is the standard proportion of science subjects." He went on and said, "It is based on the standard, isn't based on students. So, it is not" (Post Lesson3). In addition to the grading system, he also mentioned that if the test was too hard for his students to do, it would be non-student-centered (Assessment).

Strengths of Non-Student-Centered Assessment

Yord pointed out that the evaluation made by the teacher was "easier" for the teacher to do and "more reliable" than by the students. For instance, he said, "The person who makes the evolution has to be an expert in order to make the evaluation more reliable" (Pre Lesson3).

Weakness of Non-Student-Centered Assessment

When he talked about the weakness of non-student-centered assessment, Yord described that the evaluation made by other students was unreliable. He said, "The students who made an evaluation might not have any standardized criteria in the evaluation. Then, the reliability is minimized" (Pre Lesson 5).

Yord's Reflection on the Student-Centered Educational Reform Movement

Yord made four reflections on the student-centered educational reform movement. First, he believed that student-centered instruction was not suitable for high school students. He commented that in the high school level, the students should learn "fundamental knowledge" instead of conducting their own research to find "new knowledge." He explained as follows:

> If they learn by themselves all the time, students will not be able to learn all fundamental knowledge. The teacher has to teach, explain, and clarify the knowledge as well. So, for the fundamental knowledge, instruction cannot be entirely student-centered, except in the advanced level. Because it is new, it can be student-centered (1st CSCA).

He also mentioned that student-centered instruction was not "appropriate" to his students because the activities students could learn from were "not diverse." In addition, he pointed out that he preferred using various instructional activities to solely using the experimentation. He said, "I try to bring all strengths of each instructional strategy together in order to make my instruction as good as I can" (Post Lesson1).

Second, Yord suggested that in order to give students a chance to participate in student-centered instruction, the school should offer students a laboratory physics course to accompany with the regular high school physics course. For instance, he said, “I think if instruction needs to be student-centered all the time, the school should open new course, the laboratory physics course” (2nd CSCA). He also confessed, “I have to teach all of the content so I do not have enough time to do lab activities. If we open the laboratory physics courses for two periods a week, it will be more student-centered” (Pre Lesson 4).

Third, when he talked about his ideas of student-centered instruction, Yord said that he would define the term “student-centered” differently from the educators. For example, he said as follows:

> If I am an educator, I will say differently from them. Based on my view, the term ‘student-centered’ means to think about how to make students gain knowledge as much as possible, and to help them be able to read, think, analyze as much as possible. This should meet the nation's needs. This is my view. It doesn’t mean that student-centered instruction, based on the theory, is an activity where students have to think on their own or have to find knowledge on their own. On the contrary, it means an activity aiming at improving students from zero to ten, or from zero to hundred (1st CSCA).

Finally, Yord reflected that he did “not care” about the promotion of the student-centered approach. He said, “Since I know that it is just a theory made by the foreigners and it should have both strengths and weaknesses, I do not care so much about it” (1st CSCA). He also commented that “It is just a psychological strategy. I believe that everything always have both advantages and disadvantages. Some people might think that a new thing is a good thing. But for me, I think it is good but it also has the disadvantages” (Pre Lesson5). He also pointed out that it is still controversial whether the student-centered approach is better than any other approach.

CHAPTER FIVE

CROSS-CASE ANALYSIS

Review of the Research Goals

This case study aimed to develop an in-depth understanding of teachers' conceptions of the student-centered approach in physics education. Four Thai high school physics teachers, who themselves were products of the student-centered educational reform movement, were selected to participate. The previous chapter detailed the four teachers' conceptions of the student-centered approach and their perceptions of their own classroom practices. This chapter presents the results of a systematic and comprehensive cross-case analysis comparing and contrasting all four individual cases. As mentioned in Chapter Three, since there are numerous forms of the student-centered approach, each case might not be able to cover all of these forms. As a result, this study utilized cross-case analysis to discover meaningful themes by grouping similar data from all four cases together and separating dissimilar ones. This cross case analysis consisted of three steps, (a) open coding, identifying categories and codes, (b) axial coding, determining relationships between categories and codes, and (c) selective coding, developing themes to answer research questions. As described in Chapter One, this study sought to answer four main questions:

1. What are Thai physics teachers' conceptions of the student-centered approach?
2. What are Thai physics teachers' perceptions of their classroom practices in relation to their conceptions of the student-centered approach?

3. What reasons do Thai physics teachers give for supporting or opposing the implementation of student-centered practices in their own classroom?
4. What are Thai Physics teachers' reflections on the student-centered educational reform movement in relation to their conceptions of the student-centered approach?

To answer the first three research questions, data analysis focused on three educational dimensions: curriculum (what and when to teach/learn), instruction (how to teach/learn), and assessment (how to assess students' learning). This chapter addresses the first three research questions within these dimensions. Importantly, the answers to the first two questions are interrelated as the teacher's conceptions of the student-centered and non-student-centered approaches were examined through their perceptions of their own practices. As a result, in order to answer the first research question, data was analyzed by focusing on how each teacher described the characteristics of the student-centered and non-student-centered approaches. After that, data was revisited and reanalyzed by focusing on how each teacher viewed their own practices.

In order to better understand the third research question, models of implementation for the student-centered approach were developed. Even though teachers' classroom practices varied based on the nature of the teaching content, this study found that there were some commonalities of their implementation across all four learning topics: (a) Heat; (b) Force, Mass, and Laws of Motion; (c) Electric and Magnetic Field II; and (d) Motion. The models presented in this Chapter illustrated these similarities and differences.

Answers to the last research question are presented at the end of this chapter. Since this study examined teachers' conceptions of the student-centered approach based on how they viewed their own classroom practices, it is important to note that each teacher taught within a specific school context and their classroom practices could not be removed from that context. It is possible that they may have taught and viewed their classroom practices differently if they were in a different school context; Gorn may have used different teaching strategies if he instructed Ploy's students and Yord may have taught using a very different approach in Mook's school. However, although these four cases were situated in different contexts, this study found interesting comparisons and contrasts.

Curriculum

Research question 1: What are Thai physics teachers' conceptions of the student-centered approach (curriculum)?

Based on the results of the study, the teachers' conceptions of student-centered and non-student-centered curricula can be characterized into three main categories: (a) emphasis on students vs. emphasis on teacher or standards; (b) students' active vs. passive participation; and (c) benefits vs. non-benefits to students. The summary of Thai high school physics teachers' conceptions of student-centered curriculum is shown in Table 5.1.

Table 5.1

Thai High School Physics Teachers' Conceptions of Student-Centered and Non-Student-Centered Curricula

Main Category	Characteristic	
	Student-Centered Curriculum	Non-Student-Centered Curriculum
1	Emphasis on students: - Students decide what and when to learn.	Emphasis on the teacher or standards: - Teacher decides what and when to teach based on experience or the IPST textbook.
2	Students' active participation: - Teacher can implement student-centered instruction.	Students' passive participation: - Teacher can implement non-student-centered instruction.
3	Benefits to students: - Students learn things they "don't already know" and "need to know."	Non-benefits to students: - Students learn things they do not "need to know."

Category 1: Emphasis on students vs. emphasis on the teacher or standards. During the interviews, all four teachers classified their curriculum as either student-centered or non-student-centered by primary purpose–whether the aim was to address students' needs or science curriculum standards. All four teachers believed that the student-centered approach allowed students to decide what should be included in curriculum in order to be in line with their needs. For instance, Ploy, in particular, emphasized the importance of students' needs by stating, "We care about students' needs as the first priority," "At least we listen to students' ideas," and "At least, students could share their ideas." Similarly, Mook recommended instituting a "students' forum" for gathering their opinions on what and when to learn. Gorn suggested that the student-centered teacher would conduct a survey to examine students' prior knowledge, interests, and ideas before developing curriculum.

In contrast to student-centered curriculum, all four teachers believed that non-student-centered curricula were developed and constructed by teachers/professional educators and that using textbooks as a guideline to decide what and when to teach was a characteristic of non-student-centered curriculum. For instance, Yord gave an example why his curriculum was non-student-centered by saying, “I do not focus on their needs or what they want to learn. I focus on what’s contained in the standard curriculum.” Ploy pointed out that her curriculum was non-student-centered because she alone made decisions about what and when to teach without consulting her students. Gorn replied that his curriculum was non-student-centered simply because his students did not want to learn its content. He went on, “In reality, if I let students decide whether they want to learn this topic or not, they will choose not to. But, I need to teach them in order to meet the standards. Thus, [my curriculum] is non-student-centered.” Mook mentioned that her curriculum was non-student-centered because the students, as well as the teacher, had no control over curriculum. She replied, “The current curriculum has already been made by others. Students are just the followers and the teacher is just a leader who feeds them information.”

Category 2: Students’ active vs. passive participation. Yord held unique views about how to characterize whether a curriculum was student-centered or non-student-centered based on the type of instruction in the classroom. On one hand, he believed that a student-centered curriculum allowed the teacher to teach by using student-centered instruction where students participated in active learning activities, such as reading, writing, discussing, and conducting experiments. On the other hand, he pointed out that a non-student-centered curriculum allowed the teacher to implement passive learning, lecture-based instruction in the classroom.

Category 3: Benefits vs. non-benefits to students. Gorn was the only teacher who differentiated his curriculum, whether it was student-centered or non-student-centered, by looking at the benefits of curriculum to his students. In addition, he postulated that, before constructing a student-centered curriculum, there would be an examination assessing students' background knowledge. He explained that, by this method, the teacher could design a curriculum that allowed students to learn things they "don't already know" or "need to know," and, hence, what would benefit student the most. In contrast, he stated that in the non-student-centered approach, students were required to learn concepts that were not necessarily the most beneficial for them to learn.

Research question 2: What are Thai physics teachers' perceptions of their classroom practices in relation to their conceptions of the student-centered approach (curriculum)?

During the interviews, all four teachers frequently stated that they perceived their current curriculum as being non-student-centered because it was based on their decisions and the IPST textbook. However, both Gorn and Yord mentioned that their curriculum contained elements that could be seen as student-centered. For example, Gorn's curriculum allowed his students to learn concepts they did not already know and needed to know such as Transformers and Household Appliances. Yord viewed his current curriculum as being student-centered because it contained student-centered learning activities such as problem solving, experimentation, and discussion.

Research question 3: What reasons do Thai physics teachers give for supporting or opposing the implementation of student-centered practices in their own classroom?

Figure 5.1 presents a model for how teachers decide whether to implement student-centered or non-student-centered curriculum. As shown in the model, teachers' decisions about the implementation of student-centered curriculum involves three factors: (a) knowledge and beliefs about the goals of curriculum, (b) knowledge and beliefs about the construction of curriculum, and (c) knowledge and beliefs about instructional strategies.

Knowledge and beliefs about the goals of curriculum. Regarding knowledge and beliefs about the goals of curriculum, there are five sub-factors influencing teachers' implementation of their conception of student-centered curriculum. These sub-factors include: (a) students' motivation and affective states, (b) students' understanding of curriculum, (c) students' learning process, (d) content coverage, and (e) benefits to the students.

Students' motivation and affective states. All four teachers frequently mentioned the belief that student-centered curricula were better than non-student-centered curricula because students would be happier, more engaged, and more motivated to learn. Ploy stated that students would feel "interested in learning", would "want to learn", and be "proud of" the content they choose. Mook said that students would feel "happy" and "open-minded to learning." Gorn also believed that students would feel "happy,"

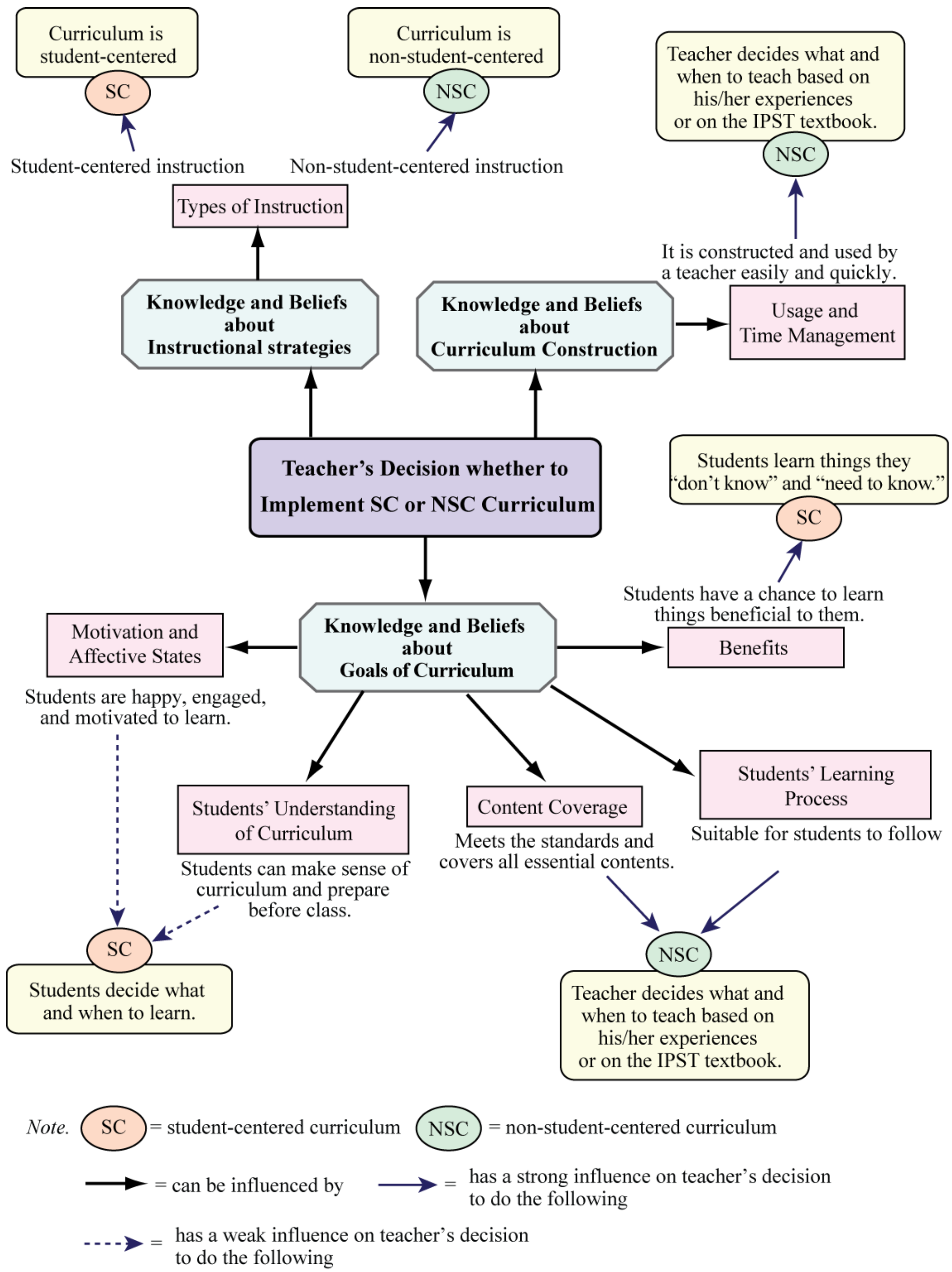


Figure 5.1. Model of factors influencing the implementation of student-centered and non-student-centered curricula.

“attentive,” and “eager” to learn if they learned concepts they actually wanted to know. Similarly, Yord pointed out that, in the student-centered approach, the students would “pay attention” because they had a chance to learn what they wanted.

On the other hand, all four teachers pointed out that students would have negative feelings toward learning in a non-student-centered curriculum. For example, Ploy responded that her students might feel “bored and [not] want to learn” the content chosen by the teacher rather than by them. Similarly, Mook expounded on the weakness of non-student-centeredness by saying, “The more we [teachers] force the students, the more they stay away. They don’t want to learn and don’t want to listen.” Gorn confirmed that his students did not want to learn the content in a non-student-centered curriculum and misbehaved by sleeping, “chit-chatting,” and “making annoying noises.”

As shown in the model, improving students’ motivation and affective states does not play a major role in a teacher’s decision on whether to implement a student-centered curriculum. None of the four participating teachers asked their students to decide what to learn and when even though they believed it could have made their students happier, more engaged, and more motivated to learn.

Students’ understanding of curriculum. During the interviews, three teachers, Ploy, Mook and Gorn, expressed the belief that students would be able to learn the content of a student-centered curriculum more effectively than a non-student-centered curriculum. In particular, they believed the strength of the student-centered approach lied in the fact their students could make more sense or “see the whole picture” of curriculum and, thus, could have a “step-by-step” plan for their learning in the next several chapters.

Students' learning process. Ploy, Mook, and Gorn also pointed out that the content of non-student-centered curriculum were appropriate for their students to learn. For example, Ploy believed that the IPST would contain correct decisions about what topics, "would be appropriate for the students." Both Mook and Gorn believed that their students would understand the subject matter easier if they followed the teacher's plans. Furthermore, Gorn pointed out that, if he took control over what and when to learn, he could instruct at a steady pace so his students did not have to, "force themselves to learn." These three teachers also believed that students learned easier in the non-student-centered approach, however, they expressed worries that it might not be fully suitable. For example, Ploy was concerned that the topics outlined in the IPST textbook were both, "too hard and too broad for [her] students to understand." Similarly, Gorn acknowledged that the content perceived by the teacher as being "easy" to learn might be viewed by the students as "too hard." Mook also pointed out that her students had a hard time following the curriculum designated by the Ministry of Education because it frequently changed to include more topics and more work assignments.

Content coverage. In terms of topics covered, all four teachers mentioned that non-student-centered curricula were superior to student-centered curricula because they met the national standards. For example, Mook noted, "the strength [of non-student-centered curricula] is the course is completed. [The students] have learned all topics the teacher wanted them to learn." Gorn also pointed out that he preferred using the IPST textbook as a guide because he wanted his students to complete the curriculum designated by the Ministry of Education. Moreover, all four teachers mentioned that by using their non-student-centered curriculum, their students would learn all concepts necessary for taking the national examinations. Ploy discussed this by saying, “At least, when they [the students] take a national examination, it will consist of this content”.

Furthermore, three teachers, Mook, Gorn, and Yord, cited a weakness of student-centered curriculum being they do not necessarily meet the standards or contain complete information. Yord stated, “The content that students have learned will be incomplete for sure. The teacher cannot let the students learn just what they want. Students won’t learn all of what the standard-setters want.” Yord also pointed out that student-centered curricula were not “standardized all over the country” and that, to ensure the fairness of the national assessment, all Thai students should learn the same topics.

Benefits to students. Gorn believed he implemented a student-centered curriculum in his classroom when he taught subjects that had practical benefits for his students. For instance, he taught his students the concept of transformers because it was safer for his students to use this knowledge.

Knowledge and beliefs about curriculum construction. The second component of the model, knowledge and beliefs about curriculum construction, emphasizes how usage and time management factors affect teachers’ decisions about how to construct and use student-centered curriculum.

Usage and time management. During the interviews, three teachers, Ploy, Mook, and Gorn, expressed their preference for non-student-centered curricula because they are convenient and efficient. For example, Ploy described the construction of a non-student-centered curriculum as “very fast,” “easy,” and “uncomplicated” and that, by using the

IPST textbook as a reference, “[t]he teachers don’t have to think much.” Similarly, Mook noted, “Because curriculum has already been specified, it is easy for the teacher to use.” According to Gorn, the IPST textbook was a good source of references for him to decide what to teach since he had “little time” to prepare.

Additionally, Ploy, Mook, and Gorn, pointed out that constructing a student-centered curriculum was more difficult for four reasons. First, it was harder to make a curriculum that met every student’s needs. Second, the construction of a student-centered curriculum was time consuming. Third, both Ploy and Gorn agreed that students constructing a student-centered curriculum might not make wise decisions about what and when to learn. Finally, in Gorn’s opinion, constructing a student-centered curriculum was difficult due to a lack of learning resources to facilitate it. For example, not all of his students had both internet access and textbooks available to them so these could not have been incorporated into a student-centered curriculum.

Knowledge and beliefs about instructional strategies. The third component is teachers’ knowledge of, and beliefs about, instructional strategies which emerged from Yord’s unique idea about student-centered curriculum. As mentioned earlier, Yord believed that student-centered curriculum employed student-centered learning activities while non-student-centered curriculum employed non-student-centered learning activities. As a result, his decision on whether to implement student-centered instruction hinged on if he could reasonably use student-centered activities in his classroom.

Instruction

Research question 1: What are Thai physics teachers' conceptions of the student-centered approach (instruction)?

The results of this study found that there were four main categories of teachers' conceptions of student-centered and non-student-centered instruction. The first three categories include (a) students' active vs. passive participation; (b) emphasis vs. non-emphasis on students; and (c) benefits to students. The fourth category encompasses learning activities that could not be easily classified as student-centered or non-student-centered. The summary of teacher's conceptions of student-centered instruction is presented in Table 5.2.

Category 1: Students' active vs. passive participation. In the first category, the teachers believed that active learning was student-centered while passive learning was non-student-centered. For them, active learning involved at least one of the following characteristics: (a) students gain knowledge on their own, (b) students experience, do, or make something by themselves, (c) students coach or teach peers, and (d) the teacher's role in students' learning is minimized. On the other hand, they believed that non-student-centered instruction involved passive learning in which knowledge was directly transferred from teacher and/or materials to students.

Table 5.2

Thai High School Physics teachers' Conceptions of Student-Centered and Non-Student-Centered Instructions

Main Category	Characteristic	
	Student-centered instruction	Non-student-centered instruction
1	Students' active participation: - Students gain knowledge on their own. - Students experience, do, or make something by themselves. - Students coach or teach peers - Teacher's role is minimized.	Students' passive participation: - Knowledge directly transferred from teacher and/or materials to students.
2	Emphasis on students: - Students share and exchange their own ideas. - Students review previously learned topics. - Students are motivated to learn. - Students are grouped and taught based on their capability.	Emphasis on the teacher: - Teacher requires students to do what he/she wants.
3	Benefits to students: - Instruction facilitates students' learning.	
4	Not applied: - Some learning activities are not easily classified.	

Students gain knowledge on their own. All four teachers pointed out that, in the student-centered approach, students gained knowledge on their own. According to Ploy, Mook, and Gorn, students using the student-centered approach would seek out and study various sources of information to obtain knowledge and understanding. For example, Ploy reasoned that reading activities were student-centered because students study on their own and research information independently. Similarly, Gorn stressed that student-centered instruction encouraged students to "use their skills to search for knowledge on their own."

Yord held a different perspective on how students gained knowledge in student-centered instruction. He believed that the student-centered teacher would encourage his/her students to gain knowledge by conducting new research studies instead of reading others' work. He stated that reading and lecture were non-student-centered activities because students learn what he called "stable knowledge," "fundamental knowledge," "knowledge in the textbook," and "not new knowledge." Yord also believed that, in a student-centered classroom, students would design and conduct new studies on their own. When he discussed conducting a classroom experiment on the topic of circular motion, he affirmed, "The best way is to not let [the students] read the textbook".

Students experience or make something by themselves. All four teachers believed that student-centered instruction consisted of activities in which students learn through actively experiencing or making something by themselves. Examples of these activities included constructing reading and exercise questions, solving exercise problems, making mind maps and presentations, and conducting experiments. For instance, Yord said, "[Exercises] are student-centered because the students do them by themselves. Whether solutions are right or wrong depends on them." Gorn discussed experimentation by saying, "If the students actively learn from materials they can touch and feel, it is a learning process called 'students is the most important'."

Yord also held the unique view that instruction became student-centered whenever students listened, thought, read, and wrote. Based on this view, he saw lecture as being both student-centered and non-student-centered because the teacher gave a lecture directly and the students participated by listening and taking notes. Accordingly, he viewed classroom discussion as both student-centered and non-student-centered since both students and teacher were actively participating.

Students coach or teach their peers. Both Ploy and Mook recognized the important role of collaborative learning in student-centered instruction. Ploy believed that activities in which students assisted each other were student-centered. Similarly, Mook noted that student-centered instruction included a “friends-help-friends” component where students trained one another to solve exercise problems and present the solutions as a group in front of the class.

Teacher’s role is minimized. When Ploy and Mook discussed the characteristics of student-centered instruction, they frequently highlighted that the teacher’s role was minimized. Mook believed that the student-centered teacher was be just an “introducer”, “facilitator”, “preparer”, and “summarizer.” For instance, regarding problem solving exercises, she stated, “The teacher just observes while students are the ones who actively do it.” Ploy held a more extreme view that, in the student-centered approach, the teacher would not get involved in students’ learning at all. Examples she gave of student-centered learning activities with no teacher involvement included learning outside the classroom, solving problems without teacher demonstration, independent reading, homework assignments, and making PowerPoint presentations. For example, homework assignments were student-centered since, “[The students] go outside the classroom where there is no teacher watching. Everything depends on them.”

Passive learning. In contrast to student-centered instruction, all four teachers believed that non-student-centered instruction involved passive learning activities where knowledge was transferred directly from the teacher and/or materials to students. Accordingly, all four teachers viewed lecture as non-student-centered. Three teachers, including Ploy, Mook, and Yord, also viewed problem solving demonstration by the teacher as non-student-centered instruction.

Their beliefs about passive learning could be grouped into four categories. First, all four teachers reported that their own instruction was non-student-centered because it was lecture-based and they “fed” knowledge to the students. Second, all four teachers characterized non-student-centered instruction as that which all information taught to the students had already been pre-prepared and summarized. Third, both Ploy and Mook discussed non-student-centered instruction by using the term “teacher-centered” to emphasize the teacher’s role as the main actor. Finally, Gorn described his own lecture as non-student-centered because he requested no alternative ideas from his students and, since ideas came exclusively from him, the in class discussion was “limited” and “not diverse.”

Category 2: Emphasis on students vs. emphasis on the teacher. Regarding the second category, all four teachers believed that student-centered instruction focused on students’ background knowledge, preferences, motivation, and learning capability, while non-student-centered instruction does not take these factors into account. In addition, the teachers believed that student-centered instruction involved learning activities in which students (a) shared and exchanged their own ideas, (b) reviewed previously learned topics, (c) were motivated to learn, and (d) were grouped and taught based on their learning capability. In contrast, non-student-centered instruction included learning activities where the teacher required students to do what he/she wanted.

Sharing and exchanging own ideas. Ploy, Gorn, and Yord shared the opinion that student-centered instruction included activities in which students shared their ideas through discussion or presentation of real world examples. For instance, Gorn stated that student-centered instruction allowed his students to learn and express a variety of ideas, while non-student-centered instruction focused on limited information provided by the teacher. Similarly, Yord discussed the presentation of students’ real world examples by saying, “It is student-centered because they think on their own and are free to think outside the box, outside of the examples given in the textbook.”

Reviewing previously learned topics. During the interviews, Mook and Gorn frequently pointed out that their teaching practices were student-centered when they asked their students to review topics they learned in previous lessons or everyday experiences. For example, Mook described an instance where, in a discussion about the importance of a tire’s tread, the class drew the comparison to a shoe’s tread; “This was something the students already knew and they brought it up [in discussion].” Gorn gave an example of a student-centered instructional activity in which he asked his students about the sine function “to test the students’ background knowledge.”

Students are motivated to learn. Based on the interviews, Gorn expressed a unique view about student-centered instruction by placing an emphasis on students’ needs. He believed that student-centered instruction allowed students to learn what they wanted to learn. For instance, he mentioned that questions constructed by students were student-centered because the questions, “represented what they [the students] want [to learn].” Based on this view, lecture could be student-centered if the teacher took time to answer students’ questions.

Students are grouped and taught based on learning capability. Another unique idea about student-centered instruction held by Gorn was that, in the student-centered classroom, students should be grouped and taught based on their learning capability. He stated, “Mixing students is not student-centered because waiting for all students to understand a topic before moving on will hold the advanced students back.”

Being required to do what the teacher wants. All four teachers stated that non-student-centered instruction was an approach in which students had to follow the teacher’s orders without objection or input. For instance, Ploy characterized an activity in which she checked whether students brought the handout to the classroom as being non-student-centered because she used this activity to address her needs. She stated, “It is non-student-centered because if it is student-centered, whether [the students] bring [the handout] to the class or not is up to them.” Gorn also stated that non-student-centered instruction did not focus on students’ needs and interests. He pointed out that both reading and exercise questions given by the teacher were non-student-centered because, since they are assigned, “students do not want to know by themselves.” He gave the example of a student once sarcastically asking, “Why don’t you [Gorn] think [solve the problem] on your own?” demonstrating his instruction was non-student-centered. He explained, “This question reflects that the student did not want to learn at all.” Yord brought up hypothetical non-student centered scenario where a teacher declines to teach his/her students. He illustrated this idea saying, “Actually, the students do not want anything more than to be taught by the teacher…Then, if the teacher teaches, it is student-centered”.

Category 3: Benefits to students. As mentioned by Gorn and Yord, the student-centered teacher would implement a learning activity that brought the benefits to the students. They believed that student-centered instruction would focus on facilitating students’ learning. According to Gorn, the student-centered teacher would conduct learning activities including checking students’ notebook at the beginning of class, giving analogies, and giving additional exercise problems when needed. For instance, he asserted that checking whether his students brought their notebooks to his class was student-centered because it benefited his students to have their notebooks for taking notes. Gorn also believed that giving additional exercise problems was student-centered because they, “still don’t have the skills and avoid practicing. They need someone to force them to practice”.

Yord defined student-centered instruction as anything that could help the students gain more knowledge and understanding. He stressed that this view of student-centered instruction differed from the “theoretical” or “promoted” definition which focuses on student experimentation. According to him, in student-centered instruction, the teacher conducts activities promoting student learning by using varied instructional activities, reporting student scores in class, and specifying keywords for students to highlight.

Category 4: Not applied. There were some in-class activities that Ploy, Mook, and Yord could not describe as either student-centered or non-student-centered. For instance, Ploy believed that the preparation or "relaxation" activities, in which her students sang songs, clapped their hands, or stretched their muscles, were neither student-centered nor non-student-centered. She stressed that it was "just play." Mook would not classify a notification activity, in which she informed her students that the final examination would be two weeks earlier than expected, because it was "not related to learning." She also mentioned that experimentation could be a mixture of student-centered and non-student-centered approaches. According to her, it would be ideal if an experiment activity was 30% non-student-centered, where a teacher gave assistance, and 70% student-centered, where students took action. Yord expressed a differing idea that some instructional activities could be both student-centered and non-student-centered. For him, both lecture and discussion were student-centered and non-student-centered because both teacher and students were active.

Research question 2: What are Thai physics teachers' perceptions of their classroom practices in relation to their conceptions of the student-centered approach (Instruction)?

A model, shown in Figure 5.2, was developed to graphically represent how teachers perceive their own instructional practices in relation to their conceptions of student-centered instruction. In the model, teachers' classroom practices are divided into five categories: (a) administrative, (b) introduction and engagement, (c) knowledge construction and/or transmission, (d) problem solving demonstration, and (e) problem solving exercises and homework assignments.

Administrative. When it comes to administrative tasks, Gorn and Yord perceived their practices as student-centered while Ploy and Mook perceived theirs as neither student-centered nor non-student-centered. Regarding discipline, Gorn mentioned that he used the student-centered strategy of asking misbehaving students to address their issues alone outside the classroom. He also said that the learning activity in which he checked students' textbook and notebook at the beginning of the class was student-centered because it would be beneficial to his students to learn by using these learning materials. Yord gave the example of having his students write the course syllabus in their notebooks as a student-centered administrative task. On the other hand, Ploy and Mook frequently stated that their administrative tasks were neither student-centered nor non-student-centered. As previously discussed, Ploy did not assign her classroom relaxation activities to either approach and Mook did not categorize announcement activities, like informing her students the final exam was rescheduled, as student-centered or non-student-centered. Furthermore, Ploy disagreed with Gorn by classifying checking whether her students brought the handout to the classroom as non-student-centered.

Introduction and engagement. Mook, Gorn, and Yord perceived that they implemented some student-centered learning activities during the introduction and engagement sections of their instruction. For instance, Mook and Gorn pointed out their introduction and engagement instruction was student-centered when they asked their students to review what they had previously learned. Mook and Yord frequently pointed

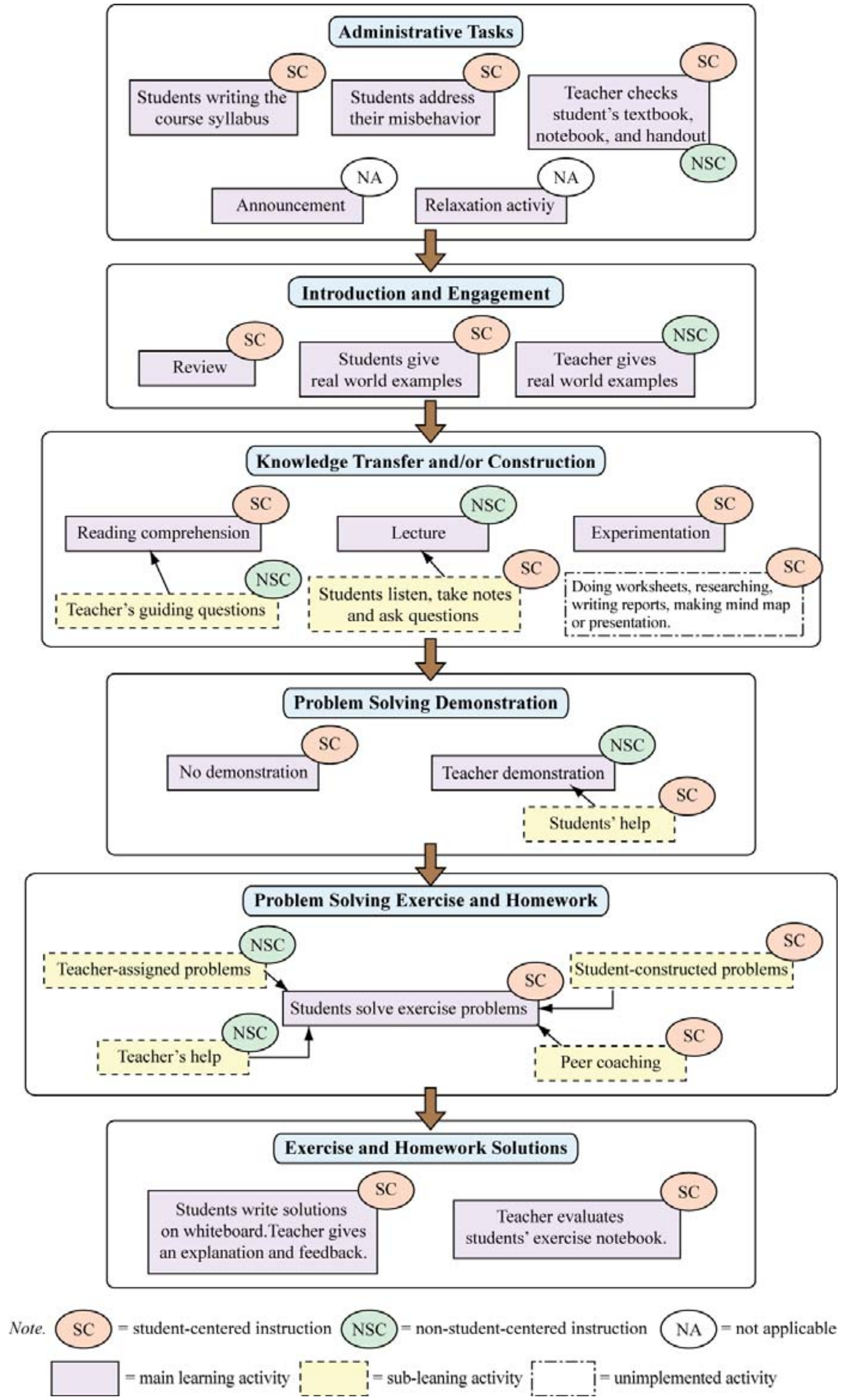


Figure 5.2. Model of Thai high school physics teachers' perceptions of their own classroom practices.

out that asking students to give real world examples related to the learning topic was student-centered. However, Ploy, Mook, and Yord mentioned that they had implemented non-student-centered activities in their classroom as well. For example, they perceived their practices as non-student-centered when they had personally selected and presented real world examples to their students. In contrast, Gorn characterized the activity where he personally selected and gave the analogy of car horsepower as student-centered because it helped his students understand the concept of voltage.

Knowledge construction and/or transmission. Three teachers, Ploy, Mook, and Yord, frequently stated that the way they delivered knowledge to their students was non-student-centered since they primarily used lecture. However, Ploy noted that she had implemented a student-centered component by asking her students to read and summarize information from the textbook. Yord once intended to implement experimentation as a student-centered activity in his classroom. However, in this case, when he could not find the carbon paper for his students to conduct an experiment on speed, the implemented experimentation became non-student-centered because his students had to obtain results from the textbook. Furthermore, Yord noted that his lecture could be seen as student-centered because his students were actively listening and taking notes.

Gorn's instruction during the knowledge transfer section consisted of two main activities including reading comprehension and lecture. Similar to Ploy, Gorn noted that reading comprehension activities in the classroom were student-centered however, when he looked at the reading questions themselves, he viewed them as non-student-centered because they were constructed by him. Moreover, similar to the other three teachers, Gorn perceived his lecture as non-student-centered.

When asked how they could make their instruction more student-centered, all four teachers frequently mentioned that they could ask their students to read or research on their own using the internet or textbook. Moreover, they repeatedly pointed out that they could make their instruction more student-centered with in-class experimentation. Ploy also talked about how to make her classroom more student-centered by asking her students to learn from worksheets, to make a mind map, and to make a PowerPoint presentation. Additionally, Yord stated that his classroom would be more student-centered if, while learning the concepts of motion, his students rode bikes, kicked footballs, or shot basketballs.

Problem solving demonstration. Ploy, Mook, and Yord mentioned several times that they employed non-student-centered problem solving demonstration in which they demonstrated how to solve the problems in front of the classroom. However, Mook mentioned an occasion where her demonstration became student-centered because she asked her students to help her solve the demonstrated problem. Ploy also stressed that her practices became more student-centered if her students solved exercise problems on their own without her demonstration. In contrast to these views, Gorn believed that teacher demonstration was student-centered because it helped the students learn how to solve exercise problems on their own.

Problem solving exercises and homework assignments. Regarding exercises and homework assignments, all four teachers repeatedly mentioned that these types of assignments were student-centered because students completed them on their own. However, Ploy noted that her instruction during exercise activities was non-student-centered because she walked around the classroom helping her students solve the problems. While solving exercise and homework problems was seen as student-centered, Ploy, Gorn, and Yord viewed the problems themselves as non-student-centered because they constructed these problems for their students. In some lessons, Ploy and Gorn tried to make their exercise activities more student-centered by asking students to construct exercise problems on their own. However, Gorn stated once that exercise problems constructed by him were student-centered because his students could learned more from solving these problems in addition to solving the easier problems constructed by themselves.

Exercise and homework solutions. Ploy, Mook, and Gorn frequently mentioned that their exercise and homework solution practices employed the student-centered approach because they had their students present exercise and homework solutions in front of the class. Ploy and Mook also implemented peer-coaching where students taught each other how to solve the problems and presented their solutions as a group. However, Gorn once pointed out an instance where asking his students to present their exercise solutions in front of the class became non-student-centered because of one student saying, “Why don’t you [Gorn] think [solve the problem] on your own?”

Research question 3: What reasons do Thai physics teachers give for supporting or opposing the implementation of student-centered practices in their own classroom?

As shown in Figure 5.3, a model of teachers' student-centered instruction implementation describes four main components of teachers' knowledge and beliefs affecting their instructional practices. These components include (a) teachers' knowledge and beliefs about context and their teaching experiences, (b) teachers' knowledge and beliefs about students' understanding, (c) teachers' knowledge and beliefs about instructional strategies, and (d) teachers' knowledge and beliefs about science curricula.

Teacher's knowledge and beliefs about context and their teaching experiences. The first component, teachers' knowledge and beliefs about context and their teaching experience is placed at the center of the model and interacts with the other three groups of knowledge and beliefs. This component illustrates that a teacher's decision about how to teach is primarily influenced by their perceptions of context (their role as teacher, educational goals, student characteristics, learning materials, etc.) and their teaching experience. For instance, teachers' beliefs about the effectiveness of each instructional strategy are influenced by their perception of the students' learning capability. On one hand, all four teachers frequently pointed out that student-centered instruction

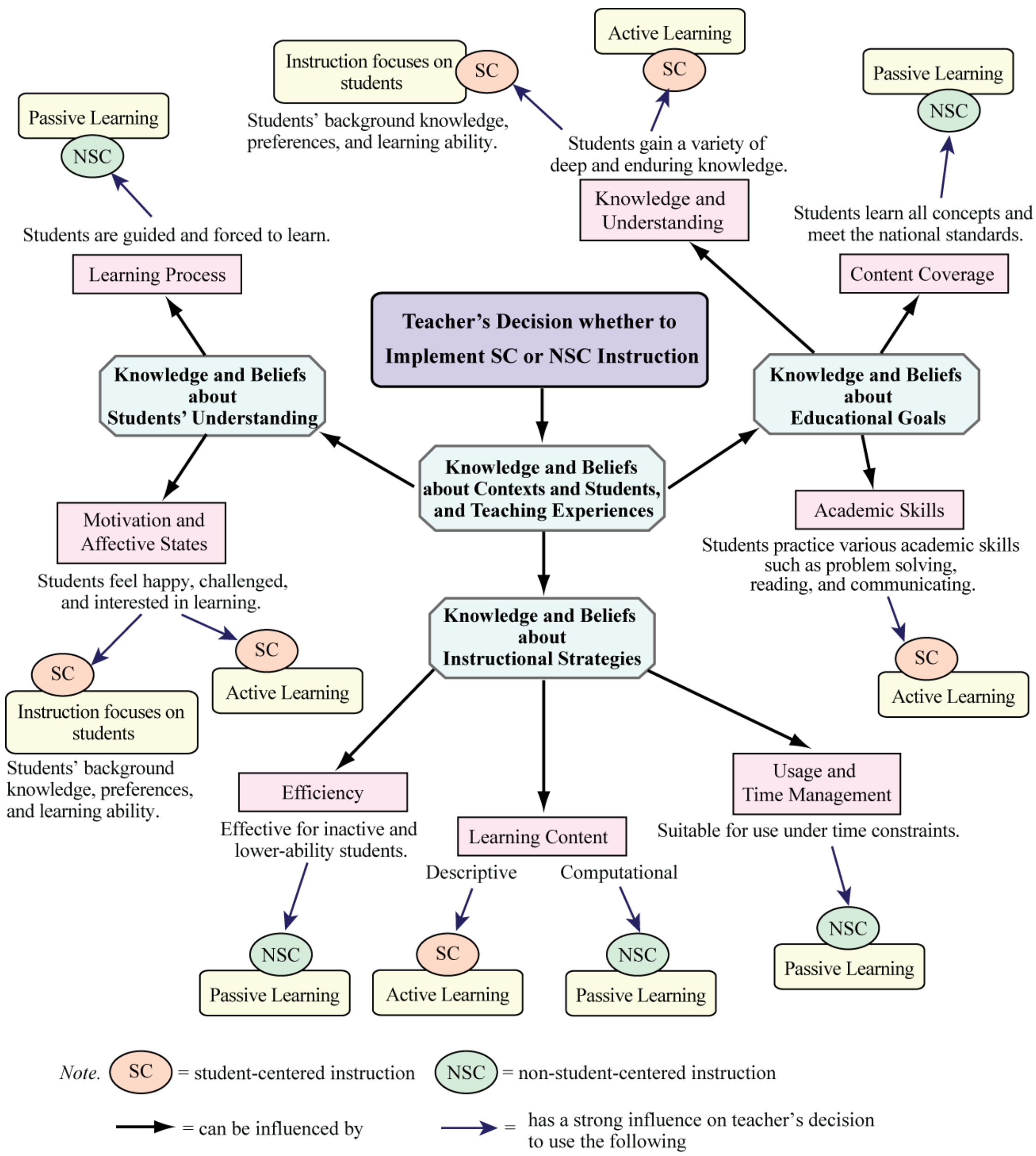


Figure 5.3. Model of factors influencing the implementation of student-centered and non-student-centered instructions.

was ineffective for their students because their students were inactive and/or had low self-learning capability. On the other hand, they believed that it would be suitable to use student-centered instruction with more advanced students or students in urban schools. Mook's case also illustrated the effect of her teaching experiences on her decision not to implement student-centered instruction in her classroom; during the interviews, she frequently mentioned that she did not want to use student-centered instruction because she had a past negative experience with the implementation of the approach. Moreover, teachers' perception of their role as a teacher also affected their practices. Since they believed that they had to teach all learning concepts to help their students meet the national standards, they employed the non-student-centered teaching approach more often.

Teacher's knowledge and beliefs about students' understanding. The second component, teachers' knowledge and beliefs about students' understanding, involves two elements: (a) students' learning process and (b) students' motivation and affective states.

Students' learning process. In terms of the learning process, all four teachers believed that non-student-centered instruction guided and forced students to learn more than student-centered instruction. For instance, Ploy pointed out that lecture required her students think her way. Mook shared the same idea about the strength of lecture by saying that at least, her students were "forced" to learn something. Similarly, Yord noted that by using lecture, he could control the students' learning process and choose appropriate examples to engage his students. He also pointed out that his students would be able to make more sense of the examples given by him compared to the examples presented by their peers.

Students' motivation and affective states. All four teachers believed that student-centered instruction made their students feel happier, more challenged, and more interested in learning than non-student-centered instruction. Gorn said that if the learning activities matched with students' learning capability, his students would feel "challenged" to complete the learning tasks. Additionally, he mentioned he could hear "students laughing" in the student-centered classroom indicating they were enjoying the learning activities. Yord noted that his students were "proud" of knowledge they obtained by themselves. On the other hand, three teachers, Ploy, Mook, and Gorn, stated that their students would not be motivated to learn in a non-student-centered classroom. For instance, Ploy mentioned that her students might not value what they learned from non-student-centered instruction because they would stop thinking and instead wait to be fed information by their teacher. Similar to Ploy, Gorn cited the weakness of lecture being that his students would stop studying on their own because they knew he would eventually give them the answers. Mook also mentioned that her students might be resistant to learning topics she required them to learn.

Teachers' knowledge and belief about instructional strategies. Teachers' knowledge and beliefs about instructional strategies involve three elements: (a) efficacy, (b) learning content, and (c) usage and time management.

Efficacy. In term of efficiency, all four teachers believed that non-student-centered instruction was more effective for their students than student-centered instruction. They gave three reasons to support their arguments: (a) their students were accustomed to copying others' work or being fed information by the teacher, (b) their students were "inactive" and unmotivated to complete a learning task, and (c) their students did not have enough knowledge and skill to complete assigned work on their own. Moreover, both Mook and Yord expressed the idea that their students did not need any student-centered instruction to learn. In addition, Mook believed that she did not have to implement experimentation because students learned the same concepts from the lecture that they would learn from experimentation. Similarly, Yord stressed that it was "not necessary" and "worthwhile" for his students to participate in some student-centered learning activities such as riding a bike, shooting a basketball, and kicking a ball.

In contrast to student-centered instruction, all four teachers believed that non-student-centered instruction was an effective way of teaching because it guided students to think the way the teachers planned. Ploy and Gorn also mentioned that it allowed them to help students instantly by directly answering their questions when problems arose. However, even though they believed that non-student-centered instruction was effective, both Gorn and Yord had concerns that non-student-centered instruction might not be as effective as they expected. For example, Gorn pointed out that his explanations might be too hard to understand by his students. Similarly, Yord mentioned that his students might not be able to follow his lecture.

Learning content. In terms of the learning content, three teachers, Ploy, Mook, and Gorn, preferred implementing student-centered instruction in their classroom when the subject matter was easier for their students to learn by themselves. They also said that they could use student-centered techniques when the subject matter did not involve complex computation. For instance, Ploy asked her students to study the concept of heat transfer on their own because her students had already learned this concept from a previous course. Mook pointed out that she would ask her students to independently study the topics of light, nuclear physics, and astronomy since they were able to make sense of these topics by themselves. Gorn also asked his students to read the textbook on the topics of generator, household appliances, and electrical safety because these topics did not involve complex computation.

Usage and time management. In term of usage and time management, all four teachers frequently stated that they can use non-student-centered instruction more easily and faster than student-centered instruction because they could control both the time and progress of instruction. For instance, Mook stated that by using non-student-centered instruction she could finish her lessons on time. Gorn also pointed out that by lecturing and giving guiding questions, he could have more time to provide additional information to his students if needed.

On the other hand, all four teachers mentioned that when they used student-centered instruction, they could not manage the instructional time effectively. For instance, Ploy noted that student-centered instruction "wasted" a lot of class time. Gorn also pointed out that experimentation was time consuming; however, he used reading comprehension to "save" his instructional time since his students could receive information faster than via lecture. In fact, all four teachers frequently cited time constraints as a main factor encouraging the implementation of non-student-centered instruction.

Teacher's knowledge and belief about educational goals. The fourth component, teachers' knowledge and beliefs about educational goals, involved three elements influencing how the teacher teaches. These elements included (a) knowledge and understanding, (b) academic skills, and (c) content coverage.

Knowledge and understanding. In term of knowledge and understanding, all four teachers believed that student-centered instruction was superior to non-student-centered instruction in three aspects. First, they stated that knowledge learned from student-centered instruction would be more “enduring” than from non-student-centered instruction. Second, all four teachers believed that students developed “a real understanding” through student-centered activities. Mook pointed out that, by actually conducting an experiment themselves, students would gain “a clear picture” of what the experiment in the textbook looks like. Gorn also mentioned that getting results from experiments makes students feel more confident that “the theory they learned is true.” Finally, they all stated that students would obtain a wider variety of information through student-centered instruction compared to non-student-centered instruction. Gorn mentioned that student-centered learning activities allowed his students to think “creatively,” “differently,” and “openly,” while lecturing limited students’ creative thinking. He also believed that his students could learn things from experimentation that could not be learned through lecture such as learning from mistakes, learning lab equipment usage, and improving safety management skills.

Academic skills. In term of academic skills, all four teachers believed that student-centered instruction allowed students to learn and practice a variety of academic skills compared to non-student-centered instruction. For instance, Ploy mentioned that she used student-centered instruction to foster students’ academic skills such as problem solving, researching, and even socializing. Gorn also stated that his students could practice various skills from student-centered learning activities such as public speaking, reading comprehension, and listening skills. Yord pointed out that by letting students conduct experiments, they would more confident conducting the experiment in the future.

Content coverage. In terms of content coverage, all four teachers pointed out that students learned all essential concepts required to meet the national science standards through non-student instruction where, in student-centered instruction, this is not necessarily so. For instance, Gorn pointed out that, through lecture, his students would have the same interpretation and the same understanding of the topics as him. Yord emphasized that the lecture gave his students a chance to learn ideas “correctly” and that by using lecture, his students would gain enough knowledge and skill to pass the national examination. In contrast to non-student-centered instruction, Yord worried that students engaged in discussion with other students might misunderstand the topic and miss the chance to learn correct ideas and approaches.

Assessment

Research question 1: What are Thai physics teachers’ conceptions of the student-centered approach (assessment)?

This cross-case analysis revealed that the four participating teachers held varied views about student-centered assessment. Their views could be classified into three main categories: (a) students’ active vs. passive participation, (b) emphasis on vs. non-emphasis on students, and (c) benefits vs. non-benefits to students. Table 5.3 summarizes key characteristics of student-centered and non-student-centered assessments stated by the participants.

Table 5.3

Thai High School Physics Teachers' Conceptions of Student-Centered and Non-Student-Centered Assessments

Main Category	Characteristic	
	Student-centered assessment	Non-student-centered assessment
1	Students' active participation: - Students design and conduct evaluation. - Teacher assesses things done by the students.	Students' passive participation: - Teacher designs and conducts evaluation.
2	Special Emphasis on students: - Real score evaluation; students are evaluated on their work performance. - Students are evaluated through multiple assessment tasks. - Students are assessed based on their individual learning capability. - Evaluation difficulty is based on students' learning capability. - Every student is assessed the same way. - Students agree with the evaluation results. - Test questions address only what students have learned in class.	Little emphasis on students: - Helping score evaluation; students are evaluated on timeliness. - Students are evaluated through one written test. - Every student is assessed the same way. - Evaluation difficulty is based on a standard assessment. - Students are assessed based on teacher's preference. - Students do not agree with the evaluation results.
3	Benefits to students: - Students have a chance to improve themselves through retests or remedial exams. - Test questions are open-ended, encouraging students to think creatively.	Non-benefits to students: - Students do not have a chance to improve themselves. - Test questions are close-ended and have pre-determined answers.

Category 1: Students' active vs. passive participation. Regarding the first category, this study found two ideas about the student-centered assessment. These ideas emerged from two different focuses including (a) evaluators, and (b) sources.

Evaluators. Three teachers, Mook, Gorn, and Yord, pointed out that, in the student-centered approach, the students played the central role in creating the evaluations assessing themselves and their peers. For instance, Gorn and Yord stated a student-centered assessment would allow their students to construct the assessment materials including test questions and solutions. Both Mook and Gorn also shared the idea that peer assessment was a student-centered activity because students participated in making the evaluation. However, Yord held a differing view; While Yord saw self-assessment as student-centered, he characterized peer assessment as non-student-centered, because "other people make the evaluation. [The students] do not evaluate themselves."

In contrast to student-centered assessment, Mook, Gorn, and Yord believed that non-student-centered assessment was assessment where the teacher, not the students, had control over content. According to Mook, "It is the teacher's assessment." Similarly, Gorn stated that he was the one who determined how to evaluate students' learning such as constructing questions, determining how to correctly answer the questions, grading, and deciding test length and scope. In addition to agreeing with Gorn's view of non-student-centered assessment, Yord also mentioned that preventing student cheating during the exam was "teacher-centered" because "[t]he teacher doesn't want the students to cheat by copying each others' answers."

Mook and Gorn held two different views on reporting students' evaluation results. On one hand, Gorn viewed test score reporting as student-centered because it encouraged his students to improve and prepare themselves for the next evaluation. On the other hand, Mook believed that reporting the accumulative in-class scores were "teacher-centered because the teacher was the one who assumed that students would look at these scores and then make a plan for the final exam."

Sources. All four teachers believed that, in student-centered assessment, the teacher assessed students' tasks demonstrating their understanding. For instance, Ploy stated that both pretests, tests given before studying a topic to gauge previous knowledge, and posttests, tests given after studying a topic to gauge knowledge gained, were student-centered because students used their own understanding and abilities to complete them. Similarly, Gorn described the discussion and test after reading comprehension as student-centered because these two activities gave his students the chance to express their knowledge and ideas. Mook pointed out that problem solving exercises were student-centered because, "[the students] think own their own without teacher training."

Category 2: Special vs. little emphasis on students. Based on the interviews, all four teachers expressed various individual views when describing student-centered and non-student-centered assessment in the second category (whether assessment placed special emphasis on students or not).

Ploy pointed out that the "real" scoring, in which students were graded solely on quality, was student-centered while the "helping" scoring, in which students earned more points for turning in assignments on time regardless of quality, was non-student-centered. She believed that giving real scores based on work performance was student-centered because it reflected students' true understanding. According to her, the non-student-centered teacher would employ helping scoring to raise students' in-class scores.

Mook pointed out that in the student-centered classroom, students would demonstrate their understanding through various tasks such as making presentations in front of the class, writing reports, and constructing mind maps. On the other hand, she mentioned that in non-student-centered assessment, the teacher would evaluate students' understanding by solely using the written examination at the end of the learning unit.

Gorn believed that student-centered evaluation would be based on the students' individual learning capability likened his idea to special assessment for students with learning disabilities. In contrast, as he mentioned, students' learning capability and progress would not be taken into consideration in non-student-centered assessment.

Yord presented four unique ideas about student-centered assessment. First, he pointed out that the evaluation would be student-centered if his students agreed with their assessment scores. Second, and at odds with Gorn, he believed that, in student-centered assessment, every student would be evaluated in the same way. Yord stressed, "[I]f they performed the same, they would get the same score." Third, he pointed out that the questions in a student-centered assessment would only ask about what students had learned in the classroom rather than asking students to speculate. Finally, now similar to Gorn, he believed that the grading system, score ratio, and test questions would be based on students' learning capability in student-centered assessment. For instance, he explained that in student-centered assessment, the teacher would administer a less difficult evaluation if the students had less learning capability and a more difficult assessment for more advanced students.

Category 3: Benefits to vs. non-benefits to students. Gorn gave two personal ideas about student-centered assessment when he looked at the benefits of assessment. First, he believed that asking students to do a retest if needed due to underperformance was student-centered because it assessed students' real understanding. He added that, since his students were not ready for the first test, "The results can be considered an anomaly." He also pointed out that employing a remedial exam for students who failed the first test was student-centered assessment because it gave these students a chance to improve themselves. Second, he mentioned that a student-centered test would consist of open-ended questions. He stressed, when answering the open-ended questions, the students would use higher level thinking. Accordingly, close-ended test questions were non-student-centered because "[t]he way to answer these questions is fixed."

Research question 2: What are Thai physics teachers' perceptions of their classroom practices in relation to their conceptions of the student-centered approach (assessment)?

When they talked about the sources to be evaluated, all four teachers frequently described their practices as student-centered assessment because they saw their students as the primary actors constructing what to be assessed. In addition, they believed that their classroom practices were student-centered because they evaluated students' understanding through students' notes, classroom presentations, and answers to their exercise and test questions.

When looking at the evaluator, Mook, Gorn, and Yord stated that their classroom practices were non-student-centered because they were the ones who decided what to assess and how to use the results of assessment. However, even though Gorn viewed most of his evaluation practices as non-student-centered, he implemented some student-centered assessment activities where his students became the evaluators. These activities included students constructing test questions and peer evaluation.

In addition to two aspects of assessment mentioned above, the participating teachers perceived their own classroom practices differently based on their own perspectives. In addition, Ploy admitted that her practices were non-student-centered because she evaluated her students using the “helping” score technique. Mook viewed her practices as being non-student-centered because students’ in-class scores were based solely on the written test at the end of the observed unit. Gorn stated that his practices were both student-centered and non-student-centered. On one hand, he believed his assessment was student-centered because he administered retests and remedial exams in his classroom for lower level students. On the other hand, the reading tests and the test at the end of the observed unit were non-student-centered because all questions were close-ended. Yord gave four reasons why he viewed his practices as student-centered: (a) his students agreed with their test results, (b) he used the same evaluation for every student, (c) the test questions confined to what he taught in the classroom, and (d) his grading system catered to his students’ learning capability.

Research question 3: What reasons do Thai physics teachers give for supporting or opposing the implementation of student-centered practices in their own classroom?

Figure 5.4 provides a model for how teachers view the implementation of student-centered assessment. The model consists of two components: knowledge and beliefs

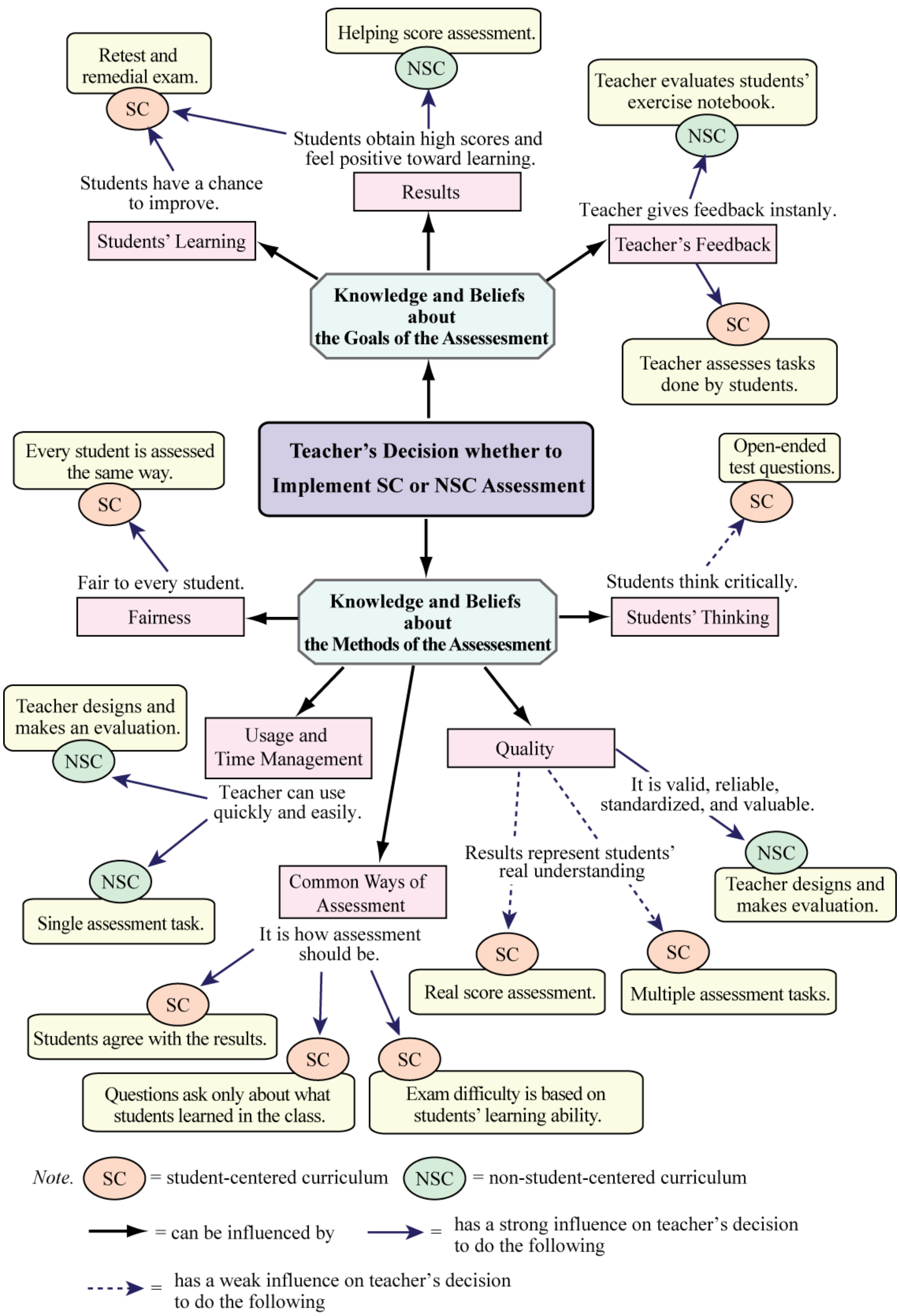


Figure 5.4. Model of factors influencing the implementation of student-centered and non-student-centered assessments.

about the goals of assessment, and knowledge and beliefs about the methods of assessment.

Knowledge and beliefs about the goals of assessment. The first component, knowledge and beliefs about the goals of assessment, had three subcomponents: (a) students' learning, (b) results, and (c) teacher feedback.

Students' learning. In terms of students' learning, Gorn mentioned that he administrated retests and remedial exams because he wanted his students to have a chance to improve themselves.

Results. Ploy used "helping" score evaluation strategy because she did not want her students to have low scores and/or fail. She also pointed out that, by using this strategy, her students would feel "positive feelings" toward learning physics. Gorn also mentioned that he decided to administer retests because the results of the earlier test did not represent the students' "real understanding."

Allowing the teacher to provide feedback. Mook and Gorn talked about the opportunity to provide students with feedback from different perspectives. Mook pointed out that she preferred using student-centered assessment by asking her students to present their exercise solutions in front of the class because she could "give them the feedback instantly." In contrast, Gorn pointed out that he tended to employ non-student-centered assessment by evaluating students' exercise solutions on this own because he could write comments and feedback in students' exercise books.

Knowledge and beliefs about the methods of assessment. The second component, knowledge and beliefs about the methods of assessment, involved five elements including (a) fairness, (b) usage and time management, (c) common forms of assessment, (d) quality, and (e) students' thinking.

Fairness. Yord preferred using student-centered assessment, in which every student was assessed the same way, because it was fair to every student.

Usage and time management. Regarding usage and time management, all four teachers used non-student-centered assessment in which the evaluation was made by the teacher because it was easier and faster to use. Moreover, Mook mentioned that she preferred using a single assessment task rather than multiple assessment tasks because it was a more convenient way. She confessed that she did not want to ask her students to complete multiple assessment tasks because she did not want to face difficulties like constructing a rubric for assessment, listening to students' presentations, and reading students' reports.

Common forms of assessment. Yord pointed out that he employed student-centered assessment because it was a common form of assessment. In addition, he believed that assessment should be based on students' learning capability, only cover what he taught in the classroom, and take students' acceptance of the assessment results into consideration.

Quality. Two teachers, Gorn, and Yord, postulated that an exam made by the teacher would be more valid, reliable, and standardized than an exam made by the students. For instance, Gorn pointed out that students might cheat to upgrade their peers' test scores. Also, test questions constructed by his students were often too easy and sometimes incomprehensible. In contrast, test questions created by the teacher would be “comprehensive” and “meet the standards.” Similarly, Yord pointed out that an assessment where students evaluated themselves would not be “valid and reliable.” He explained, “If I let them evaluate themselves, they will give themselves a four [A] grade.” He also mentioned that, unlike teacher evaluation, peer evaluation was unreliable because students “might not have any standardized criteria in the evaluation”.

However, Ploy and Mook, pointed out that the results of student-centered assessment would represent real students’ understanding more accurately than the results of non-student-centered assessment. Additionally, despite her use of the “helping” technique, Ploy noted that “real” score evaluation was superior because the results could differentiate the level of understanding among students. Mook believed that assessing students from multiple assessment tasks was a better way to evaluate real understanding. However, it is important to note that the representation of students’ understanding did not have a strong influence on both Ploy and Mook’s practices in their classrooms.

Students’ thinking. Gorn preferred using more difficult, open-ended or student-centered test questions to promote students’ creativity and higher order thinking. However, this element had a weak influence on his practices since he did not actually use the open-ended test format in his classroom.

Teachers’ Reflections on the Student-Centered Educational Reform Movement

Research question 4: What are Thai Physics teachers’ reflections on the student-centered educational reform movement in relation to their conceptions of the student-centered approach?

This cross-case analysis showed that teachers' reflections on the student-centered educational reform movement could be grouped into three categories: (a) positive, (b) neutral, and (c) negative reflections.

Positive reflections. Ploy, Mook, and Gorn expressed support for the student-centered educational reform movement. Ploy believed that the student-centered approach would teach her students to learn independently and enable them to solve real world problems on their own. Mook commented that the student-centered approach would be good for her students if it was, "promoted the right way." Gorn supported the implementation of the student-centered approach because it would encourage his students to think creatively. He also stressed that each student should be taught based on their learning capability. He said, "Everyone is born with different levels of ability so making all of them accomplish the same thing within the same period of time is impossible."

Neutral reflections. In contrast to the other three teachers, Yord neither supported nor opposed the student-centered educational reform movement. He commented, "[the student-centered reform movement] is just a foreign theory that has both strengths and weaknesses. I do not care so much about it." He also believed that the promotion of the student-centered approach was a, "psychological strategy" to promote the implementation of experimentation in the classroom.

Negative reflections. In addition to their positive reflections, Mook and Gorn joined Yord in expressing concerns regarding the student-centered educational reform movement. Mook mentioned that many teachers still did not have "a clear picture" of what the student-centered approach was and confessed that she herself did not understand why she had been asked to employ the 5-E learning model in every lesson. Gorn said that it was “too early” for widespread implementation of the student-centered approach in real classrooms. He was concerned that, even using the student-centered approach, many students still, “lack the motivation and willingness to learn.” Yord also asserted that the student-centered approach was not suitable for his students for three reasons. First, instruction could not be student-centered because high school students had to learn “fundamental knowledge” before discovering “new knowledge”. Because of this, it was not appropriate for high school students to conduct new research studies. Second, the student-centered approach minimized students’ chances of learning from diverse activities. He stated that students should learn through varied learning activities rather than through only experimentation. Third, some subjects, such as electromagnetism, could not be taught by student-centered instruction because the students could not realistically conduct an experiment addressing it. Yord recommended that, in order to succeed in the promotion of the student-centered approach, the school should offer high school students a lab-based physics course to complement the current lecture-based physics course. Furthermore, Yord would like to define the student-centered approach differently. He believed that the student-centered approach should be promoted as a way to facilitate and improve students’ learning experience rather than as a way to let students discover new knowledge or conduct new research on their own.

Summary

The data analysis reveled that there were three main characteristics shared across student-centered curriculum, instruction, and assessment (as shown in Figure 5.5). These characteristics included (a) students' active participation, (b) special emphasis on students, and (c) benefits to students.

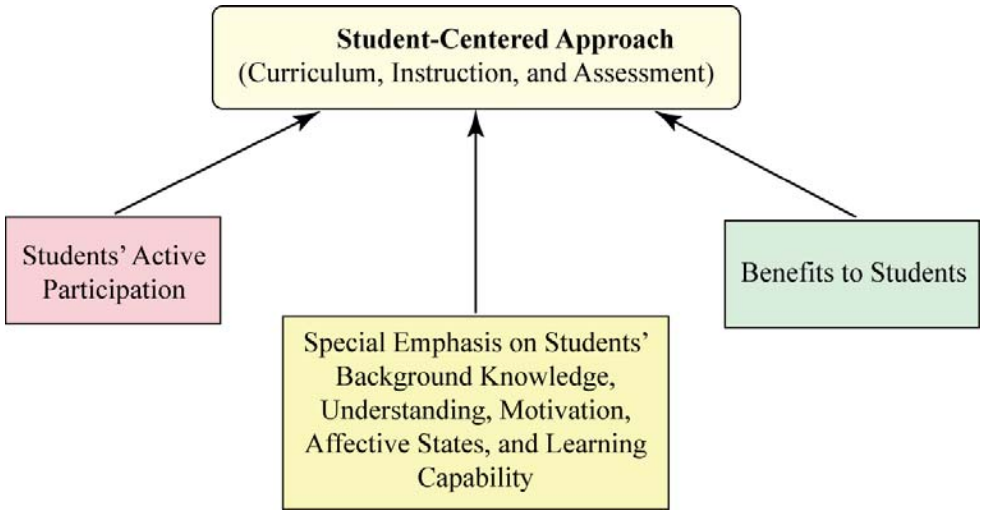


Figure 5.5. Main characteristics of the student-centered approach.

Regarding the first characteristic, all four teachers believed that in the student-centered classroom, students would participate in active learning activities. Examples of these activities included designing the content of curriculum, searching knowledge on their own, reading the textbook, conducting an experiment, solving exercise problems, teaching each others, constructing assessment tools, and assessing either themselves or others. In contrast, they stated that the non-student-centered approach involved an activity where students played passive role in the learning process such as learning based on the textbook, listening to teacher's lecture, and being evaluated by the teacher.

Regarding the second characteristic, the participating teachers frequently pointed out that the student-centered approach involved learning activities where students' background knowledge, understanding, motivation, affective states, and learning capability were taken into special consideration. Examples of these activities included class discussion, review, real score evaluation, and multiple-task assessment. On the contrary, the non-student-centered teacher would implement learning activities without considering those factors. Based on this perspective, examples of non-student-centered teaching strategies include forcing students to bring the textbook and notebook to the classroom, coercing students to solve the problem when they do not want to do so, and using only one written test at the end of the learning unit.

The last characteristic of the student-centered approach referred to learning activities which causes benefits to the students. This characteristic was mentioned by two teachers, Gorn and Yord. Gorn was the only teacher who talked about this characteristic across all three aspects of education (curriculum, instruction, and assessment). According to him, the student-centered teacher would teach students the concept they need to know for their daily life, force them to bring the textbook to the classroom, and use open-ended test questions to stimulate students' creativity. Yord looked at the benefits to his students when he characterized his instructional practices. He believed that giving students a punishment, using various instructional activities, and telling students the keywords to be highlighted were examples of student-centered teaching strategies because these activities enhanced students' learning process.

Figure 5.6 presents a model summarizing teachers' decisions to implement the student-centered and non-student-centered approaches. Based on the interviews, all four teachers perceived their actual classroom practices as being mixed between student-centered and non-student-centered approaches. In regard to their conceptions of the non-student-centered approach, they believed that they used non-student-centered curriculum in their actual classroom because it was based on their decisions and the IPST textbook rather than their students' decisions. They also viewed their lecture and problem solving demonstration as being non-student-centered because students received information passively from the teacher. Moreover, they perceived their assessment has a characteristic of the non-student-centered approach because they, as teachers, had the control over the assessment questions, the scope of the evaluation, and evaluation methods. They gave four main reasons for supporting the use of these non-student-centered learning/teaching activities. These reasons included (a) they, as teachers, could implement these activities in the classroom quickly and easily; (b) their students would be able to learn all essential content and meet the standards; c) their students would be forced and guided to learn; and d) most of their students who were in-active and low-achievement could learn effectively through these non-student-centered activities.

In addition to non-student-centered activities, the participating teachers also mentioned that they had implemented some student-centered activities in their actual classroom. The examples of the student-centered activities included problem solving exercise, discussion, experimentation, reading, and homework. They also viewed their assessment based on the products of these activities as being student-centered. According to the interviews, there were three main reasons fostering the implementation of these activities. First, they believed that students who participated in student-centered activities would gain an in-depth and enduring understanding. Second, based on their perspective, student-centered activities would allow their students to practice variety of academic skills such as reading, summarizing, analyzing, public speaking, observation, and especially problem solving skills. Finally, by using the student-centered approach, students would be happy, engaged, and motivated to learn.

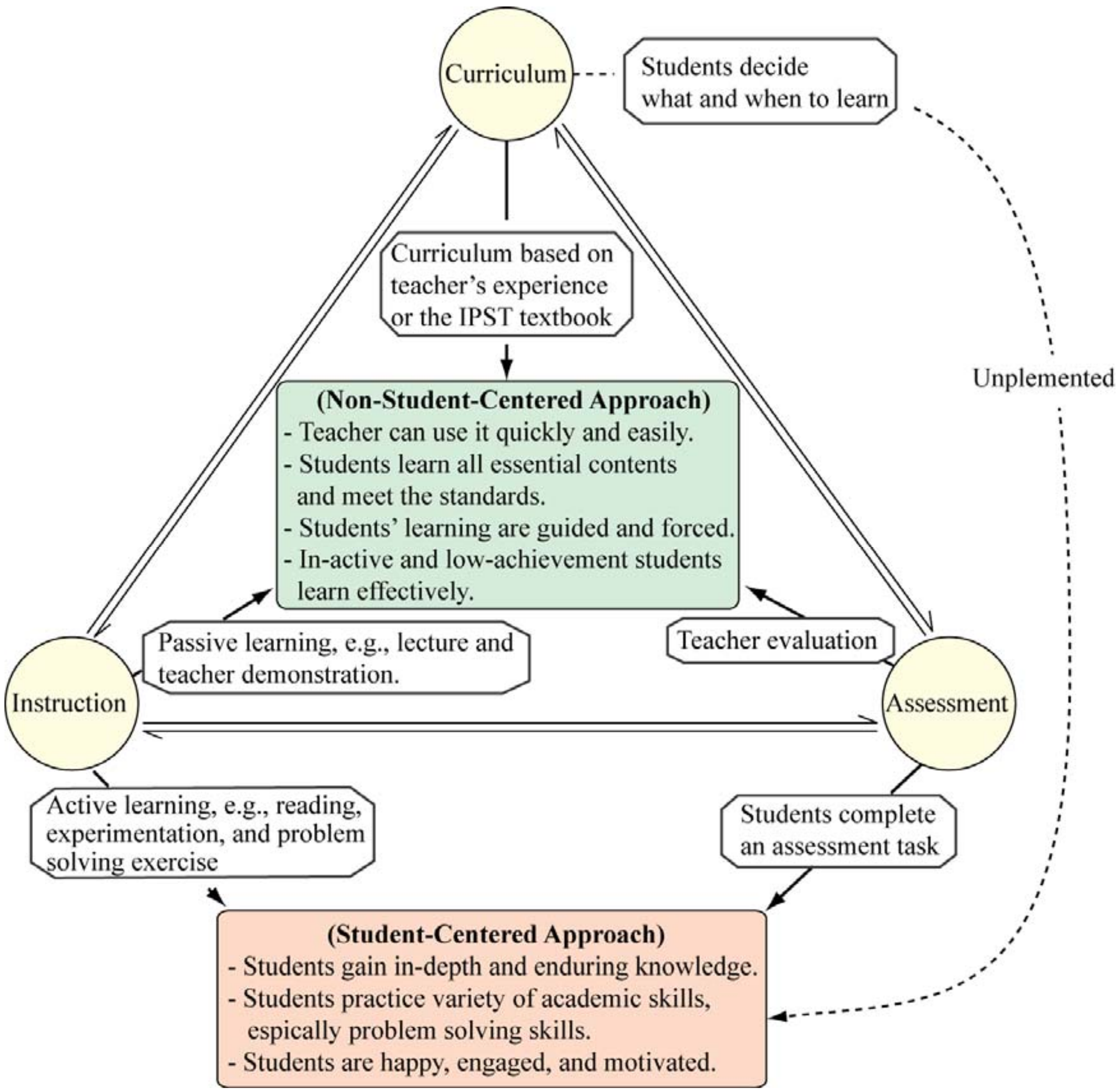


Figure 5.6. Teachers' decisions to implement the student-centered and non-student-centered approaches.

CHAPTER SIX

DISCUSSION AND IMPLICATIONS

As an orchid takes a long time to blossom, so education requires time to flourish.
But once in bloom, it is glorious and can be admired by all.
Mom Luang Pin Malakul
Translated by UNESCO (2007)

This study found that Thai high school physics teachers held various views about the student-centered approach and their actual practices. The interview data also suggested that they had a variety of reasons for implementing or not implementing their conceptions of the student-centered approach in their actual practices. This chapter aims to discuss how these results related to the literature and previous research studies on student-centered teaching, and suggest implications for researchers, science educators, and professional development providers to successfully promote the implementation of the reform-based, student-centered approach.

Discussion

This section discusses four Thai high school physics teachers' conceptions of the student-centered and non-student-centered approaches, how they perceived their classroom practices, and what reasons they gave for implementing or not implementing their conceptions of the student-centered approach in their actual classroom. In addition, the focus of the discussion is to compare the findings with the literature on the student-centered education and research studies on teacher's knowledge, beliefs, and their classroom practices. It also aims to provide empirical evidence to enrich the existing literature and research studies.

The current study found that there were various forms of the student-centered approach in teachers' actual classroom practices. These forms had at least one of the following characteristics: (a) students' active participation, (b) special emphasis on students' background knowledge, understanding, motivation, affective states, and learning capability, and (c) benefits to students. These characteristics were shared across all three aspects of education: curriculum, instruction, and assessment. This result was consistent with Pellegrino's (2006) assumption. However, for the purpose of the present study, the discussion of this section is divided into three parts: (a) curriculum, (b) instruction, and (c) assessment.

Teachers' Conceptions of Student-Centered Curriculum

The findings of this study reveal that all four teachers categorized their curriculum as student-centered or non-student-centered by looking at who was the primary curriculum developer. They believed that student-centered curriculum was that which was constructed and developed by the students in order to match the students' interests and needs, while non-student-centered curriculum was that which was designed by the teacher and was based on the teacher's experiences or the IPST textbook. Based on this view, they pointed out that student-centered curriculum would not cover all essential content and would not meet the national science standards, but using non-student-centered curriculum would allow their students to learn all concepts in the national science standards at an appropriate pace. These findings are inconsistent with the appropriate conceptions of student-centered curriculum suggested by the literature (APA, 1997; Fry, 2002; Finley, 2000; McCombs & Miller (2007), which states that student-centered curriculum could be designed by the teacher and be based on science textbooks and stresses that student-centered curriculum must meet the national standards.

This study found two ideas about student-centered curriculum that resonated with the student-centered literature. The first idea was held by Gorn who believed that curriculum allowing students to learn things they “don’t already know” and “need to know” was student-centered even though it was based on the teacher or IPST textbook. His idea is similar to an underlying principle of the student-centered approach: student-centered curriculum takes students’ prior knowledge and needs into account (APA, 1997; ONEC, 2000, 2003). The second idea was found in Yord’s case. He believed that student-centered curriculum was any curriculum in which the teacher implemented student-centered instruction. This idea is analogous to Pellegrino’s (2006) idea that all three educational aspects, including curriculum, instruction, and assessment, are connected and interrelated with each other. Based on this view, in order to succeed in the implementation of the student-centered approach, these three aspects of education have to be student-centered. However, Yord still had some misunderstandings about student-centered instruction. Thus, instruction he perceived as being student-centered might be described by the educational reformers as being non-student-centered. These misunderstandings will be discussed in the next section.

The findings of this study also illustrate that there is inconsistency between what teachers believed they should do as a student-centered teacher and what they had to do as a good teacher. All four teachers in this study generally made a decision about what and when to teach by employing an approach perceived by them as the non-student-centered approach rather than the student-centered approach. In addition, they preferred using non-student-centered curriculum because it was easier for them use and allowed their students to meet the science standards more than student-centered curriculum.

Teachers' Conceptions of Student-Centered Instruction

This study provides empirical evidence illustrating the similarities and differences between Thai physics teachers' conceptions of student-centered instruction and the appropriate conceptions of student-centered instruction recommended by the student-centered literature. The results of this study show that the participating teachers' conceptions of student-centered instruction are closely aligned with the underlying principles of the student-centered approach suggested in the literature in three aspects. First, all four teachers believed that a defining characteristic of student-centered instruction was that students would be active in the learning process, while in non-student centered-instruction students were passive recipients of information. Second, all four teachers in this study believed that the student-centered teacher would encourage his or her students to apply knowledge they learned to solve exercise problems. In other words, they usually viewed problem solving exercise activities as being student-centered. Third, the participating teachers thought that the student-centered teacher would design instruction to address students' prior knowledge and experience, preferences, and learning capability.

Though the participating teachers' conceptions of student-centered instruction are, on the whole, closely aligned with the literature, there are four aspects of these teachers' conceptions that were identified as misunderstandings of student-centered instruction.

These aspects are: (a) active learning, (b) lecture and students' interpretations, (c) teacher's role, and (d) effectiveness and students' learning capability.

Active learning. The first misunderstanding commonly held by the participating teachers is that active learning is always student-centered. They frequently stated that active learning activities, such as conducting an experiment, reading textbooks, and gathering information from the internet were student-centered. The findings of this study are similar to those reported by Fry (2002). However, constructivists would perceive all of these activities, though active, as being non-student-centered if the teacher did not pay attention to students' interpretations of the information they obtained. In addition, the constructivist learning theory placed special emphasis on students' mental process rather than physical action. Both constructivists and conceptual change theories suggested that the student-centered teacher would encourage students to examine their current conceptions, verify all possible conceptions, and accommodate the scientifically accepted conceptions (e.g., Posner et al., 1982). Based on this view, the student-centered teacher would carefully pay attention to what prior knowledge and experiences students bring to the classroom and how students use that knowledge and experiences to interpret information presented in the classroom. Similarly, instead of focusing on physical action, Bransford et al. (2000) described active learning by emphasizing the importance of mental action. The authors also stressed that active learning involved an activity in which students metacognitively monitor their own learning.

Furthermore, based on the constructivist perspective, some active learning activities are non-student-centered if these activities do not aim to promote students' learning. As a result, the learning activities mentioned by Yord as being student-centered such as riding a bike, kicking a football, or shooting a basketball would be classified by constructivists as being non-student-centered because it was not necessary for the students to participate in these activities. In addition, he believed that his students should spend more time on learning the concepts related to these activities rather than actually doing these actions during the class period since they had already did these from their daily lives.

Lecture and students' interpretation. The second misunderstanding about student-centered instruction held by the participating teachers is that lecture is always non-student-centered while other active learning activities such as reading comprehension, information searching, discussion, review, and experimentation are always student-centered. All four teachers in this study believed that knowledge was directly transferred from the teacher to the students through a lecture while knowledge was constructed by the students during these active learning activities. This view is different from the constructivist perspective since constructivists focus more on how students interpret information they have rather than how students obtain information (e.g., Bransford et al., 2000; Gunstone, 2000; Posner et al., 1982). Additionally, constructivists believed that learning by reading the textbook, by gathering information from the internet, and by conducting an experiment could be viewed the same as learning through the lecture. Constructivists also believed that when students participated in theses activities, these students still constructed their own understanding. For instance, Bransford et al. (2000) noted, "[E]ven listening to a lecture involves active attempts to construct new knowledge" (p.11). These authors also pointed out that a lecture can become a constructivist student-centered teaching method. They emphasized, "Nevertheless, there are times, usually after people have first grappled with issues on their own, that 'teaching by telling' can work extremely well" (p.11). A similar view was expressed by one of the Thai educational reformers mentioned in the report of Atagi (2002). This person said, "The NEA [National Education Act] says 'learners are most important' meaning that teachers should choose appropriate instructional modes for [the] students' sake. For certain content, lecture is most appropriate. That's still 'learner-centered'" (p.53).

In the constructivist perspective, the distinction between student-centered and non-student-centered instruction is that student-centered instruction places a special emphasis on students' interpretations of the information they receive. Constructivists suggested that student-centered learning activities would aim to elicit student's interpretation and helping students to correct their interpretation through four stages of conceptual change process: (a) feeling dissatisfaction of the current concept, (b) being able to understand the new concepts, (c) recognizing the plausibility of the new concepts, and (d) seeing the usefulness of the new concepts (Posner et al., 1982). In contrast, non-student-centered instruction does not take students' interpretation into consideration because knowledge could directly transfer from the knowledge sources to students (e.g., Cuban, 1990, 1993; Jackson, 1986).

This study found that the participating teachers tended to implement what they perceived as a student-centered learning activity without carefully examining students' interpretation. These teachers seemed to think that their students would receive the information completely and correctly when they read the textbook, gather information from the internet, discuss with their peers, conduct an experiment, and listen to teacher's explanation. Even though Gorn and Yord recognized that their students could form misinterpretations from these student-centered learning activities, they avoided asking their students to express these misinterpretations and directly gave a correct explanation to these students at the end of these learning activities. Thus, their beliefs were majorly dominated by the view of learning as knowledge acquisition.

Teacher's role. The third misunderstanding held by the teachers comes from their minimization of the teacher's role in the student-centered classroom. For instance, Ploy mentioned that in the student-centered classroom, students would study alone without their teacher around. Yord noted that the learning activities such as a discussion between students and teacher or a demonstration by the teacher were always non-student-centered because the teacher was involved. The idea of teacher non-involvement was identified by Finley (2000) and Fry (2002) as a misunderstanding of student-centered instruction. In addition, Fry (2002) stressed that, contrary to this misunderstanding, the student-centered teacher would have an even more significant role in helping students learning.

Moreover, even though the literature on student-centered education suggests that any learning activity aiming to facilitate students' learning was student-centered, the teachers in this study reported some confusion about whether a learning process facilitated by the teacher was student-centered or not. Yord's case is a good illustration of the confusion over his conception of student-centered instruction and what he thought as the one preferred and recommended by Thai educational reformers. In many interviews, he directly stressed that his definition of student-centered instruction was different from those being promoted. For him, student-centered instruction included any instructional activities aimed to make “students gain knowledge and understanding as much as possible.” This idea is congruent with the appropriate conceptions of student-centered instruction suggested by the student-centered reformers (e.g., APA, 1997; Finley 2000; Fry, 2002). However, when Yord talked about student-centered instruction suggested by Thai student-centered reformers, he expressed a different notion that students would “have to find knowledge on their own” without any teacher’s guidance and help.

Furthermore, three teachers in this study (Ploy, Mook, and Yord) usually viewed the problem solving demonstration given by the teacher as being non-student-centered, even though they realized that the demonstration could help their students to learn how to solve exercise problems. This understanding is different from the notions of student-centered instruction mentioned in the literature. Based on Vygotsky's (1978) notion of the zone of proximal development, teacher’s demonstrations could be one type of student-centered learning activities. He suggested that the teacher should provide appropriate scaffolds for students to help them learn to accomplish tasks beyond their current capability. Nevertheless, giving too much scaffolding by the teacher can cause negative effects; students may stop thinking and stop trying to learn to solve the problem on their own. As a result, based on this view, the student-centered teacher should know when to give their students demonstrations and when to ask their students to learn to solve the problem on their own. This notion is congruent with Ploy, Mook, and Gorn’s views about teacher demonstration in some aspects. For instance, Ploy thought that letting her students to solve exercise problems without her demonstration was student-centered because she knew that her students had enough knowledge and understanding to do it. Mook made her demonstration become more student-centered by asking her students to help her solve the demonstrated problem. Gorn described the demonstration by the teacher as being student-centered because it helped his students to know how to solve problems.

Effectiveness and students' learning capability. The fourth misunderstanding is that student-centered instruction is effective for high-achievement students but ineffective for low-achievement students. All four teachers in this study frequently mentioned that they did not want to adopt the student-centered approach since their students had low levels of both self-learning capability and motivation to learn. These findings are similar to other findings reported by Thai educational reformers (e.g., Atagi, 2002; Fry, 2002; Yokfar, 2005). They reported that Thai teachers had a tendency to think that their students were "too naïve" to learn on their own, like buffalos. As a result, many Thai teachers equated the term "student-centered" with "buffalo-centered" (Atagi, 2002; Yokfar, 2005). For instance, Yokfar (2005) reported that many Thai teachers became disillusioned and believed that student-centered instruction "won't work as the learners are too young to know what they want to learn and how to learn." (p. 11). This belief is contrary to the underlying principle of the student-centered approach that states that students have a potential to learn if they participate in learning activities matched with the level of their learning capability (APA, 1997; ONEC, 2000). Fry (2002) stressed that it was the teacher's job to find those activities that promote students' learning. Gorn was the only teacher in this study who recognized this idea. He agreed that if students were taught based on their learning capability, they would be motivated and able to learn. However, he stated that this could not be implemented in the real classroom due to the mixed variety of students' learning levels.

In addition to these four misunderstandings about student-centered instruction, the results of this study are also consistent with previous research studies showing that there is no simple link between teachers' conceptions of teaching and learning and their classroom practices (e.g., Kang & Wallace, 2004; Koballa et al. 2000; Mellado 1998; Tsai, 2002). This study found that even though the teachers perceived student-centered instruction as being effective for motivating their students to acquire variety of academic skills and to obtain an enduring knowledge, and viewed knowledge from non-student-centered instruction as not being permanent and in-depth, they still preferred using non-student-centered instruction as the main instructional activity in the classroom.

Furthermore, the findings of this study also support the recent studies on teachers' knowledge and beliefs influencing the use of the traditional instructional strategy or lecture. This study found that the participating teachers' use of lecture was influenced by four elements of their knowledge and beliefs. First, all teachers in this study believed that lecture was the best way to help students receive the knowledge they need to know. This result is similar to the report by Thanraksa (2003) which stated that one reason Thai teachers continue using lecture is that they see themselves as a "righteous guru" who possesses the knowledge and has to transfer that knowledge to the students (p.62). She also pointed out that Thai teachers frequently viewed the lecture as the best teaching strategy so they did not need to change the way they teach. Similarly, Tobin and McRobbie (1996) found that the Australian chemistry teacher, Mr. Jacobs, tended use lecture because he perceived his role as “a principal source of knowledge” and perceived his students’ role as “receivers of knowledge” (p.229).

Second, the participating teachers pointed out that they preferred using lecture over others instructional teaching strategies because it made they feel that they have taught something to their students. Additionally, they believed that their students learn something from the lecture rather than not learn anything from student-centered learning activities. This finding was also supported by the Chutima’s (2003) report. She noted that many Thai teachers and students preferred the lecture because it gave them evidence that the students have learned something.

Third, the participating teachers believed that lecture allowed their students to learn all key essential content and meet the standards. Tobin and McRobbie (1996) reported similar findings; Mr. Jacobs tended to use lecture because he view himself as a “guardian of the standards” (p.233). They also found that this teacher valued the content coverage as more important than learning with understanding.

Finally, the teachers in this study believed that lecture was an appropriate teaching strategy for their students under the constraints they faced such as limited time to teach, a heavy workload, and students with low self-learning capability. This result is congruent with the result obtained by Tobin and McRobbie’s study (1996). They reported that Mr. Jacobs tended to use lecture as the main instructional strategy to save his energy because he had a lot of school work and little time to prepare how to teach.

Teachers' Conceptions of Student-Centered Assessment

The teachers in this study explained their conceptions of student-centered assessment in terms of sources, evaluators, method of evaluation, variety of the assessment tasks, a chance for students' improvement, type of the test questions, individual differences, evaluation difficulty, fairness, students' acceptance, and the focus of the test questions. Among these various aspects of assessment, two common conceptions of student-centered assessment resonate with the appropriate conceptions suggested by the student-centered literature (APA, 1997; ONEC, 2000; McCombs & Miller 2007). The first appropriate conception is that student-centered assessment aims to examine students' real understanding through the products of student learning such as students' exercise solutions, exam answers, and homework should result from students' own understanding. The other assessment activities with this characteristic include real score evaluation strategies mentioned by Ploy, multiple assessment tasks mentioned by Mook, re-test mentioned by Gorn. These findings are consistent with those recommended in the student-centered literature; one of the main goals of student-centered assessment is to make an evaluation of students' real understanding and then provide meaningful feedback for their improvement (APA, 1997; Bransford et al. 2000; ONEC, 2000; McCombs & Miller 2007). However, the teachers in this study paid less attention to the use of the assessment results for facilitating students' learning and instead tended to use their assessment as a summative rather than a formative assessment. In addition, they had a tendency to ask their students to move on to a new learning topic after giving their students the evaluation results rather than helping students review and revise incorrect or incomplete ideas revealed in the assessment tasks. Thus, their view was slightly different from that recommended in the student-centered literature. Furthermore, one of the four teachers, Ploy, used the term “authentic assessment” in a slightly different meaning from the literature. For her, the authentic assessment refers to the evaluation strategies in which the teacher make an evaluation based on students’ work performance rather than their work submission. In contrast, the authentic assessment was frequently defined in the literature as the assessment in which the teacher examines students’ understanding through variety of assessment tasks in order to be as close as possible to the way students apply knowledge in real life (e.g., IPST, 2004; Stiggins, 1994; Wiggins, 1990, 1998).

Another appropriate conception of student-centered assessment is that the focus of student-centered assessment is to motivate and challenge students to complete the assessment tasks. Examples of student-centered assessment with this characteristic mentioned by the teachers in this study included evaluation elements made by the students such as the scope of assessment, the assessment questions, and the solutions to the assessment problems. The participating teachers pointed out that these elements were student-centered because they represented students' interests and curiosities. Moreover, Gorn also believed that retest and remedial exam, open-ended test questions, and assessment based on individual differences were student-centered because these assessing activities motivated his students to learn. Similarly, Yord mentioned that the assessment based on students’ learning capability, fairness, students’ acceptance, and what he taught in the classroom was student-centered because it enhanced students' motivation to learn. These findings are similar to the idea of student-centered assessment suggested by the student-centered literature that student-centered assessment tasks would be at an appropriate level which inspires, motivates, and encourages students to complete the tasks (APA, 1997; McCombs & Miller, 2007).

In addition to two appropriate conceptions mentioned above, the participating teachers' conceptions of student-centered assessment held by the participating teachers could be viewed by the educational reformer as inappropriate or incomplete conceptions in three aspects: (a) teacher's evaluation, (b) peer- and self-assessments, and (c) assessment quality.

Teacher's evaluation. The first inappropriate conception is that an evaluation made by the teacher is always non-student-centered even though this assessment may be beneficial to the students. The teachers in this study tended to characterize the assessment activities by focusing on the primary actors, whether students or teacher made the evaluation, rather than by the learning benefits to the students. For instance, three teachers, Mook, Gorn, and Yord, believed that the test questions constructed by the teacher were always non-student-centered even though these questions were more comprehensive, challenging, and meaningful than student-constructed questions. Gorn's case illustrates another example of this misunderstanding. He pointed out that evaluating students' works was non-student-centered even though it allowed him to write some feedback on students' workbook. This conception is contrast to the appropriate conceptions of student-centered assessment mentioned in the literature that states that the teacher still plays a key role in designing and administering student-centered assessment (e.g., Bransford et al., 2000; Finley, 2000; Fry, 2002). Bransford et al. (2000) stressed that "teacher-made tests" were still necessary in the effective learning environment.

Peer- and self- assessments. The second inappropriate conception is that both peer- and self-assessments are always student-centered. Based on the student-centered literature, peer assessment could be student-centered because it promotes students' motivation to learn and allows students to learn during assessment. Many student-centered educators recommended the implementation of peer- and self-assessments in the student-centered classroom (e.g., McCombs & Miller, 2007; Bransford et al. 2000). They pointed out that these assessments could be used to enhance students' metacognition such as self-appraisal, self-monitoring, self-evaluation, and self-directed skills. However, peer assessment could also be seen as being non-student-centered if it does not enhance students' learning or it encourages students to strengthen inappropriate behaviors such as cheating. Thus, the peer assessment mentioned by Gorn as being student-centered would be categorized as being non-student-centered because it made his students learn to cheat to increase their peers' score.

Assessment Quality. The third inappropriate conception is that student-centered assessment is not valid, reliable, standardized, and valuable. All four teachers in this study frequently mentioned that they preferred using non-student-centered assessment because its quality was higher than the quality of student-centered assessment. They believed that student-centered assessment focused more on addressing students' needs and interests rather than on ensuring the quality of assessment. However, based on the student-centered literature, student-centered assessment is not characteristically low quality (APA, 1997; Finley, 2000).

Implications

The results of this study might not be able to generalize to the entire population of high school physics teachers due to the limited number of the participants. However, the findings in this study suggest several important implications for theory and practice in science education. The first implication pertains to the definition of the student-centered approach. In addition, the results of this study reveals that in the real world, the teachers have to cope with several constraints such as limited instructional time, heavy teacher workloads, a lack of learning materials, a lot of content to be covered, and a low level of students' motivation and self-learning capability. Thus, according to the teachers in this study, the student-centered learning principles should take these constraints into account. Thus, this study proposes that the model of the student-centered approach, presented in Chapter Two, should be modified by adding one essential component, the contextual constraints. The modified model is presented in Figure 6.1.

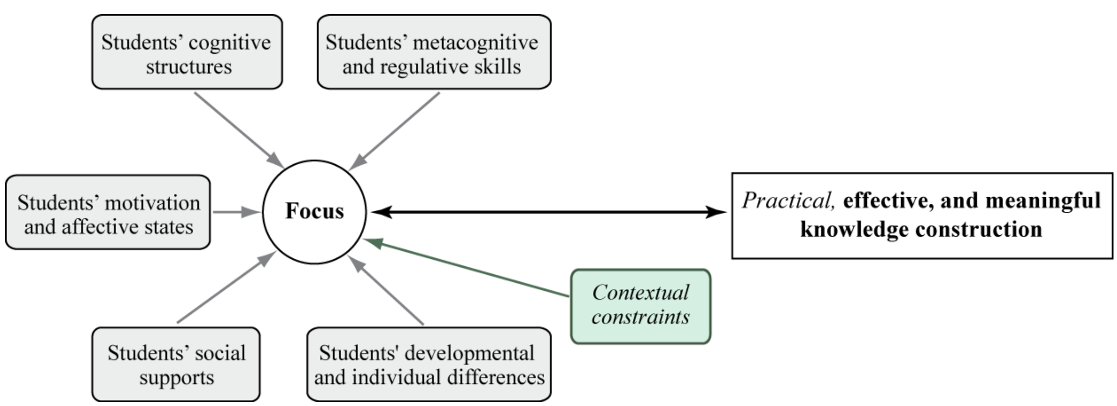


Figure 6.1. Modified model of the student-centered approach.

The second implication relates to research in science education. This study indicates that the teachers could hold one or more competing sets of beliefs about teaching and learning. This result echoes some findings in the literature (e.g., Tobin & McRobbie, 1996, Tsai, 2002; Wallace & Kang, 2004). This study also illustrates that a research study aimed to determine two opposite competing sets of beliefs would provide a more broadened insight into teachers' thought processes. Moreover, this study proposes three models of curriculum, instruction, and assessment implementations, as shown in Chapter Five, for describing how teacher's knowledge and beliefs influencing their classroom practices. Even though these models do not include all elements of teachers' knowledge and beliefs, they could be used to explain and predict teachers' classroom behavior.

Regarding research in science education, this study suggests that there are some Thai teachers who still do not have a clear understanding of the benefits of the student-centered approach over the non-student-centered approach. None of the teachers in this study could give an in-depth explanation about how and why the student-centered approach works effectively with students. Moreover, they believe that the student-centered approach is good and effective only for students in an ideal classroom and that it is not applicable for their students. Thus, these teachers need evidence that the student-centered approach is practical and effective in the real classroom. There is a need for more research addressing this issue.

The third implication applies to teacher education and professional development. The results of the study shows that the current teacher education program in Thailand do not provide sufficient information and practical experience for the teacher to be able to develop a complete and accurate conception of the student-centered approach and to see it as an intelligible, plausible, and fruitful approach to real-world teaching. The findings of this study imply that teacher educators need to look back at the current teacher education program whether it has the following characteristics: (a) engaged in the student-centered education, (b) in line with the student-centered learning principles, (c) providing the teacher with the sufficient teaching experience for competently adopting the student-centered approach, and (d) aiming to correct the misunderstandings about the student-centered approach and the naive views of teaching and learning. If it is not, then the teacher educators need to develop or redesign the program that has these characteristics.

This study also found that the teachers still hold limited knowledge and experiences about educational strategies and methods. Teachers need to know more about effective strategies for eliciting, identifying, and correcting students' misconceptions and misinterpretations. They also need to know more about how to capture, promote, and sustain students' interest and motivation to learn. Moreover, in order to promote lifelong learning, they should have more information about how to develop students' metacognition and self-regulation. With limited knowledge and understanding, teachers perceived the student-centered approach as being ineffective and maintained the use of the traditional approach in which students passively received knowledge from external knowledge sources. Thus, the teacher education and professional development programs should be designed to provide teachers with knowledge and experiences that allow them to effectively and successfully implement the student-centered approach in their practices.

This study also provides implications for policymakers and student-centered education reformers. The results of this study illustrate the dangerous consequences of the student-centered educational reform movement that could arise when teachers hold inappropriate conceptions of student-centered curriculum, instruction, and assessment. For instance, the promotion of the implementation of the student-centered approach can make the teachers think that using the curriculum based on their experiences and science textbooks is wrong and can encourage them to teach students without focusing on the national standards. It can also make teachers think that they should not give students help, guidance, and explanations even though the students need these from them. With incomplete conceptions of the student-centered approach, teachers might believe that to engage in student-centered education they must let students have the freedom to engage in behaviors detrimental to the student’s education, such as not bringing the textbooks to school, wasting instructional time to do unnecessary tasks, and learning to cheat on the test. . Therefore, policymakers and reformers need to quickly and effectively find ways to correct and clarify the inappropriate conceptions held by Thai physics teachers.

This study found that teachers’ classroom practices were influenced by six major factors, including content coverage, instructional time, school activities, teacher’s workloads, students’ learning capability, and the national examination. With a large breadth of content students need to learn, limited instructional time, many school activities, heavy teaching workloads (such as instructional courses and school work), students' low level of self-learning capability and motivation, and the perceived focus of the national examination on problem solving and memorization, the teachers tended to use the lecture-based, teacher-centered instructional pedagogy more frequently than the student-centered one. Therefore, this study recommends that the science content standards should be revised to account for these factors. Policymakers and school administrators might need to consider the reduction of the content coverage, school activities, and teacher workloads and to mandate the expansion of instructional time. The entrance examination should be revised to focus more on student thinking, reasoning, and conceptual understanding while still maintaining a problem-solving focus.

The findings also reveal that the teachers strongly want to help their students learn as much as possible. This study found that all four participating teachers chose learning activities that they thought were most effective and efficient for their students. They did not really care much whether their practices were student-centered or non-student-centered, even though they were forced by laws and encouraged by reformers to make their practices more student-centered. They did not implement what they perceived as student-centered activities because they did not see them as beneficial to their students. In other words, these teachers' hearts were actually student-centered. They always thought about their students and placed their students as the first priority, even though they were told by others that what they did was wrong. The reason why their classroom practices had a tendency to adopt the non-student-centered approach rather than the student-centered one was not because they did not think about their students; it was because they had very limited knowledge and beliefs about students' learning and faced a lot of constraints.

In order to succeed in the student-centered educational reform, cooperation and coordination among different agencies such as science educators, teacher educators, researchers, policy makers, and reformers, are needed. This study suggests three important tasks that should be done immediately by these agencies. First, the student-centered approach should be promoted by referring to the notion of finding the most efficient way to educate students rather than the notion of changing lecture-based instruction to a physically active learning activity. The teachers with the student-centered heart should be reinforced and supported even though they still majorly adopt a lecture-based pedagogy in their practices.

The second task is to help teachers understand learning not as knowledge acquisition but instead as knowledge construction. Teachers should be made aware of the importance of students' prior knowledge, experiences, motivations, affects, and interactions with their peers in student learning. Moreover, they should be informed about the current trends in science education such as scientific inquiry, inquiry-based instruction, conceptual change theory, and the nature of science. This information would help them to develop and modify their views of science teaching and learning to those that are aligned with the student-centered principles.

Finally, teachers should be encouraged to form communities of practice (e.g., Murray et al., 2011; Wenger, 1998). They should have a place to share and exchange knowledge, ideas, experiences, and feedback in a supportive atmosphere. This task might start with forming the community of the PSMT teachers and then expanding to other groups of the teachers.

Recommendations for Future Research

This study still cannot answer many questions relating to Thai physics teachers' conceptions of the student-centered approach. The short list of these questions awaiting further investigation includes:

- When, how, and why have teacher's conceptions of the student-centered approach been developed? This study found that four participating teachers held various conceptions of the student-centered approach and perceptions of their classroom practices. Even though three teachers, including Ploy, Mook, and Yord, graduated from the same university and took almost all the same undergraduate physics courses and teacher preparation courses, their conceptions of the student-centered approach were different in some aspects. Further research could investigate the sources and factors that influence the construction of personal conceptions of the student-centered approach. It is hoped that this research will contribute to valuable information suggesting how educators can create appropriate teacher education programs that successfully address teachers' misunderstandings of the student-centered approach.
- What are the conceptions of the student-centered approach held by others? Since the number of participants in this study is limited to four PSMT teachers with two years of teaching experience, the results of this study cannot be generalized to any larger population. The models of curriculum, instruction, and assessment

implementations might not include all key elements of teachers' knowledge and beliefs influencing their practices. Thus, a further study with more participants is required to confirm the present findings. There is also a need for a further study with different groups of teachers to verify and expand the results of the current study. The possible groups of teachers included pre-service teachers, PSMT physics teachers with higher or lower than two years of teaching experiences, regular Thai physics teachers, teachers who are proven to be successful in implementing the student-centered approach, the teachers in different subject specialization (e.g., chemistry, biology, and mathematics), and the non-Thai teachers (e.g., U.S. science teachers). A further study might expand to investigate other groups of people such as reformers, teacher educators, school administrators, students, and students' parents.

- What are teachers' perceptions of the same instructional activity in relation to their conceptions of the student-centered approach? This study used an actual instructional activity of each teacher as a tool to examine their conceptions of the student-centered approach. However, since each participant had implemented different instructional activities, it was hard to make a comparison between each case. It might be interesting to see how these teachers perceive the same activity in relation to their conceptions of the student-centered approach. The card sort technique might be used for further investigation (e.g., Friedrichsen & Dana, 2003). Some of the instructional activities mentioned in this study can become useful sources for developing scenarios for examining teachers' thinking processes. A further study employing the card sort technique might provide more complete information about teachers' conceptions of the student-centered approach and their perceptions of their classroom practices.

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Appendix A

APA's Learner-centered Psychological Principles

Cognitive and Metacognitive Factors:

1. Nature of the learning process

    The learning of complex subject matter is most effective when it is an intentional process of constructing meaning from information and experience.

2. Goals of the learning process

    The successful learner, over time and with support and instructional guidance, can create meaningful, coherent representations of knowledge.

3. Construction of knowledge

    The successful learner can link new information with existing knowledge in meaningful ways.

4. Strategic thinking

    The successful learner can create and use a repertoire of thinking and reasoning strategies to achieve complex learning goals.

5. Thinking about thinking

    Higher order strategies for selecting and monitoring mental operations facilitate creative and critical thinking.

6. Context of learning

    Learning is influenced by environmental factors, including culture, technology, and instructional practices.

Motivational and Affective Factors:

7. Motivational and emotional influences on learning

    What and how much is learned is influenced by the learner's motivation. Motivation to learn, in turn, is influenced by the individual's emotional states, beliefs, interests and goals, and habits of thinking.

8. Intrinsic motivation to learn

    The learner's creativity, higher order thinking, and natural curiosity all contribute to motivation to learn. Intrinsic motivation is stimulated by tasks of optimal novelty and difficulty, relevant to personal interests, and providing for personal choice and control.

9. Effects of motivation on effort

    Acquisition of complex knowledge and skills requires extended learner effort and guided practice. Without learners' motivation to learn, the willingness to exert this effort is unlikely without coercion.

Development and Social Factors

10. Developmental influences on learning

    As individuals develop, there are different opportunities and constraints for learning. Learning is most effective when differential development within and across physical, intellectual, emotional, and social domains is taken into account.

11. Social influences on learning

Learning is influenced by social interactions, interpersonal relations, and communication with others.

Individual Difference Factors

12. Individual differences in learning

Learners have different strategies, approaches, and capabilities for learning that are a function of prior experience and heredity.

13. Learning and diversity

Learning is most effective when differences in learners' linguistic, cultural, and social backgrounds are taken into account.

14. Standards and assessment

Setting appropriately high and challenging standards and assessing the learner as well as learning progress -- including diagnostic, process, and outcome assessment -- are integral parts of the learning process.

Appendix B

Background and Context Interview Protocol

1. Could you tell me about by answering the following questions?
   Motivation
   a. Why do you want to be a teacher?
   b. Why did you join the PSMT program?
   c. Why did you choose physics as your major?
   d. Are you planning to pursue Masters' degree? Why? What is your goal and motivation?

   Experiences
   e. High school:
      - What is your experience as a high school science student?
      - What does your physics learning experience at high school level look like?
   f. Undergraduate:
      - What is your experience as an undergraduate science student?
      - What does your learning experience in physics at university level look like?
   g. One-year teaching professional program:
      - What is your experience as a student teacher in one-year teaching professional program?
      - What does your learning-to-teach experience in this program look like?
      - What did you learn from this program?
   h. What are the most positive and negative experiences that you had with learning physics? Why?
   i. What are your ways of learning physics? Are your ways of learning physics similar or different from other disciplines (e.g. biology, chemistry, mathematics, and history)?
   j. How do you see yourself as a physics teacher? What are your main strengths and weaknesses as a physics teacher?

   Typical classroom instruction
   Students:
   k. How do your students learn physics?
   l. What motivate your students to learn physics?
   m. What are characteristics of a good physics student?

   Curriculum (what to teach)
   n. What do you want your students to learn from your physics course?

   Instruction (how to teach)
   o. How do you teach physics?
   p. What do your classroom instructions look like?

   Assessment (how to assess what you teach)
   q. How do you assess student learning?

2. Could you tell me about your school context by answering the following questions?
    a. What are the characteristics, goals, supports, expectations, and cultures of the followings?
        - Your principal
        - Your colleges (including school teachers, science teachers, and physics teachers)
            - What are the most common teaching methods used by these teachers?
        - Parents
        - Students
        - People around the school
        - Educational Service Area Office
    b. What are the characteristics of the followings?
        - Location of your school
        - Size of your school (school area, number of students)
        - School Environments
        - Classroom environments (facilities, laboratory equipments, class sizes)
    c. Tell me about the Thai educational system?
        - What do you think about the content standards and the implementation of the standards?
        - What do you think about physics content described in the standards?
        - What do you think about the national assessment process?
        - What do you think about the university admission process?
    d. Are there any school factors that facilitate or impede your classroom practices or student learning?
3. Could you tell me about the class that I will observe?
    a. Characteristics of the students
    b. Class sizes (males, females)
    c. Classroom environments
    d. Grading system
    e. Why do you recommend me observing this class?
4. Could you list factors affecting how you teach? What are the top three factors? Why?

Questionnaires

1. Could you tell me about your works by answering the following questions?
ขอให้ท่านช่วยกรุณาอธิบายเกี่ยวกับภาระงานของท่านโดยตอบคำถามต่อไปนี้
   a. How long have you been teaching at this school? คุณสอนที่โรงเรียนแห่งนี้มานานเท่าไรแล้ว
      …………. Years …….….… Months
   b. What subjects/courses are you currently teaching, this semester? And how long have you ever taught these courses?
      มีวิชาอะไรบ้างที่คุณสอนเทอมนี้ และคุณสอนวิชาเหล่านี้มานานเท่าไรแล้ว
      ……………………………………………………………………………..…
      ……………………………………………………..……………………………
      ……………………………………………..……………………………………
   c. What subjects/courses have you ever taught? And how long have you ever taught these courses? มีวิชาอะไรบ้างที่คุณเคยสอนมา และคุณสอนวิชาเหล่านี้มานานเท่าไรแล้ว
      ……………………………………………………………………………..…
      ……………………………………………………..……………………………
      ……………………………………………..……………………………………
   d. On average, how many hours per week do you teach?
      โดยเฉลี่ยแล้วในแต่ละสัปดาห์ คุณมีชั่วโมงในการสอนกี่ชั่วโมง
      ……. hrs จากทั้งหมด From total ……. hrs
   e. On average, how many hours per week do you spend preparing to teach?
      โดยเฉลี่ยแล้วในแต่ละสัปดาห์ คุณมีชั่วโมงในการเตรียมการสอนกี่ชั่วโมง
      ……. hrs แบ่งเป็น ใน รร In school ……. hrs, นอก รร Outside school ……. hrs
   f. Do you have other school responsibilities? If yes, what are they? And how many hours per week do you spend doing these activities?
      คุณมีภาระงานอื่นในโรงเรียนหรือไม่ ถ้ามี มีอะไรบ้าง ช่วยบอกพร้อมจำนวนชั่วโมงต่อสัปดาห์ที่คุณใช้ในการจัดการภาระงานเหล่านี้
      …………………………………………………………………………….
      ……………………………………………………..……………………………
      ……………………………………………..……………………………………
   g. Have you attended any professional meetings, seminars, or conferences that focused on promoting student-centered teaching and learning in the past three years? If yes, what are they? What did you learn from them?
      ในสามปีที่ผ่านมานี้ คุณเคยเข้าร่วมการประชุม สัมมนาใดๆ หรือไม่ที่มีการพูดถึงการจัดการเรียนการสอนที่ยึดผู้เรียนเป็นศูนย์กลาง ถ้าใช่มีอะไรบ้าง คุณเรียนรู้อะไรจากกิจกรรมเหล่านั้น
      ……………………………………………………………………………..…
      ……………………………………………………..……………………………
      ……………………………………………..……………………………………
   h. จำนวนนักเรียนทั้งหมด No. of Students ……..…. คน
      ม. ต้น Middle school Students …. คน ม. ปลาย High school students ……. คน
   i. จำนวนครูทั้งหมด No. of Teachers ……. คน
      ครูหมวดวิทย์ทั้งหมด Science Teachers .... คน ครูฟิสิกส์ทั้งหมด Physics teachers .... คน

Appendix C

Conceptions of Student-Centered Approach (CSCA) Interview Protocol

Introduction:

For almost ten years, Thai education has been reformed with a special emphasis on learning reform through a student-centered approach. As a result, the phrase “student-centered” has become quite popular in Thai educational community. However, there is no common agreement on the definition of “student-centered teaching and learning”. This phase has been generally used but rarely defined in the literature.

I am interested in what teachers like you think about the phrase “student-centered teaching and learning”. I would like to ask you to help me to define this phrase. I will ask you about your general idea of what do you mean by “student-centered”. Then, I will focus on three educational aspects: curriculum, instruction, and assessment. I am also interested in both teachers’ actions and students’ actions that you classify as being or not being student-centered. Using some examples, analogies, or metaphors would help me to understand your idea.

Finally, I want you to know that there is no “right” or “wrong” answer to the following questions. I am only interested in your ideas of student-centered teaching and learning.

Conceptions of Student-Centered Approach Interview Protocol

1. Have you ever heard the phrase "student-centered teaching and learning"? How did you hear this word?

2. Do you think "student-centered teaching and learning" is a good or bad idea? Why?

Now, I would like to ask you to take a role in informing new beginning teachers what student-centered education look like by answering the following questions?

3. Curriculum:

Introduction: In education, we use the term "curriculum" when we talk about what and when to teach.

   a. Do you think that curriculum can be student-centered or not? Why or Why not?
   b. What are the characteristics of student-centered curriculum? Or, when deciding what and when to teach, what do student-centered teachers do?
   c. What are the characteristics of non-student-centered curriculum? Or, when deciding what and when to teach, what do non-student-centered teachers do?
   d. What are the similarities and differences between student-centered and non-student-centered curricula?
   e. Are there any factors supporting the use of student-centered curriculum? What are they? Why?
   f. Are there any factors hindering the use of student-centered curriculum? What are they? Why?

4. Instruction:

   Introduction: In education, we use the term "instruction" when we talk about how to teach or how to learn.

   a. Do you think that instruction can be student-centered or not? Why or Why not?
   b. What are the characteristics of student-centered instruction?
      i. What do teachers do in student-centered classrooms?
      ii. What do students do in student-centered classrooms?
   c. What are the characteristics of non-student-centered instruction?
      i. What do teachers do in non-student-centered classrooms?
      ii. What do students do in non-student-centered classrooms?
   d. What are the similarities and differences between student-centered and non-student-centered instructions?
   e. Are there any factors supporting the use of student-centered instruction? What are they? Why?
   f. Are there any factors hindering the use of student-centered instruction? What are they? Why?

5. Assessment:

Introduction: In education, we use the term "assessment" when we talk about how to assess students' learning and what to do with the results of assessment.

a. Do you think that assessment can be student-centered or not? Why or Why not?
b. What are the characteristics of student-centered assessment?
    i. In order to assess students' learning, what do student-centered teachers do?
    ii. What do student-centered teachers do with the results of assessment?
c. What are the characteristics of non-student-centered assessment?
    i. In order to assess students' learning, what do non-student-centered teachers do?
    ii. What do non-student-centered teachers do with the results of assessment?
d. What are the similarities and differences between student-centered and non-student-centered assessments?
e. Are there any factors supporting the use of student-centered assessment? What are they? Why?
f. Are there any factors hindering the use of student-centered assessment? What are they? Why?

Appendix D

Pre-instructional Interview Protocol

Curriculum:

1. What are you planning to teach this week? How do you decide what to teach?
2. What are your educational outcomes (e.g., knowledge, attitudes, and skills that your students will learn)? Why?
3. How does this lesson fit into the whole unit?

Instruction:

1. How are you going to teach in order to accomplish these outcomes?
    a. Could you describe possible teaching and learning activities? How will these activities help?
    b. Are there any assignments your students will work on? What are they? How will these assignments help?
    c. What teaching and learning materials will be used in the classroom? How will these materials help?
    d. What do you expect to see yourself doing in the classroom? Why?
    e. What do you expect to see your students doing in the classroom? Why?
2. Are there any other ways of teaching you can use to teach this topic?
    a. What are they?
    b. What make you decide to use or not use these particular activities (or materials)?

Assessment:

1. Are there any assessment activities?
    a. If yes, what do you do in terms of assessing students' learning? Why do you decide to use these assessing strategies?
    b. What are you going to do with the results of assessment?
2. Are there any other ways that you can use to assess students' learning?
    c. What are they?
    d. What make you decide to use or not use these particular activities (or materials)?

Focus questions:

From what we discuss today (what to teach, how to teach, and how to assess students' learning):

1. Are there any of teacher's and students' activities can be described as being student-centered?
    a. What are they?
    b. Why do you characterize them as being student-centered?
    c. What are strengths and weaknesses of these student-centered activities?
2. In contrast, are there any of teacher's and students' activities can be described as non-student-centered teaching and learning?
    a. What are they?
    b. Why do you characterize these activities as not being student-centered?
    c. What are strengths and weaknesses of these student-centered activities?

3. Are there any other ways of teaching you can use to make your lesson to be more student-centered?
    a. What are they?
    b. What make you decide to use or not to use these particular activities?
    c. What are strengths and weaknesses of these activities?

Appendix E

Post-instructional Interview Protocol

Curriculum:

1. What were the key educational outcomes (e.g., knowledge, skills, and attitudes that your students have learned) that you have accomplished?
2. How did you develop those outcomes?

Instruction:

1. What did you do in order to accomplish these outcomes?
    a. Could you describe key teaching and learning activities? How did these activities help?
    b. Were there any assignments your students will work on? What were they? How did these assignments help?
    c. What teaching and learning materials were used in the classroom? How did these materials help?
    d. What did you do in the classroom? Why?
    e. What did your students do in the classroom? Why?

Assessment:

1. Were there any assessment activities?
    a. If yes, what did you do in terms of assessing students' learning? Why do you decide to use these assessing strategies?
    b. What did you do with the results of assessment?

Focus questions:

From what we discuss today (activities about what you have taught, how you taught, and how you assessed students' learning):

1. Are there any of teacher's and students' activities can be described as being student-centered?
    a. What are they?
    b. Why do you characterize them as being student-centered?
    c. What are strengths and weaknesses of these student-centered activities?
2. In contrast, are there any of teacher's and students' activities can be described as being non-student-centered?
    a. What are they?
    b. Why do you characterize these activities as not being student-centered?
    c. What are strengths and weaknesses of these non-student-centered activities?
3. Are there any other ways of teaching you can use to make your lesson to be more student-centered?
    a. What are they?
    b. What make you decide to use or not to use these particular activities?
    c. What are strengths and weaknesses of these activities?

Appendix F

Assessment Interview Protocol

Assessment:

1. What did you do in terms of assessing students' learning? Why do you decide to use these assessing strategies?
2. What did you do with the results of assessment?

Focus questions:

From what we discuss today (activities about how you assessed students' learning):

1. Are there any of teachers' and students' activities can be described as student-centered assessment?
    a. What are they?
    b. Why do you characterize them as being student-centered?
    c. What are strengths and weaknesses of these student-centered activities?
2. In contrast, are there any of teacher's and students' activities can be described as non-student-centered assessment?
    a. What are they?
    b. Why do you characterize these activities as not being student-centered?
    c. What are strengths and weaknesses of these non-student-centered activities?
3. Are there any other ways of evaluation you can use to make your assessment to be more student-centered?
    a. What are they?
    b. What make you decide to use or not to use these particular activities?
    c. What are strengths and weaknesses of these activities?

Appendix G

Instructional Flow Charts

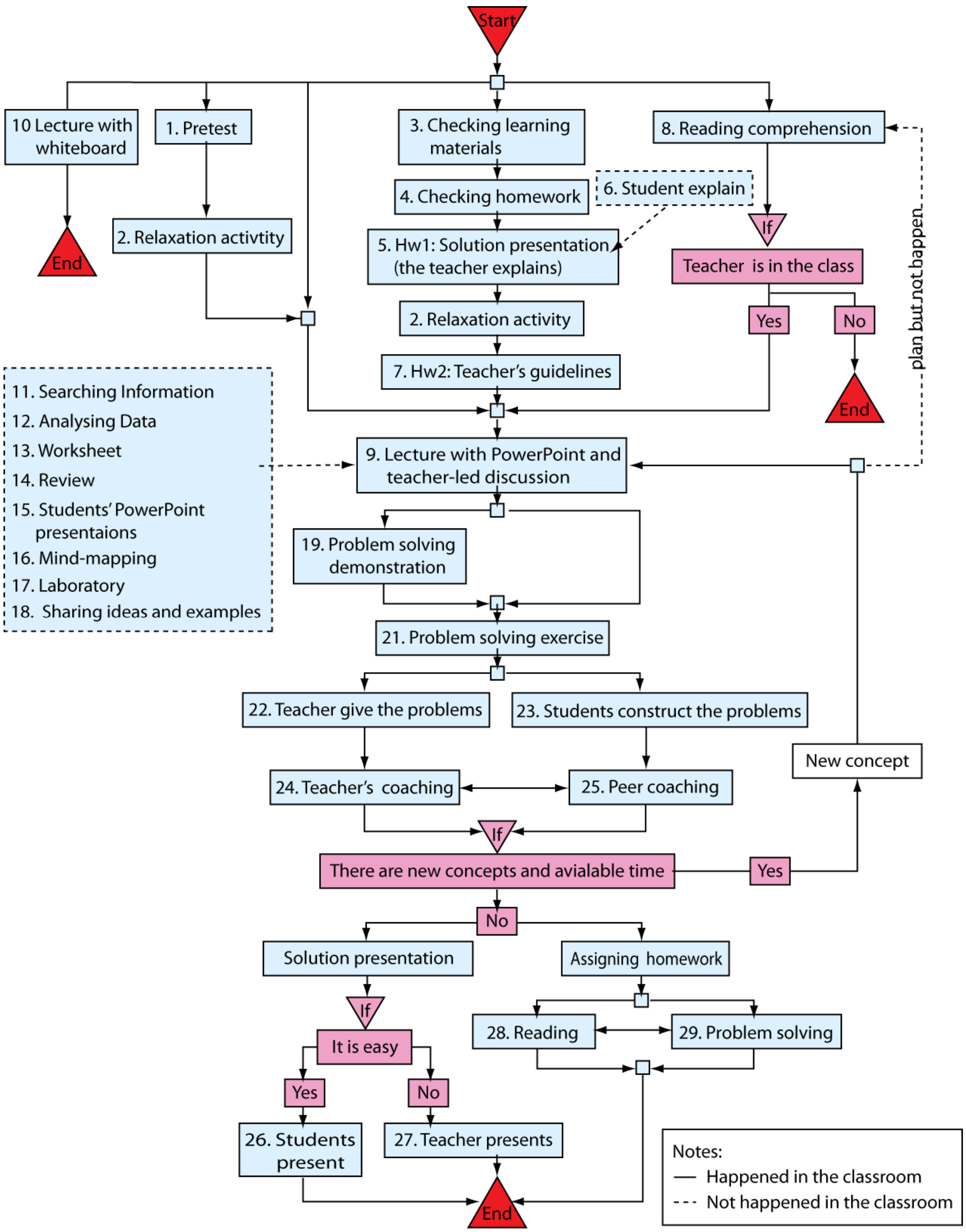

Figure G-1. Ploy's instructional flow chart.

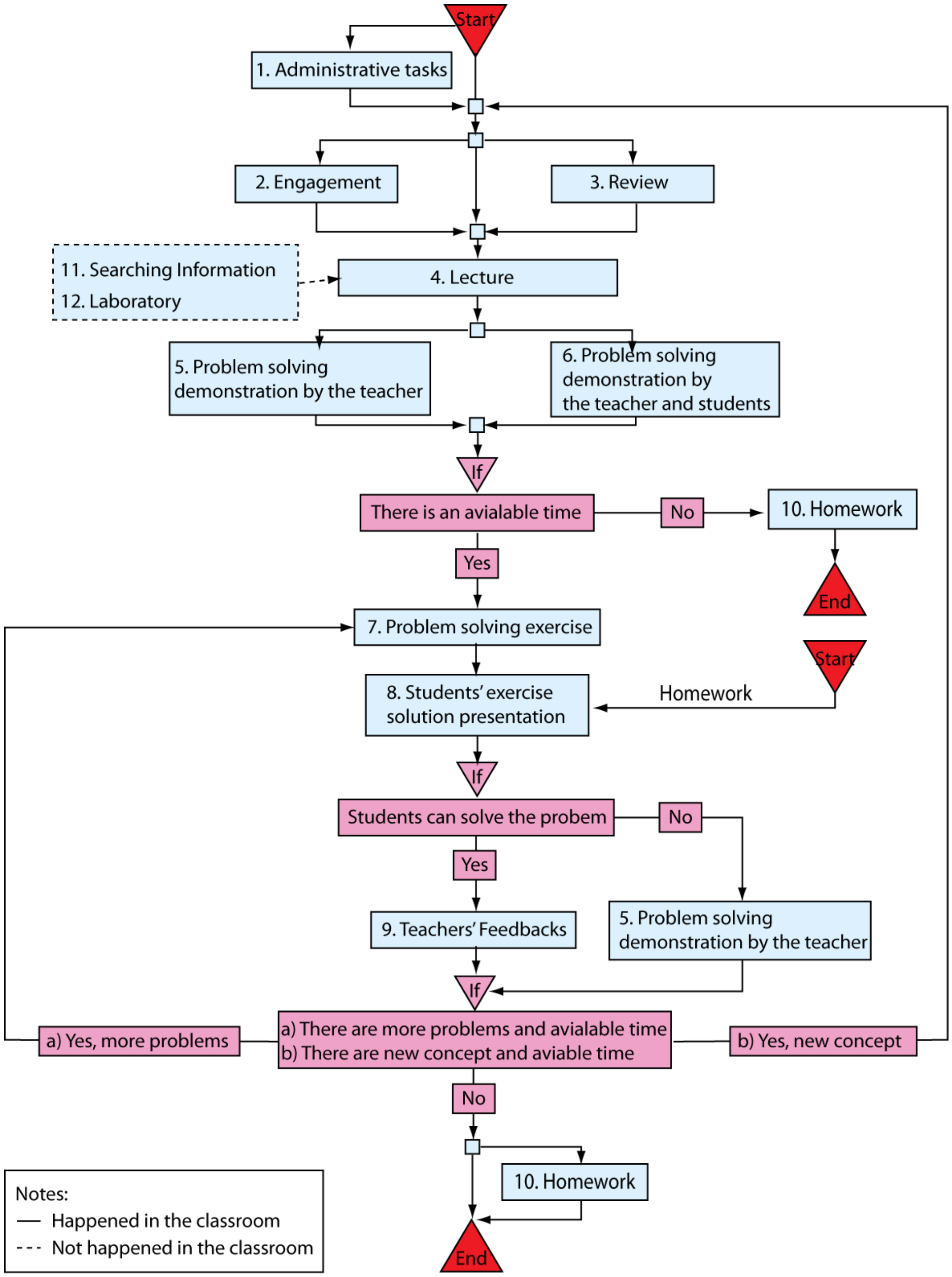

Figure G-2. Mook's instructional flow chart.

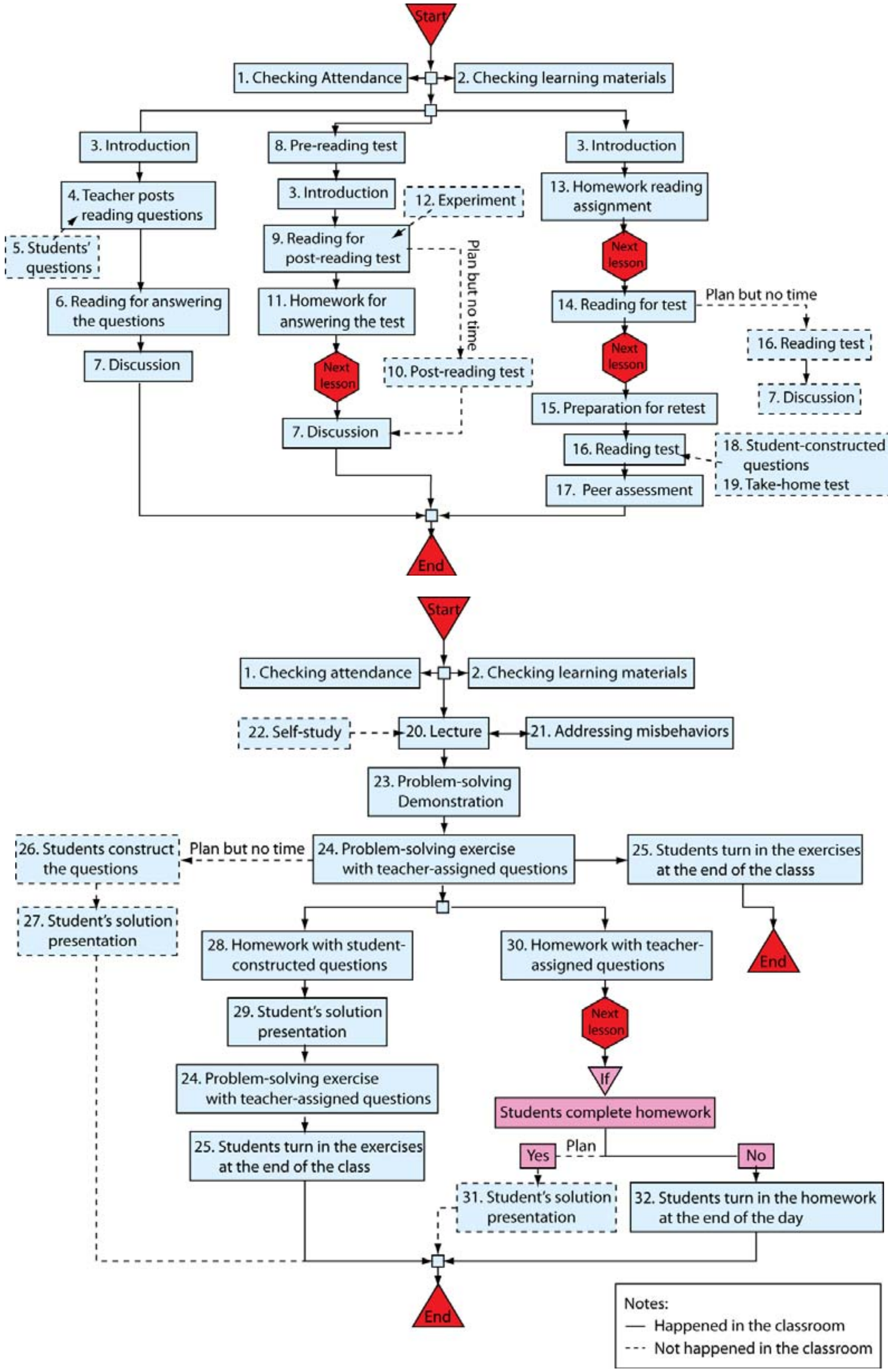

Figure G-3. Gorn's instructional flow chart.

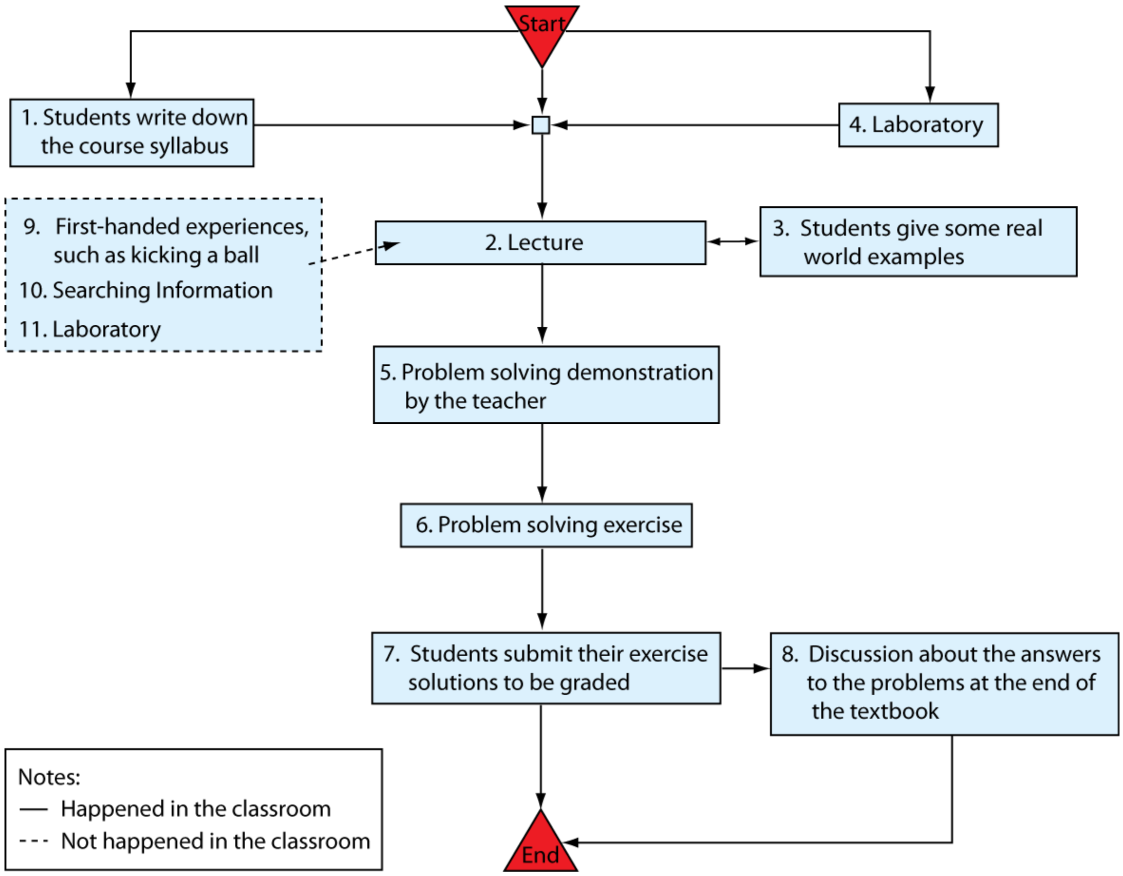

Figure G-4. Yord's instructional flow chart.