Science and Mathematics Education Centre

Teacher-Student Interactions and Laboratory Learning Environments in Biology Classes in Thailand

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DECLARATION

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university. To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgement has been made.

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ABSTRACT

The first purpose of the study described in this thesis was to provide validation information of three questionnaires that were modified and translated into the Thai language, namely, the *Questionnaire on Teacher Interaction* (QTI), the *Science Laboratory Environment Inventory* (SLEI), and the *Attitude to Biology Class* (ABC). A second purpose was to determine students' perceptions of teacher-student interactions and laboratory learning environments and their attitudes to biology classes in secondary schools in Thailand. A sample of 1,194 students from 37 biology classes in 37 schools completed the three questionnaires.

The results of the study showed that most students in secondary schools of Thailand have moderately positive attitudes to their biology class. Students perceived their teachers as having good leadership, being helping/friendly, and understanding, but seldom uncertain, dissatisfied or admonishing. They also perceived that sometimes their teachers were strict, however allowing students responsibility and freedom. In biology laboratories, they perceived the environments as employing good student cohesiveness, less open-endedness and integration of the theory and practical, the rules were not clear and the materials were not good and insufficient. There were differences between students' actual and ideal perceptions of classroom interactions and laboratory learning environments. Students preferred teachers who showed strong leadership, were more helping and understanding, who gave their students more responsibility and freedom, and who were less uncertain, dissatisfied, admonishing and strict. Also, students preferred a biology laboratory environment with higher levels on the scales of Open-Endedness, Integration, Rule Clarity, and Material Environment but not Student Cohesiveness.

Some commonality between the QTI and the SLEI scales was found in their contributions to the variance in student attitudes to biology classes. So now the QTI and the SLEI can be used by biology teachers and other science teachers in secondary schools who wish to improve science teaching and learning in Thailand.

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CHAPTER 1

INTRODUCTION

The research study described in this thesis concerned interactions between teachers and students and the learning environment in secondary school biology classes in Thailand. The instruments used to investigate students' perceptions were translated and modified into Thai versions and were, namely, the *Questionnaire on Teacher Interaction* (QTI) and the *Science Laboratory Environment Inventory* (SLEI). The QTI and SLEI assess teacher-student interactions and biology laboratory learning environments, respectively. This was the first time students' perceptions had been used to assess Grade 10 biology classes in Thailand. The students' perceptions were compared between their actual and preferred situations. The validity of the instruments was computed by using quantitative data and then qualitative data from interviewing the students who answered the questionnaires. In addition, associations between students' perceptions of teacher-student interactions and learning environments and students' attitudes to their biology classes were investigated. These students' perceptions described the characteristics of biology classes in Thailand and provided basic information that could be used to improve these classes in the future.

1.1 BACKGROUND OF EDUCATION IN THAILAND

Learning reform in Thailand was considered in 1999 and the National Education Act became policy by August, 2002. Before considering this reform, a brief description of the Thai education system is provided.

Education in Thailand is divided into three types: formal, non-formal, and informal. The formal education system is divided into four levels: preschool, primary, secondary, and tertiary. The primary and secondary levels are classified as basic education and are offered for 12 years from grade 1 to grade 12. It is divided into six years in primary school, three years in lower secondary school and three years in

upper secondary school. According to Section 22 of the National Education Act, all learners are capable of learning and self-development and are regarded as being most important. To ensure desirable characteristics of future learners, child-centered learning has been promoted by all agencies concerned. Both teachers and learners are currently encouraged to change their roles. Teachers have been changing from roles as "tellers" to new roles as "facilitators" and students are encouraged to learn by themselves with the guidance of their teachers. Furthermore, there are standards on teaching progression in the Act to encourage teachers to continue developing their profession. The standards are examples for teaching and learning and are as follows:

Standard 1: Being an active and productive member of teaching professional organizations.
Standard 2: Judging all practices to the learners' benefit.
Standard 3: Aiming at learners' optimum development.
Standard 4: Developing effective lesson plans to bring about empirical learning outcomes.
Standard 5: Developing efficient and innovative learning materials responsive to learners' needs.
Standard 6: Practising best instructional practices for learners' latent development.
Standard 7: Presenting systematic reports on learners' development based on objective and authentic measures.
Standard 8: Being a good behavioural model for learners.

Compulsory education has expanded from six years eventually to 12 years and is a free service provided by the state. The Ministry of Education which controls and manages education, religion and culture has developed approaches in order to attain its education reform policy which are:

1) School Reform
2) Teacher Reform
3) Curriculum Reform
4) Administration Reform.

For basic education, a new curriculum was introduced in the academic year 2002. It began with the first year of each key stage and the second and third in the following years as follows: Grade 1, 4, 7 and 10 in Academic Year 2002; Grade 2, 5, 8, and 11 in Academic Year 2003; and Grade 3, 6, 9 and 12 in Academic Year 2004. The new *Curriculum Framework for Basic Education* consists of concepts and principles, curriculum structure, objectives, basic education standard, standard of groups of learning contents, assessment of learning contents, organization of learning, as well as monitoring, inspection, evaluation, and reporting.

In order to promote and support schools and basic education systems that are in the process of teaching and learning reform, 1,000 schools were selected by the Ministry of Education to be leading schools for learning reform. These schools were provided with documents on educational and learning reform, support for personnel development, and some financial support for the reform of learning. However, there are many schools still using the traditional approaches to the new curriculum, including many secondary schools.

Secondary education in Thailand was managed by the Department of General Education (the DGE), which is in the Ministry of Education. The three-year upper secondary schooling system is divided into two parallel tracks: general or academic and vocational. General upper secondary education has remained provided by the DGE. The structure of the upper secondary school curriculum includes four components: core subjects, prescribed elective subjects, free elective subjects, and activities. The structure of the core curriculum has been developed comprising eight subject groups: 1) Health Education and Physical Education; 2) Art, Music and Dramatic Arts; 3) Mathematics; 4) Thai Languages; 5) Social Studies; 6) Science and Technology; 7) Foreign Language; 8) Career and Work Education. The interest in this thesis is in the Science and Technology subject group.

1.2 TEACHING AND LEARNING OF SCIENCE IN THAILAND

Although there has been reform in education in Thailand, there are still problems in science teaching and learning. These problems are generally acknowledged in Thailand as the following. First, the budget given to the schools is not enough to

supply and provide equipment, instruments, and chemical reagents in the laboratory. During the past decade, efforts were made in science education development but it still has not been successful, especially in introducing the laboratory approach to learning science in school (Ministry of Education [MOE], 2003). In addition, most secondary schools have not provided the laboratory for every class in their schools so it is shared between the classes of the school. However, the students accept and rarely complain about the traditional teaching approach because the lecture approach is thought to be better in helping them to succeed in multiple choice exams and thus improving their chances of passing the entrance exam for higher education. Currently, there is an attempt to change the method of entrance examination for higher education in Thailand.

Secondly, the number of students per class should be considered because it is a major problem in science laboratories in Thailand. In 2002, the average number of students per classroom in Thailand for upper secondary school was 36 (MOE, 2003). The science classrooms appear crowded and it makes managing the classroom difficult for teachers. Thirdly, because of economic problems, many schools reduce the number of types of teachers and this results in incompetent teachers. Some science teachers have to teach both biology and chemistry and some teach mathematics and biology. In addition, only the big schools located in the big towns or cities are successful in recruiting qualified science teachers. Unfortunately, the secondary schools located in the smaller communities are not able to attract qualified science teachers. Fourth, the psychosocial environment in science classes is still neglected by science teachers and administrators and this makes this study important towards improving the situation in Thailand.

1.3 BACKGROUND TO THE STUDY

Education in Thailand has changed rapidly in recent years following the policy of the National Education Act, 1999 and the National Education Reform of Thailand. Teaching and learning in Thailand, as in other countries, has shifted from a traditional approach to a new paradigm, especially a student-centred approach (ONEC, 2001). Today, the roles of teachers in the classroom are in accord with Piagetian-based learning approaches. These approaches have been considered and

have influenced learning in science (Ormrod, 2000). The United Nations Educational, Scientific and Cultural Organization (UNESCO) states that aspects of the classroom environment can help to promote the intrinsic motivation that is necessary for intellect functions (UNESCO, 1980). The learning environment is one of the factors that science teachers should consider for managing their classes, especially laboratory classes.

A number of teachers as facilitators of the learning process have provided and designed maximally beneficial classrooms for all students. They know that classrooms are places with specific social and psychosocial characteristic, which motivate students' learning. In addition, they realize that the classroom is a social environment where interaction and interpersonal dynamics occur (Parsons, Hinson, & Sardo-Brown, 2001). Fraser, Anderson, and Walberg (1982) stated that the classroom social climate or learning environment includes the interpersonal relationships among pupils, relationships between pupils and their teachers, relationships between pupils and both their subjects and the method of learning. They developed an instrument to assess these environments, namely the *Learning Environment Inventory* (LEI), which was an expansion and improvement of the *Classroom Climate Questionnaire* described by Hemphill and Westie (cited in Fraser, Anderson, & Walberg, 1982). They then developed a simplified form of the LEI named the *My Classroom Inventory* (MCI) (Fisher & Fraser, 1981).

In the last three decades, the growth of instruments for assessing learning environments is remarkable, especially in science education. Some other examples of instruments for assessing classroom environment and interpersonal behaviour of teachers or students are the Questionnaire on the Teacher Interaction (QTI) (Wubbels & Levy, 1993), the *College and University Classroom Environment Inventory* (CUCEI) (Fraser, Treagust, Williamson, & Tobin, 1987; Nair, 1999), the *Computer Classroom Environment Inventory* (CCEI) (Maor & Fisher, 1993; Maor, 1998), the *What Is Happening In This Class?* (WIHIC) (Fraser, Fisher, & McRobbie, 1996), and the *Constructivist Learning Environment Survey* (CLES) (Taylor & Fraser, 1991; Taylor, Fraser, & White, 1994). A particular instrument used in assessing science classroom environment is the Science Laboratory Environment Inventory (SLEI) (Henderson, Fisher, & Fraser, 1994; Fraser, Giddings, &

McRobbie, 1992) and an alternative version is named the *Computer Laboratory Inventory* (CLEI) (Newby & Fisher, 1996).

Surprisingly, while the instruments have been developed in various versions in English, as well as modified in other languages: for example, a Korean version of the CLES (Kim, Fisher, & Fraser, 1999), Korean versions of the CLES, QTI and the SLEI (Lee, 2001). There are Chinese versions of the WIHIC (Aldridge, Fraser, Taylor, & Chen, 2000) and the CLES (Aldridge, Fraser, & Huang, 1999) also exist. There are Indonesian- language versions of the WIHIC (Margianti, Fraser, & Aldridge, 2001; Soerjaningsih, Fraser, & Aldridge, 2001) and CUCEI (Soerjaningsih, et al., 2001), a Malay version of the QTI (Scott & Fisher, 2001), and a Hindi version of the LEI (Walberg, Singh, & Rasher, 1977). However, there are still a relatively small number of studies on the impact of new curriculum on learning environments in Asia (Fraser, 2002).

Although education in Thailand has been reformed, the tradition of research in education, especially in science education, is still a concern with associations between cognitive and affective learning outcomes and the psychosocial environment rarely investigated. Therefore, it is desirable to provide valid instruments to gather information on students' perceptions of learning environments and interactions between teacher and students in science classroom. The two questionnaires (the QTI and SLEI) to be used in this study will contribute to our understanding of biology classes in Thailand. It is hoped that eventually the QTI and the SLEI will be used to provide feedback to Thai teachers, so that they can use this information to evaluate and improve their own effectiveness.

1.4 SIGNIFICANCE OF THE STUDY

This study is significant for three reasons. First, it is likely to provide two new valid instruments to gather information on science in Thailand: the QTI and the SLEI. Secondly, it will allow us to know more about biology classes in secondary schools in Thailand. Finally, information gained from this study may be used to improve biology teaching and learning by giving this new knowledge to biology teachers.

1.5 AIM AND RESEARCH QUESTIONS

The overall aim of this study was to describe biology classrooms in Thailand. In order to do this, questionnaires on teacher-student interaction and laboratory learning environments for use in secondary school biology classes in Thailand were validated and used to examine associations between students' perceptions and attitudes to their classes.

From this aim, the following research questions were proposed:

1. Is the Thai version of the QTI a valid and reliable instrument for use in Thailand?
2. Is the Thai version of the SLEI a valid and reliable instrument for use in Thailand?
3. What are students' perceptions of interactions between them and their teachers in biology classes?
4. What are students' perceptions of their learning environments in biology classes?
5. How do students' perceptions of their learning environments relate to teacher -student interactions?
6. What associations exist between teacher-student interactions and student attitudes to their biology classes?
7. What associations exist between laboratory learning environments and student attitudes to their biology classes?
8. What are the characteristics of biology classes in Thailand?

1.6 RESEARCH METHODS

The sample was composed of students who study biology classes at the grade 10 level of secondary schools in Thailand. These schools were classified into three types: large, medium and small. Large schools were defined as having more than 1,500 students, medium schools had between 500 and 1,499 students, and small schools had less than 500 students (MOE, 2003). The total sample involved 1,194 students who completed the questionnaires in their biology classes in the academic year 2002. The instruments used in this research were the questionnaires, namely,

the Questionnaire on Teacher Interaction (QTI), the Science Laboratory Environment Inventory (SLEI), and the Attitude questionnaire. The Attitude questionnaire used to assess student attitudes to biology was based on an adaptation of the *Test of Science Related Attitudes* (TOSRA) (Fraser, 1981). It was adapted, specifically for this subject, and named the *Attitudes to Biology Class* (ABC). Most of questionnaires employed in this study are Australian versions that were modified and translated into Thai versions. The QTI, the SLEI, and the ABC consist of 48 items, 35 items, and 7 items, respectively. Students indicated their perceptions on response sheets provided for each of the QTI, SLEI, and ABC using a 5-point Likert scales. The construct validities of the QTI and SLEI to identify biology classes in Thailand were confirmed through interviews using the Thai language with students from some schools. During the interviews, the group of students were asked questions to confirm their understanding in the questionnaires and their perceptions.

1.7 OVERVIEW OF THE THESIS

This thesis is composed of six chapters. The first one has provided the background to the study, significance and objectives of the study, and concludes with an overview of the thesis. A literature review of the study of learning environments and discussion concerning the development of the instruments to assess teacher-student interactions and learning environments in biology class is presented in Chapter 2. It also includes a review of the use of the questionnaires and students' attitude in other countries. The methods adopted for the study are described in Chapter 3 where both quantitative and qualitative approaches for collecting the data are described. The results of the analysis of the validation and descriptive information of learning environmental measures and descriptive analysis are reported in Chapter 4. Chapter 5 contains a report about students' perceptions on learning environments including their teacher-student interactions and laboratory learning environment in biology classes. Finally, the conclusions are discussed in Chapter 6, which also includes some recommendations for Thai biology teachers arising from this study.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The aim of this study was to investigate students' perceptions of learning environments, including the learning environment in the laboratory and teacher-student interactions in biology classrooms. The study also determined associations between these measures and students' attitude to biology. This was the first study of this kind in Thailand.

This chapter provides a review of topics related to this aim and consists of teachers' roles in their classrooms (Section 2.2); theoretical frameworks relating to classroom environment (Section 2.3); development and use of classroom environment questionnaires for secondary schools (Section 2.4); a summary of instruments based on Moos' scheme (Section 2.5); a theoretical framework for the study of interpersonal behaviour (Section 2.6); alternative forms/versions of learning environment instruments (Section 2.7); associations between students' perceptions of learning environment in science classes and student achievement (Section 2.8); students' attitude toward science (Section 2.9); research on learning environment (Section 2.10); research on biology classes (Section 2.10); and recent developments relating classroom environment with developments in technology which is a new paradigm in education (Section 2.11).

2.2 TEACHERS' ROLES IN THEIR CLASSROOMS

Although the role of teachers is to teach and those of learners to learn, teachers themselves have to understand what "learning" is before they teach. To make learning productive, both teachers and learners have to know the meaning of learning and the roles of teachers and learners. They need to know what it means to learn, when and where learning most effectively takes place, and what the outcomes and

effects of learning are. These are some of the issues which teachers need to understand and use to make their planning and instruction more effective. To make teaching effective, teachers should have teaching skills; understand instructional systems and the content of what they are to teach as well as knowledge of the philosophies of learning and teaching. It is necessary that teachers should be aware of the meanings of learning and conscious of the background knowledge of their students.

Attempts have been made to define what learning is and what the role of the teacher is. In doing this, many scholars have presented their views on learning. For example, Capel, Leask, and Turner (2001) have compared three theories of learning by Piaget (1958), Vygotsky (1962), and Bruner (1966), three outstanding psychologists.

Piaget considered that all children learn to perceive reason and understand things rationally through a series of stages of learning developed through 'intellectual revolutions', not by 'a continuous accumulation of things learnt step by step'.

Vygotsky agrees with Piaget's theory in that the development of learning and thinking are achieved through a combination of instruction and social interaction as well as communication. He considered that the 'Zone of proximal development' or the gap between what learners can do on their own and what they are capable of doing with assistance from a more knowledgeable or skilled person, plays a crucial role in their growth in learning and thinking. Bruner, like Vygotsky, considered culture as an important factor in formation of the mind (cited in Carpel, Leask, & Turner, 2001). He stated that the role of teachers is to help children find a symbolic rational thinking. That pattern is regular and predictable. Like Piaget, he viewed abstract symbolic thinking as starting through action and mental development partially attained through social experience.

Aside from these three learning theories, Capel, Leask, and Turner also probed into the views of Kyriacou who defined learning as a change in a pupil's behaviour, which takes places as a result of being engaged in an educational experience (Capel, Leask, & Turner, 2001). They also referred to Gagné who described five conditions

of learning, namely, intellectual skills, verbal skills, cognitive strategies, attitudes, and motor skills.

However, learning is viewed differently by Ormrod (2000), who proposed two definitions of learning, which were 'Learning is a relatively permanent change in behaviour due to experience'; and secondly, 'Learning is a relatively permanent change in mental associations due to experience' (Ormrod, 1995, p. 5). She saw learning as a permanent change in terms of behaviour and mental development. The first definition is commonly called social cognitive theory and the second one as cognitive psychology. Cognitivists consider learning as emphasising thinking while behaviourists see learning as change in students' behaviour. A teacher is viewed as a controller of stimuli and a shaper of behaviours through reinforcement.

Today, views of teaching and learning, particularly in science, often focus on a constructivist view that suggests that learning should be made meaningful and promoted through learner-centered teaching. Some constructivist theories on learning focus on how people construct meaning from events and these are referred to as individual constructivism. Others emphasise the interaction of communities of learners and this is referred to as social constructivism (Treagust, Duit, & Fraser, 1996). In contrast to the theories of cognitivist and behaviourists, constructivists emphasise learners' prior understanding, their ability to construct their own understanding, social interaction and authentic learning tasks to promote meaningful learning. So the teacher becomes a facilitator of the learning process and a designer of learning situations.

Meacham and Wiesen (1969) viewed the classroom as a laboratory in which there is a continuous complex of experiments. In the laboratory, the teacher is the manager who arranges the learning environment to maximize the desired changes in the behaviour of the students. In experimental terms, the independent variable is teacher behaviour and the dependent variable is the student behaviour. They suggested that the teacher's role in the classroom is to make changes in the classroom environment that will affect changes in the behaviour of students; so the behaviour of the student depends on the behaviour of the teacher. This process is followed up and applied in this thesis. Furthermore, Meacham and Wiesen (1969) classified teacher behaviour

into three kinds, namely, behaviour that is designed to elicit some response from the student, responding to what the student does which includes some favourable or unfavourable comment, a smile, a frown, a mark on a paper or physical contact, and setting goals for students or helping them set their own goals.

To assist students in their learning achievement, the role of teachers is crucial. In the past, teachers were viewed as tellers or instructors who provided knowledge to students. However, today, the roles of teachers in the classroom have been considered differently by educators. According to Vygotsky who contributed to ideas on constructivism, the role of teachers is to facilitate difficult learning tasks by providing help such as scaffolding. For Piaget, a teacher is an organizer of the learning environment, an assessor and initiator of students' thinking.

To understand classroom properties, Doyle (1986) proposed that the classroom setting could be viewed as an ecological system. It was suggested that there are six properties that teachers could use to shape behaviour regardless of how students are organized for learning. These properties of the classroom are multidimensionality, simultaneity (extent to which many things happen at once in classrooms); immediacy (extent to which teachers should give continuously praising and reprimanding); unpredictability (extent to which classroom events often take unexpected turns); publicness (extent to which classroom is a public place); and history (extent to which classes meet five days a week for several months).

According to Schmuck and Schmuck (1979) there are six group processes that produce a positive classroom climate; the processes involve the expectation, leadership, friendship, norms, communication, and cohesiveness. Meanwhile, Moos (1979b) defined the classroom with a house analogy as a structure sometimes fixed by tradition, however, sometimes capable of being altered. The structures that teachers use to organize classroom life may involve classroom task structures, classroom goal structures, classroom reward structure, and classroom participation structure.

Clearly, if teachers are to maximize their students' learning one of their main roles is the provision of an effective learning environment. Therefore, the development of

the field of learning environment is discussed in the following sections and became the focus for this thesis.

2.3 THEORETICAL FRAMEWORKS ON CLASSROOM ENVIRONMENT

The origin of research on learning environments occurred over 60 years ago with the work of Lewin and Murray. Most interestingly and used widely in psychosocial research is the human behaviour formula proposed by Lewin (1936). Lewin was an American psychologist, born in Germany and influenced by Gestalt psychology. He considered problems of motivation of individuals and of groups in a given situation and proposed the human behaviour formula; B = f (P,E) which explained human behaviour (B) as a function of both individual personality (P) and environment (E).

Soon after, Murray (1938) introduced the Needs-Press Model to describe an individual's personal needs and environmental press. He also used the term alpha press to describe the environment as assessed by an observer and the term beta press to describe the environment as perceived by milieu inhabitants. This latter approach became the foundation for the study of learning environments with student questionnaires.

The assessment of learning environments, using this beta press idea, started with the work of Walberg and Anderson (1968) who developed the *Learning Environment Inventory* (LEI) for use in the evaluation of the Harvard Project Physics curriculum in the USA (Fraser, Anderson, & Walberg, 1982; Walberg & Anderson, 1968). About the same time, Moos developed social climate scales for studying human environments including the *Classroom Environment Scale* (CES) questionnaire, particularly for the classroom environment (Moos & Trickett, 1987). These questionnaires are addressed further in subsections 2.4.1 and 2.4.3, respectively.

Moos (1979) realized that social environment has important effects on satisfaction, learning, and personal growth. He attempted to evaluate the social environment of education settings by considering three approaches: personality and other individual difference variables; stable long-term settings; and the products of popular and

professional writers, to describe the destructive impact of the physical and social environments in schools and other social settings.

Furthermore, Moos synthesised a number of research studies in developmental psychology (Bronfenbrenner, 1977), clinical and community psychology (Holahan, 1978), gerontology (Lawton & Nahemow, 1973), and psychosomatic medicine and health psychology. He also proposed a social-ecological model (Moos, 1979a) to emphasise the inclusion of social–environmental and physical–environmental variables. The model that he arrived at for use in describing these variables is illustrated in Figure 2.1

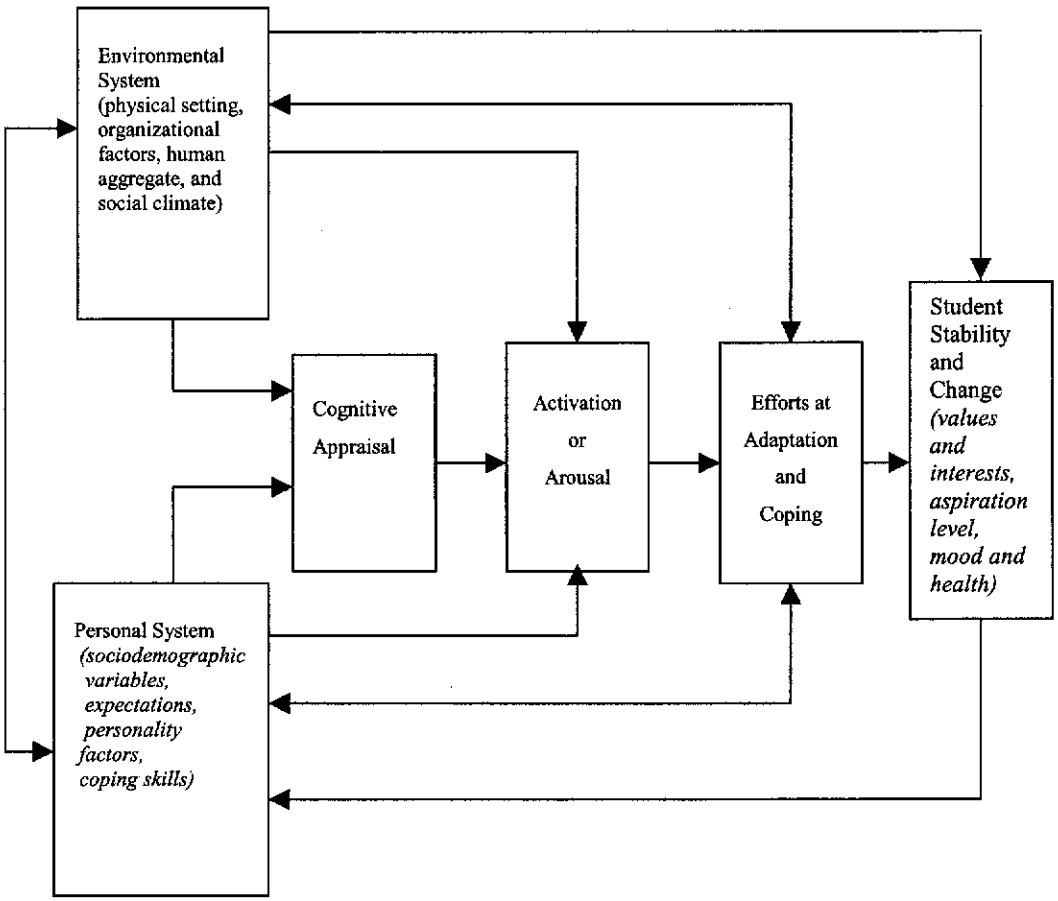


Figure 2.1. A model of the relationship between environmental and personal variables and students' stability and change.
(Moos, 1979a, p. 5)

The model indicates how both environmental and personal variables affect each other through the processes of cognitive and activation or motivation. After they are

activated, students try to adapt to the environment by using a preferred set of coping skills that affect (either stability or change) outcomes such as values, self-concept and achievement levels. These criteria are also affected directly by the personal system and environmental system. In turn, changes in these indices influence both systems. Additionally, Moos (1987) suggested that individuals are affected by a social matrix which explains human behaviour in terms of interactions between cognitive, behavioural, and environmental influences.

Classroom learning environments contain both social and physical dimension, and many educators and researchers have attempted to find ways of measuring these learning environment dimensions. Moos (1974) made a major contribution to this by describing learning environments dimensions that characterise psychosocial environments. These dimensions are: Relationship Dimension (e.g. Support, Involvement); Personal Development Dimension (such as Autonomy, Competition); and System Maintenance and System Change Dimension (such as Innovation, Clarity, Work Pressure). The Relationship Dimension assesses the extent to which people are involved in the setting, the extent to which they support and help one another, and the extent to which they express themselves freely and openly. The Personal Growth or Goal Orientation Dimension measures the basic goals of the setting, that is, the areas in personal development and self-enhancement tend to occur. The System Maintenance and Change Dimension measures the extent to which the environment is orderly and clear in its expectations, maintains control, and responds to change.

Another conceptual framework for classroom environments was introduced by Arends (1994). It focused specifically on building a productive learning environment. He also proposed basic ideas on how to build a more productive learning environment. This framework is shown in Figure 2.2 and presents four dimensions of classroom environment. These basic ideas include classroom climate, classroom properties, classroom process, and classroom structures.

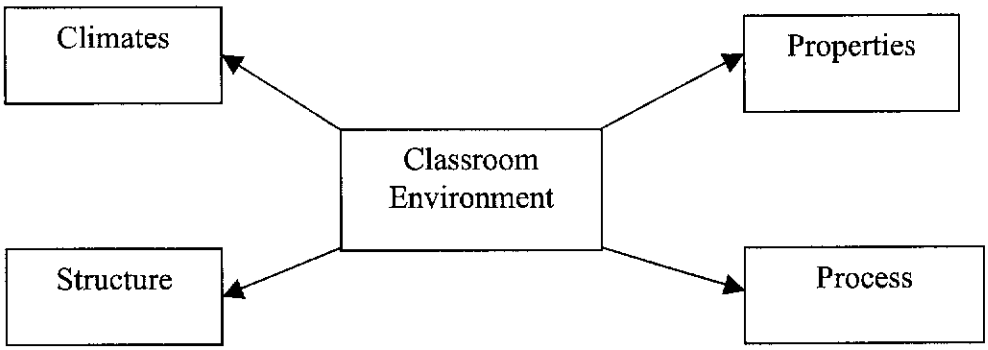


Figure 2.2. Four dimensions of classroom environment.
(Arends, 1994, p.104)

In addition, classroom climate and its relationship to behaviour were clarified by Getzels and Thelen's (1960) model as presented in Figure 2.3.

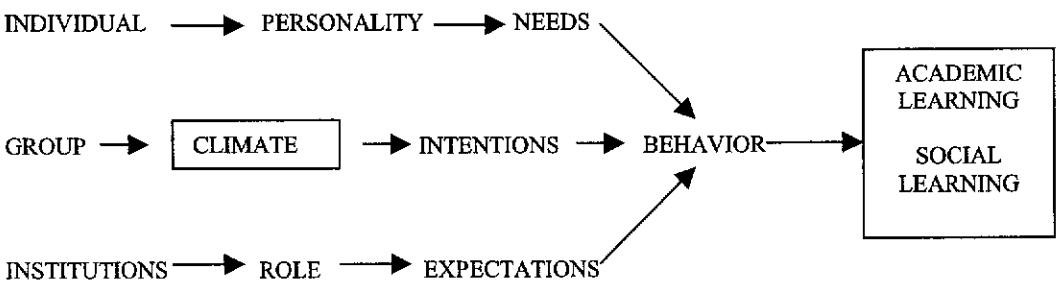


Figure 2.3. The class as a social system.
(Arends, 1994, p.105)

In the Getzels and Thelen's model, classroom groups have two important dimensions; the personal dimension and the social dimension. Both social and personal dimensions determine behaviour within a classroom setting and shape a particular classroom's climate.

2.4 DEVELOPMENT AND USE OF CLASSROOM ENVIRONMENT QUESTIONNAIRES IN SECONDARY SCHOOL

Today, it is clear that the classroom environment plays an important role in teaching and learning and many research studies have indicated quality classroom environment associated with positive learning outcomes (Fraser, 1998).

As mentioned earlier, Moos (1979) identified three domains for use in assessing different educational settings, including university student living groups, junior or senior high school classrooms, families, work milieus, and treatment settings, such as hospitals. Similar to other educators, Moos believed that the classroom is an important focus for student personal and academic growth and this led Moos and Trickett to develop a questionnaire for assessing the qualities of the classroom. The Classroom Environment Scale (CES) was developed and focused on the psychosocial environment of junior high and high school classes. Table 2.1 shows these three domains as used in junior or senior high school classroom of concern to the present research study together with the scales of the CES.

Table 2.1

Moos' Domains of Social Climate Dimensions for Junior or Senior High School Classroom

Relationship	Personal Growth	System Maintenance and Change
Involvement	Task Orientation	Order and Organisation
Affiliation	Competition	Rule Clarity
Teacher Support		Teacher Control
		Innovation

Since that time Moos' influence has led educators to develop more classroom environment instruments based on his dimensions, that are particularly useful in secondary school classroom. Some are the *Individualised Classroom Environment Questionnaire* (ICEQ) (Rentoul & Fraser, 1979), *Constructivist Learning*

Environment Survey (CLES) (Taylor, Fraser, & Fisher, 1997), *What Is Happening In this Classroom* (WIHIC) (Fraser, Fisher, & McRobbie, 1996), *Cultural Learning Environment Questionnaire* (CLEQ) (Fisher & Waldrip, 1997), and *Science Laboratory Environment Inventory* (SLEI) (Fraser, McRobbie, & Giddings, 1993). The development and applications of these questionnaires in previous studies are briefly discussed in the following subsections. It was deemed necessary to do this in order to select the most appropriate questionnaires for use in this research study.

2.4.1 Learning Environment Inventory (LEI)

The Learning Environment Inventory (LEI) was developed in the USA in the late 1960s for use in the evaluation of the Harvard Project Physics course (Fraser, Anderson, & Walberg, 1982) and it contained 14 scales. Originally, it was administered to 500 students in 144 physics classes throughout the USA. The results included the finding, with some modification, that the LEI was a valid and reliable questionnaire and the final version contains15 scales each of 15 items. These scales are Cohesiveness, Diversity, Formality, Speed, Material Environment, Friction, Goal Direction, Favouritism, Difficulty, Apathy, Democracy, Cliqueness, Satisfaction, Disorganisation, and Competitiveness. In the Fraser, Anderson and Walberg study with 1,048 students in 149 classes, the scale alpha reliabilities ranged from 0.54 (for the Diversity scale) to 0.85 (for the Goal Direction scale) and the mean correlation with other scales, a measure of discriminant validity, ranged from 0.08 (for the Competitiveness scale) to 0.40 (for the Disorganisation scale).

Each item is responded to on a four-point scale with the alternatives of 'Strongly Disagree, Disagree, Agree, and Strongly Agree'. Typical Items are, 'All students know each other very well' (the Cohesiveness scale) and, 'The pace of the class is rushed' (the Speed scale).

The LEI also was used to measure learning environments in another country. The Hindi version of LEI was administered in a study involving approximately 3,000 tenth grade students in 83 science and 67 social study classes (Walberg, Singh, & Rasher, 1977). Lawrenz (1975) used three scales of the LEI as a measure of teacher characteristics. These three scales of the LEI were Goal Direction, Formality, and

Democratic scale, and the findings of this study suggested that the Formality scale was negatively related with student achievement.

2.4.2 My Class Inventory (MCI)

The My Class Inventory (MCI) is a simplified form of the LEI for use at the elementary school level (Fraser, 1991). However, it has been found to be useful in the junior high school. It consists of 25 items of the LEI's original 15 scales and a two–point (Yes-No) response format. Typical items are: 'The pupil enjoy their schoolwork in my class' (Satisfaction), 'Certain pupils always want to have their own way' (Friction), 'Most pupils want their work to be better than their friend's work' (Competitiveness), 'In my class the work is hard to do' (Difficulty), 'In my class everybody is my friend' (Cohesiveness).

Majeed, Fraser, & Aldridge (2002) modified the MCI for use in Brunei and employed it to investigate students' perception among 1,565 students from 81 classes in 15 government lower secondary schools in Brunei. The results showed that this modified instrument was valid and reliable. The findings suggested that students generally perceived a positive learning environment in mathematics classes; however, boys and girls had different perceptions of the same classroom learning environment. It was again apparent that these questionnaires could be modified for use in an Asian context.

2.4.3 Classroom Environment Scale (CES)

As discussed earlier in this section, the Classroom Environment Scale, developed by Trickett and Moos (Moos, 1979), was based on Moos' three types of dimension found to be present in all human environments including classrooms' psychiatric wards, military basic training companies and family environments (Moos, 1979; Fisher & Fraser, 1983a). The scales of the CES were designed to cover each of these dimensions: the Relationship dimension contains Involvement, the Affiliation, and Teacher Support; the Personal Growth or Goal Orientation dimension contains Task Orientation and Competition; and the System Maintenance and System Change

dimension contains Order and Organization, Rule Clarity, Teacher Control and Innovation (see Table 2.1).

The CES has three forms each of 90 items. They are the Real Form for assessing the actual classroom, the Ideal Form for assessing teacher and student conceptions of an ideal classroom, and an Expectations Form for assessing expectations about a new classroom. For the item response, a true and false format was used. Typical items are: 'Students put a lot of energy into what they do here' (Involvement scale) and 'The teacher takes a personal interest in the students?' (Teacher Support).

Hirata and Sako (1998) constructed scales to assess Japanese school environments based on the CES. This questionnaire consisted of 29 items and had a different scale structure from the original CES. It consisted of the scales of: Sense of Isolation, Teacher Control that were drawn from the Rule Clarity scale. For the scale of Task Orientation and Conception were not revealed via factor analysis. The 1,635 students from four junior high schools perceived their perceptions through the CES-J. The results suggested that the Sense of Isolation and Affiliation scales are valid factors for at-risk students in Japan.

Fisher and Fraser (1983) used the CES for the first time in Australia. The sample was 1,083 students in secondary science classes. The results showed the alpha reliability ranged from 0.51 (Competition) to 0.75 (Order and Organisation), and the mean correlation of one scale with the other scales ranged from 0.16 to 0.40.

In Asia, Lee and Kim (2002) reported Noh and Choi's study that translated the CES into the Korean language to investigate classroom environments at three different levels in Korea. The levels were primary, junior secondary and senior secondary schools. The findings suggested that the higher-school level students perceived their classroom environments less favourably than did students at the lower school level.

2.4.4 Individualised Classroom Environment Questionnaire (ICEQ)

The initial version of the Individualised Classroom Environment Questionnaire was developed by Rentoul and Fraser (1979). The final version contains 50 items in five scales; these are Personalisation (extent to which opportunities for individual students to interact with the teacher and on concern for the personal welfare and social growth of the individual), Participation (extent to which students are encouraged to participate, rather than be passive learners.), Independence (extent to which students are allow to make decisions and have control over their own learning and behaviour), Investigation (extent to which the skills and process of inquiry and their use in problem solving and investigation), and Differentiation (extent to which the selective treatment of students based upon ability, learning style, work rate, and personal interest).

Typical items are 'The teacher talks with each student (Personalization), and 'Different students do different work' (Differentiation). Each item is responded to on a five-point scale that there is alternative of Almost Never (1), Seldom (2), Sometimes (3), Often (4), and Very Often (5). However, typical of these early questionnaires there are some negative items that have to recode when scoring.

Fraser (1991) suggested that the ICEQ is a valid and reliable from the study conducted with 1,849 students; the value of alpha reliability ranged from 0.68 (for Independence) to 0.79 (for Personalisation), and mean correlation with other scales ranged from 0.07 to 0.28.

Hurst (1999) in a study in the USA reported assessing the impact of a teacher enhancement program on classroom environment in the USA. The ICEQ was used in workshops that were designed for teachers on improving their teaching of life science and biology. The ICEQ was used again to investigate students' perceptions after the professional development program. The findings showed that there was an increased opportunities for individual students to interact with their teacher, the skills and process of inquiry and their use in problem solving and investigation.

2.4.5 Constructivist Learning Environment Surveys (CLES)

The Constructivist Learning Environment Survey (CLES) was developed in 1991 (Taylor & Fraser, 1991) to enable educators and researchers to measure students' perceptions of the extent to which constructivist approaches are part of the classroom environment. This version was based on a psychosocial view of constructivist reform that emphasises students as co-constructors of knowledge. Because the originally used theoretical framework supported only a weak program of constructivist reform, the CLES was revised by incorporating a critical theory perspective on the socio-cultural framework of the classroom learning environment (Taylor, Fraser, & White, 1994). The final version of the CLES (Taylor, Fraser, & Fisher, 1997) consists of five six-item scales. These scales are Personal Relevance (focuses on the connectedness of school science to students' out-of-school experiences), Uncertainty (assesses the extent to which opportunities are provided for students to experience scientific knowledge as arising from theory-dependent inquiry), Critical Voice (assesses the extent to which a social climate has been established in which students feel that it is legitimate and beneficial to question the teacher's pedagogical plans and methods), Shared Control (measures the extent to which students being invited to share with the teacher control of the learning environment and learning goal), and Student Negotiation (concerns with opportunities exist for students to explain and justify their developing ideas to other students).

The CLES is available in two forms, Actual and Preferred. The response format uses a five-Likert scale from Almost Never to Almost Always (scoring from 1 to 5). Typical items are: 'In this class, I learn about the world outside of the classroom' (Personal Relevance), 'I help the teacher to assess my learning (Shared Control)'.

Dryden and Fraser (1998) used the CLES to study the impact of systemic reform efforts in promoting constructivist approaches in high school science in the USA. This study compared the learning environment between biology classes and integrated science classes for the scale of Learner-Centredness. The results of mean score showed that there is slightly more emphasis learner-centred lessons in biology classes than in integrated science classes.

Kim, Fisher, and Fraser (1999) translated the CLES into the Korean language. It was found to be valid and reliable when used for the first time in Korea with 1,083 school students in grades 10 and 11 in 24 classes in 12 schools. They compared the differences in students' perceptions between two grade levels that were grade 10 students who had studied general science and grade 11 students who had studied one of four sciences, such as physics, chemistry, biology, or earth science. There were differences in students' perceptions in that grade 10 students perceived their environment as more constructivists for most scales except Uncertainty. Overall, the results indicated that the efforts of curriculum reform in Korea had produced some positive effects on improving the science learning environment.

Moreover, the CLES was used in a cross-national study (Aldridge, Fraser, Taylor, & Chen, 2000) when administered to 1,081 science students in 50 classes in Australia with the original English version of the CLES and to 1,897 science students in 50 classes in Taiwan with a Mandarin version. When using the individual student as the unit of analysis, they reported the alpha reliabilities ranged from 0.76 (for Uncertainty) to 0.91 (Shared Control) for the English Version and from 0.73 (Critical Voice) to 0.92 (Shared Control) for the Mandarin Version. The mean correlation of one scale with the other scales ranged from 0.31(Shared Control) to 0.44 (Personal Relevance) for the English version and from 0.32 (Shared Control) to 0.42 (Personal Relevance and Student Negotiation) for the Mandarin version.

In 2004, Wanpen and Fisher modified and translated the 30-item version of the CLES into the Thai language to investigate students' perceptions in tertiary computer classes in Thailand. The CLES Thai version showed good reliability and validity indicating that learning environment questionnaires could be translated and used in the Thai language. The students indicated that they preferred a more constructivist learning environments to what they actually perceived to be present.

2.4.6 What Is Happening In this Classroom (WIHIC)

The What is Happening In this Classroom questionnaire (WIHIC) developed by Fraser, Fisher, and McRobbie (1996) includes relevant dimensions from past questionnaires and combines these with dimensions that measure aspects of

cooperation and other emphases relevant to the environment of contemporary classrooms.

The original version of the WIHIC consisted of nine scales and 90 items and was used to measure 355 junior high school science students' perceptions of their classroom environment. The WIHIC was refined by both statistical analysis and interviewing, and the final version contains eight items in each of seven scales. These scales are: Student Cohesiveness that refers to the extent to which students are friendly and supportive of each other; Teacher Support examines the extent to which the teacher helps, befriends, and is interested in students; Involvement assesses the extent to which students have attentive interest, participate in class and are involved with other students in assessing the viability of new ideas; Investigation refers to the extent to which there is emphasis on the skills and of inquiry and their use in problem-solving and investigation; Task Orientation measures the extent to which it is important to complete planned activities and stay on the subject matter; Cooperation refers to the extent to which students cooperate with each other during activities; and Equity assesses the extent to which the teacher treats students equally, including distributing praise, question distribution, and opportunities to be included in discussions.

Typical items are: 'I make friendships among students in this class' (Student Cohesiveness), 'The teacher takes a personal interest in me' (Teacher Support), 'I discuss ideas in class' (Involvement), 'I carry out investigations to test my ideas' (Investigation), 'I do as much as I set out to do' (Task Orientation), and 'I work with other students in this class' (Cooperation). Response alternative are Almost Never, Seldom, Sometimes, Often, and Almost Always, for scoring with 1, 2, 3, 4 and 5, respectively.

Rickards, den Brok, Bull, and Fisher (2003) used the WIHIC with a large sample of Californian middle-school classes to determine which factors influenced students' perceptions of their learning environment. The results indicated that some scales of the WIHIC are more inclined to measure personal, idiosyncratic features of students' perceptions of their learning environments; whereas other scales contain more

variance at the class level. For gender difference perceptions, girls perceived their learning environment more positively than did boys.

Koul and Fisher (2003) reported a study that investigated classroom learning environments by using the WIHIC with 1,021 students from 32 science classes in seven co-educational private schools in Jammu, India. The study confirmed the validity and reliability of the WIHIC. There were positive associations between the three scales of WIHIC (Investigation, Task Orientation and Equity) and student attitudes. The girls on the whole had more positive perceptions of their science classes than did boys and perceived their teacher as more cohesive, task oriented, cooperative and giving them equal opportunity in the class. On the other hand, the boys perceived more teacher support, involvement and investigation activities in the science classroom.

2.4.7 Cultural Learning Environment Questionnaire (the CLEQ)

The Cultural Learning Environment Questionnaire (CLEQ) developed by Fisher and Waldrip (1997) was based on Grashna's three styles of learning: Competitive-Collaborative, Avoidant-Participant, and Dependent-Independent; Hofstede's four dimensions which consist of Power Distance, Uncertainty-Avoidance, Individualism, Musculinity-Feminity; and Moos' dimensions which consist of Relationship, Personal Development, and System Maintenance and Change.

The CLEQ contains 35 items in seven scales: Equity (assesses the extent to which students perceive males and females are treated equally), Collaboration (assesses the extent to which students perceive they collaborate with other students rather than act as individuals, Deference (measures the extent to which students feel they defer to the opinions of others), Competition (concerns the extent to which the students are competitive with each other), Teacher Authority (refers to the extent to which students perceived the teacher has authority in the classroom), Modelling (measures the extent to which the students expect to learn by a process of modelling), and Congruence (assesses the extent to which the students perceive learning at school matches their learning at home). Each scale contains five items that are responded to on a five-point scale with alternative of Disagree-Agree (scoring from 0 to 4).

Typical items are: 'I think that both females and males make excellent teachers' (Equity), 'I like working in groups' (Collaboration), 'I try to say what I think the teacher wants rather than give my own opinions' (Deference), 'It concerns me if I don't do as well as the other students' (Competition), 'I like to question what teachers tell me in class' (Authority), 'I like to have teachers tell me how to work in class' (Modelling), and 'What I learn in this class helps me at home' (Congruence).

Evans (1998) used the CLEQ to examine the cultural background of 2,986 students in secondary science classroom in Australia. The results indicated that the CLEQ was a valid and reliable instrument. The students were aware of gender equality and desirable working groups. Moreover, there was a positive relationship between the scales of CLEQ and students' attitude.

Fisher and Waldrip (2002) used the CLEQ with 3,785 school students in 186 classes in 67 schools in Australia. The findings suggested that each scale of the CLEQ was reliable and valid. There were positive associations with students' attitudes (except Deference and Modelling scale) and achievement of enquiry skills (except Teacher Authority and Modelling scale). In addition, they reported that there were differences in students' perceptions of culturally sensitive factor of the classroom learning environments in four communities in Australia: metropolitan, provincial, rural, and mining town schools. The findings indicated that students from mining areas were more likely to model teachers than metropolitan area students.

2.4.8 College and University Classroom Environment Inventory (CUCEI)

The CUCEI was developed to assess students or instructor perceptions of either actual or preferred environment in small tertiary classes which are often referred to as seminars or tutorials (Fraser, Treagust, Williamson, & Tobin, 1987). The initial development was guided by four criteria: consistency with secondary school instruments; coverage of Moos' general categories; salience to higher education teachers and students, and economy for answering and processing. The first version of the CUCEI contained seven scales (12 items per scale). The final version consists of 49 items in seven scales. These scales are: Personalization (emphasis on opportunities for individual students to interact with the instructor and on concern

for students' personal welfare); Involvement (extent to which students participate actively and attentively in class discussions and activities); Student Cohesiveness (extent to which students know, help, and are friendly toward each other); Satisfaction (extent to which students enjoy the classes); Task Orientation (extent to which class activities are clear and well organized); Innovation (extent to which instructor plans new, unusual class activities teaching techniques, and assignments); and Individualization (extent to which students are allowed to make decisions and are treated differentially according to ability, interest, and rate of working).

Response alternative are Strongly Agree, Agree, Disagree, and Strongly Disagree for scoring with 1, 2, 3, and 4, respectively. Some items are scored in the reverse manner.

Typical items are, 'The instructor considered students' feelings.' (Personalization), 'The instructor talks rather than listens' (Involvement), 'The class is made up of individuals who don't know each other well' (Student Cohesiveness), 'The students look forward to coming to classes' (Satisfaction), 'Students know exactly what has to be done in our class' (Task Orientation), 'New ideas are seldom tried out in this class' (Innovation), 'All students in the class are expected to do the same work, in the same way and in the same time' (Individualization).

Nair (1999) used the CUCEI to investigate the actual and preferred classroom environments at the tertiary levels of education. The sample contained 504 students studying biology, physics, computers science and mathematics in senior secondary schools and tertiary institutions in Australia and Canada. The results of the study showed that the CUCEI was valid and reliable. The results also indicated that the students' learning environment at the higher level was less favourable. Furthermore, there were significant differences in the students' perceptions of the classroom environment according to the maturity of the students. Mature students perceived task orientation and equity more favourably than did younger students. Overall, senior secondary students were more satisfied with their science course than post-secondary students.

2.4.9 Science Laboratory Environment Inventory (SLEI)

It is apparent in the previous sections that during the past three decades, much attention has been focused on the development and use of instruments to assess the quality of the classroom-learning environment from the perspective of students. However, these instruments were developed for non-laboratory learning environments. Consequently, Fraser, McRobbie, and Giddings (1993) developed a new instrument to investigate student perceptions of laboratory learning environments, in both Class and Personal Forms, called the Science Laboratory Environment Inventory (SLEI). It was constructed based on five criteria: consistency with the literature on laboratory teaching, consistency with instruments for no laboratory settings; coverage of Moos' general categories, salience to teachers and students; and economy, achieved with few scales and small number of items.

The initial version of SLEI contained 72 items in eight scales. After field-testing and validity and reliability testing, the final version consists of 35 items in five scales (Fraser, McRobbie, & Giddings 1993) as presented in Table 2.2.

Each item is responded to on a five-point scale with alternatives of Almost Never, Seldom, Sometimes, Often and Very Often. There are some items needed to be reverse scored: Almost Never (5), Seldom (4), Sometimes (3), Often (2) and Very Often (1).

McRobbie and Fraser (1993a) used the SLEI in the first investigation between laboratory environment and student outcomes. The findings showed strong positive associations with both students' cognitive and attitudinal outcomes. Furthermore, they used the SLEI to develop a typology of science laboratory learning environments. (McRobbie & Fraser, 1993b). The finding showed that the elementary schools had a more favourable school environment than high schools, district school or secondary colleges on most of scales.

Table 2.2

Descriptive Information and Sample Item for Each Scale of the SLEI

Scale name	Description of scale	Sample item
Student Cohesiveness (SC)	Extent to which students know, help and are supportive of one another.	I get on well with students in this biology laboratory. (+)
Open-Endedness (OE)	Extent to which the laboratory activities emphasise an open-ended, divergent approach to experimentation.	There is opportunity for me to pursue my own biology interests in this laboratory class. (+)
Integration (I)	Extent to which the laboratory activities are integrated with non laboratory and theory.	What I do in our regular biology class is unrelated to my laboratory work. (-)
Rule Clarity (RC)	Extent to which behaviour in the biology laboratory is guided by formal rules.	My biology laboratory has clear rules to guide my activities. (+)
Material Environment (ME)	Extent to which the biology laboratory equipment and material are adequate.	I find that the biology laboratory is crowded when I am doing experiments. (-)

Items designed (+) are scored 1, 2, 3, 4, and 5 respectively for the responses Almost Never, Seldom, Sometimes, Often, and Very Often. Items (-) are scored in the reverse manner.

Wong and Fraser (1994) used the SLEI with a sample of 1,592 high school chemistry students in 56 classes of Singapore. All scales of the SLEI, with the exception of Open–Endedness, were found to be positively related to students' attitudinal outcomes. Furthermore, it showed that females perceived their environment more favourably than did males on all scales except Open-Endedness.

Harrison, Fisher, and Henderson (1997) used the SLEI to study students' perception of senior high school biology, chemistry and physics laboratory learning environments with 370 students in 20 classes in Tasmania, Australia. The findings showed that scale mean scores for the whole sample ranging from highest to lowest

scores were: Integration (4.14), Student Cohesiveness (3.90), Material Environment (3.86), Rule Clarity (3.54), and Open-Endedness (2.72). The biology students had the lowest scores on the scale of Open-Endedness. The findings also suggested that the SLEI could differentiate between the three subject areas: biology was less integrated than either physics or chemistry; chemistry had more rule clarity than biology and physics. They indicated that in both chemistry and physics, laboratory work was more integrated with theory than was the case in biology.

In Korea, Lee (2003) employed a modified and Korean version of the SLEI to assess 440 students from three streams (humanities, science-oriented, and science-independent stream) in Korea High Schools. This version of the SLEI consisted of 23 items that survived out of the original 35 items of the SLEI after it was validated. The 23-items version had Cronbach alpha coefficients ranging from 0.62 to 0.72 (when using the individual student as the unit of analysis) and 0.58 to 0.97 (when using the class mean as the unit of analysis). The discriminant validity ranged from 0.16 to 0.34. This version indicated that each scale was satisfactory reliability. The results showed that students perceived their science laboratory lessons relatively favourably (by the range of 2.6 to 3.9 for SLEI average item means). Students perceived a high level of cohesiveness and integration but the material and equipment was inadequate. Moreover, there was less open-endedness in the lab. For the differences between the three streams, the students of stream 1 (humanities) and stream 2 (science-oriented) perceived the environment similarly with stream 3 (science independent) perceiving more cohesiveness between themselves in their laboratory sessions and more open-endedness than did the other two streams. Apparently, the rules in the laboratory were less clear than in the other two streams. However, the material environment was perceived more positively than in the other two streams.

Biology practical work is an important component of the biology curriculum in Thailand. Consequently, the SLEI is an appropriate instrument for use in assessing students' perceptions of learning environment in laboratory classes. Therefore, it was translated into Thai and modified for use in the present study. The details of the translation and modification are presented in Chapter 3.

2.5 SUMMARY OF INSTRUMENTS BASED ON MOOS' SCHEME

As has been described in the preceding sections, the development of each questionnaire has built upon the theoretical framework of Moos and his three dimensions of Relationship, Personal Development, and System Maintenance and Change. An overview of the scales of the eight instruments reviewed each of which has been used to assess classroom-learning environment is presented in Table 2.3 together with their classification into Moos' scheme. Recently, other instruments have been developed for specific use in on-line and other technology-rich situations. These are discussed in section 2.11.

Table 2.3

Overview of Scales of Questionnaires Based on Moos' Scheme

Instrument	Scales classified according to Moos' scheme		
	Relationship Dimension	Personal Development Dimensions	System Maintenance & Change Dimensions
Learning Environment Inventory (LEI)	Cohesiveness Friction Favouritism Cliqueness Satisfaction Apathy	Speed Difficulty Competitiveness	Diversity Formality Material Environment Goal Direction Disorganization Democracy
Classroom Environment Scales (CES)	Involvement Affiliation Teacher Support	Task Orientation Competition	Order & Organization Rule Clarity Teacher Control
Individualised Classroom Environment Questionnaire (ICEQ)	Personalization Participation	Independence Investigation	Differentiation
My Class Inventory (MCI)	Cohesiveness Friction Satisfaction	Difficulty Competitiveness	
Cultural Learning Environment Questionnaire (CLEQ)	Equity Collaboration Deference	Competition Modelling	Teacher Authority Congruence
What Is Happening In this Classroom (WIHIC)	Student Cohesiveness Teacher Support Involvement	Investigation Task Orientation Cooperation	Equity
The College and University Classroom Environment Inventory (CUCEI)	Personalization Involvement Student Cohesiveness Satisfaction	Task Orientation	Innovation Individualization
Science Laboratory Environment Inventory (SLEI)	Student Cohesiveness	Open-Endedness Integration	Rule Clarity Material Environment

2.6 THEORETICAL FRAMEWORK OF CLASSROOM INTERACTION

Students and teachers are continually interacting in biology classrooms in Thailand, therefore, it was decided to examine the nature of such interactions. Bany and Johnson (1964) referred to interaction as the modification of behaviour that occurs when two or more persons come in contact for a period of time. They also suggested that individuals influence one another through use of other forms of communication. The process involves the reactions of a number of persons to one another. Moreover, it includes the way in which individuals relate to one another and carry out the tasks essential for the development, maintenance, and growth of the group or social system. The pattern of responding among individuals and within groups' results in the development of cohesiveness, structure, norms, and mutual goals, or conversely, that may lead to conflict and disorganization. In a classroom, interactions may occur between students and students, or students and teachers (Arends, 1994; Bany & Johnson, 1964; Meacham & Wiesen, 1969).

Teacher-student interaction is an important factor in classroom management, as teachers need to achieve good relationships with their students. Using an instrument, such as the Questionnaire on Teacher Interaction (QTI) is a way of finding out how students see these interactions. The QTI was developed as a feedback instrument three decades ago and has been successful in providing feedback to teachers (Wubbels, Créton, Levy, & Hooymayers, 1993). The QTI was influenced by and developed from a model of interpersonal teacher behaviour. In the Netherlands, this model was used to map interpersonal teacher behaviour by Wubbels, Créton, and Hooymayers (1985). Their model was based on a model proposed by Leary (1957) which contains two dimensions, the Proximity or Cooperation-Opposition dimension and the Influence or Dominance-Submission dimension, as presented in Figure 2.4.

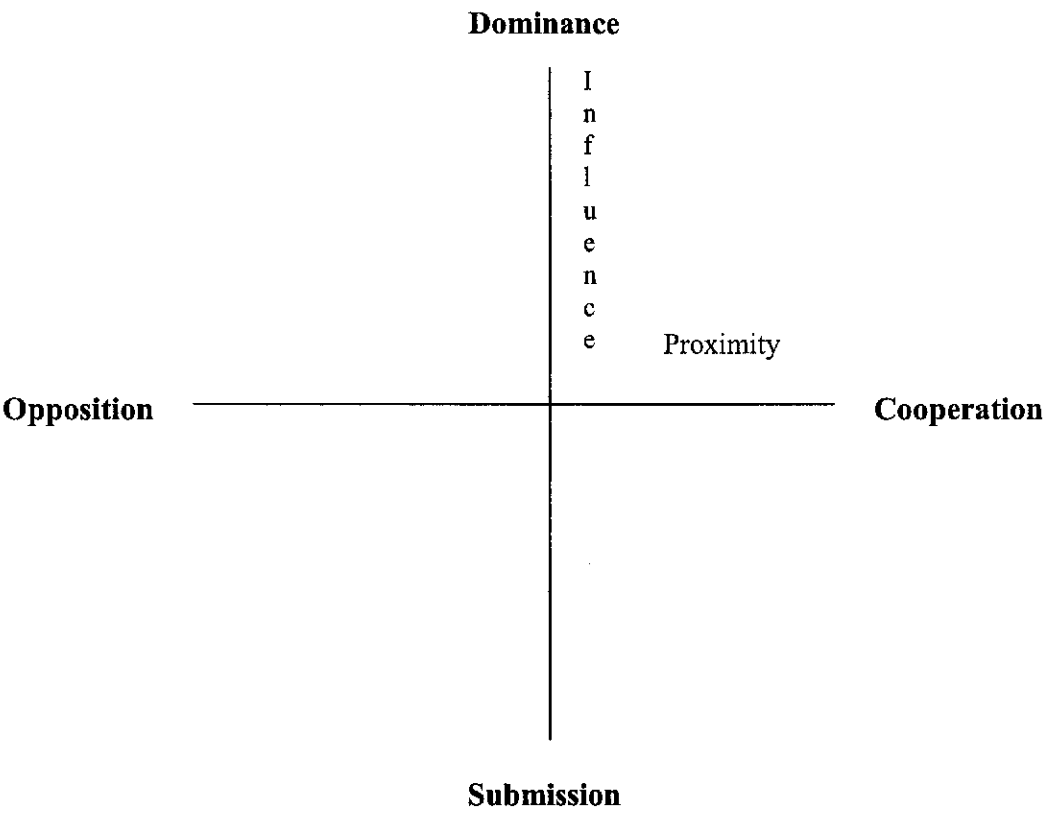


Figure 2.4. The coordinate system of the Leary model.
(Wubbels, Créton, Levy, & Hooymayers, 1993, p. 15)

The Leary model originally was developed for use in research in clinical psychology, and was used to analyze patient-therapist dialogues and group discussions in clinics. This model placed personality at the heart of interpersonal behaviour. (Wubbels, Créton, Levy, & Hooymayers, 1993).

2.6.1 The Questionnaire on Teacher Interaction (QTI)

The Questionnaire on Teacher Interaction (QTI) thus arose based on Leary's Model, (Wubbels, Brekelmans, & Hooymayers, 1991; Wubbels & Levy, 1993). The model was further developed and divided into eight equal sectors. Each sector describes a particular type of behaviours and is named: Leadership (DC), Helping/Friendly (CD), Understanding (CS), Student Responsibility/Freedom (SC), Uncertain (SO), Dissatisfied (OS), Admonishing (OD), and Strict (DO). These sectors are labelled DC, CD, CS, SC, SO, OS, OD and DO which relates to their position in the coordinate system. For example, the two sectors, DC and CD, are both characterized

by Dominance and Cooperation. In the DC sector the Dominance aspect prevails over the cooperation aspect (Wubbels, Créton, Levy, & Hooymayers, 1993). This model can be used to map the behaviour of both teachers and students and is shown in Figure 2.5.

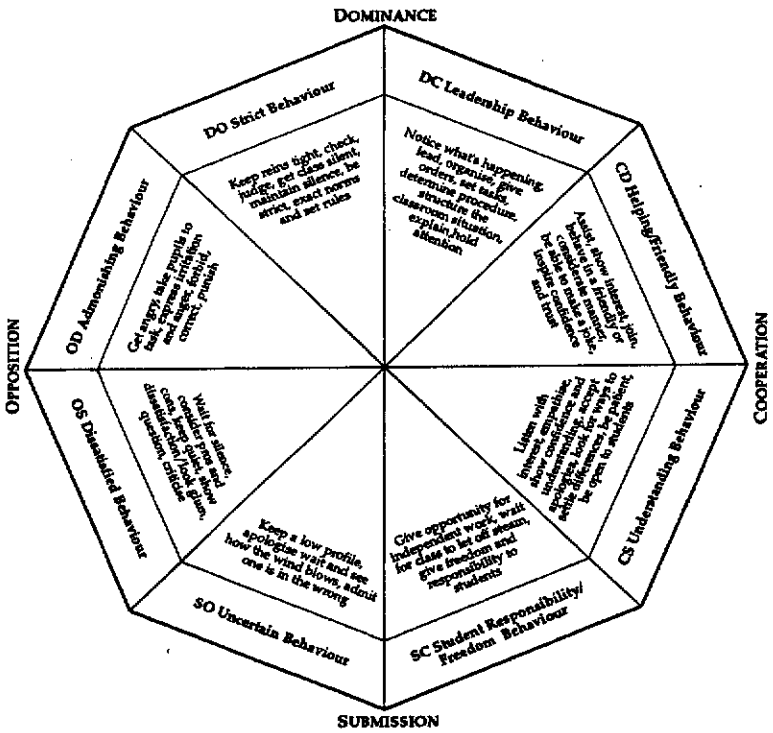


Figure 2.5. The Model for Interpersonal Teacher Behaviour.
(Wubbels, Créton, Levy, & Hooymayers, 1993, p.16)

The first QTI was developed in Dutch for use in the Netherlands (Wubbels, Brekelmans, & Hooymayers, 1991). In the Dutch version each sector scale of the QTI consisted of about ten items. An American version was developed from the Dutch version in the late 1980s (Wubbels & Levy, 1993) and contains 64 items. However, it was shortened in a version used in Australia that consists of 48 items. Table 2.4 presents the number of items allocated in each of the scales in the Dutch, American and Australian versions.

Table 2.4

Number of Items of the QTI in the Dutch, American and Australian Version

Scale		No of items		
		Dutch	American	Australian
DC	Leadership	10	7	6
CD	Helping/Friendly	10	8	6
CS	Understanding	10	8	6
SC	Student Responsibility /Freedom	9	8	6
SO	Uncertain	9	7	6
OS	Dissatisfied	11	9	6
OD	Admonishing	9	8	6
DO	Strict	9	9	6
	Total items	77	64	48

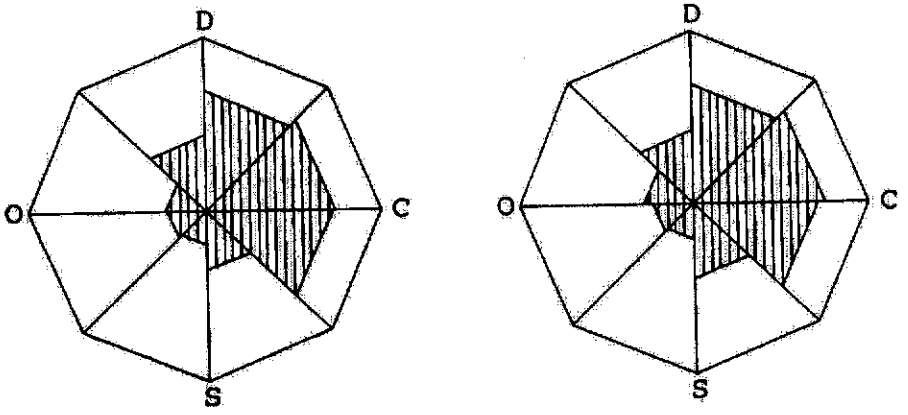
The 48-item version of the QTI is economical in its use of time and is used widely in Australia and other countries. It can be used by teachers to gather students' perceptions both in an Actual Form or an Ideal or Preferred Form. Table 2.5 presents a description of the scales of the QTI and an example item from each scale in the Actual Form.

Table 2.5

Description Information and Sample Item for Each Scale of the QTI (Actual Form)

Scale name	Description of scale	Sample item
Leadership (DC)	Extent to which teacher provides leadership to class and holds student attention	This teacher talks enthusiastically about his/her subject.
Helping/Friendly (CD)	Extent to which teacher is friendly and helpful toward student.	This teacher helps us with our work.
Understanding (CS)	Extent to which teacher shows understanding/ concern/ care to student.	This teacher trusts us.
Student Responsibility/ Freedom (SC)	Extent to which students are given opportunities to assume responsibilities for their own activities.	I can decide some things in this teacher class.
Uncertain (SO)	Extent to which teacher exhibits her/his uncertainty.	This teacher seems uncertain.
Dissatisfied (OS)	Extent to which teacher shows unhappiness/ dissatisfaction with student.	This teacher thinks that we cheat.
Admonishing (OD)	Extent to which teacher shows anger/temper/ impatience in class.	This teacher gets angry unexpectedly.
Strict (DO)	Extent to which the teacher checks, maintains silence & strictly enforces the rules.	This teacher is strict.

The student responses to the QTI items can be totalled for each scale to give a score for that scale. Then these scores can be plotted directly on to the model. For example, Figure 2.4 presents the profile of students' perceptions of volunteer American teachers (across disciplines) and Australian science and mathematics teachers (Levy, Créton, & Wubbels, 1993)



Australian Students American Students

Figure 2.6. Average students' perceptions of volunteer American teachers (across disciplines) and Australian science and mathematics teachers.
(Levy, Créton, & Wubbels, 1993, p. 31)

2.6.2 The QTI and Typology of Teaching

Of note in Moos' (1979a) study was an identification of types of classes using a multivariate cluster analysis procedure resulting in six clusters: Innovation Oriented, Structured Relationship Oriented, Supportive Task Oriented, Supportive Competition Oriented, Unstructured Competition Oriented and Control Oriented. He suggested that these typologies are useful for allowing investigators to select classes to study with some assurance that they are distinctive and represent important and reasonably representative types.

This idea of creating typologies was used in the Netherlands by Wubbels, Brekelmans and Hooymayers (1991). Their typology was based on students' perception of the teacher's interpersonal behaviour and eight types emerged from the cluster analysis. The eight types were: Directive, Authoritative, Authoritative and Tolerant, Tolerant, Uncertain/ Tolerant, Uncertain/Aggressive, Repressive, and Drudging.

The researchers then observed the classrooms of representative teachers of each type. The eight types of teacher styles are different in their characteristics and the natures of the learning environments created in their classes and were described by Wubbels, Brekelmans, and Hooymayers in the following way.

Type 1: Directive teachers are organised, the lesson is well-structured and task-oriented. Directive teachers dominate class discussion. He or she has high standards.

Type 2: The Authoritative teacher is enthusiastic and open to students' needs and frequently use other techniques in his/her class.

Type 3: Authoritative and Tolerant teachers maintain a structure that supports student responsibility and freedom, use a variety of methods and ignore minor disruptions.

Type 4: Tolerant teachers give students more freedom. Their classes sometime become a little confused.

Type 5: The Uncertain/Tolerant teachers are highly cooperative in the class but the classes are always in disorder and they tolerate that situation. However, they are willing to explain and repeat some things to students who have not been listening. Mostly their classes are unstructured.

Type 6: Uncertain/Aggressive teachers are characterized by unpredictable and unbalanced behaviour. It appears that in their classes that learning is viewed as the least important aspect of the class.

Type 7: Repressive teachers make students afraid of them because they always get angry. Their classes are structured but unpleasant. Students will work on individual activities with no help from their teachers.

Type 8: Drudging teachers struggle to manage the classes and do not motivate their students. The class is neither enthusiastic nor supportive nor competitive.

The existence of these typologies allows other teachers to be matched to them as was done in this study.

2.6.3 Past Research on the QTI

Henderson, Fisher and Fraser (2000) used the 48-item version of the QTI with 489 students from 28 senior biology classes (Grade 11 and 12) in eight schools in Tasmania. It had an acceptable internal consistency, with figure for student responses ranging from .63 to .83 when using individual students as the unit of analysis, and from .74 to .95 when the class mean was used as the unit of analysis. The findings showed that students preferred teachers who show strong leadership, more helping and understanding, and who gave their students more responsibility and freedom. Students also preferred teachers who were less uncertain, dissatisfied, and admonishing. For the Strict scale, actual students' perceptions seemed to be similar to their ideal perceptions.

Evans (1998) used the QTI to investigate students' perception in teachers' interpersonal behaviours in 153 classes in 48 Australian lower secondary (grade levels of 8, 9, and 10) schools in two Australian states, Victoria and Western Australia. The result from quantitative methods showed that science teachers in this study were related relatively high on three scales: Leadership, Helping/Friendly and Understanding. A qualitative approach confirmed that students perceived that their teachers were friendly and supportive. The QTI scales of Leadership, Helping/Friendly, Understanding and Student Responsibility had a positive influence on students' attitude toward science, but the scales of Uncertainty, Dissatisfied, Admonishing and Strict had negative influences on students' attitude toward science.

Fisher and Rickards (2000) used the QTI to gather the perceptions of 3,589 students in 173 science classes of grade levels 8, 9, and 10 in 35 different schools in Australia. The result showed that it was a valid and reliable instrument both in a teacher and student version. Teachers perceived greater leadership, helping/ friendly and understanding behaviours in them than did their students and thought they gave less responsibility than did their students. Fisher and Rickards (2000) concluded that the difference indicated that teachers believed they were more cooperative and less

oppositional in the classroom than their students perceived. The alpha reliabilities ranged from 0.63 to 0.88 by using the individual student as the unit of analysis and from 0.78 to 0.96 by using the class mean as the unit of analysis.

In Brunei, Scott and Fisher (2000) translated the QTI into the Malay language and employed it with 3,104 (Years 4, 5, and 6) students in 136 classes in 12 government schools in Brunei Darussalam. The students consisted of 2,542 from special Science Project schools and 562 from Non-Project schools.

The results showed that the Malay version of the QTI was a valid and reliable instrument and it had the ability to differentiate between classrooms and the interscale correlations fitted the circumplex model. The scale means showed that students perceived their teachers mostly as good leaders, helping/friendly, understanding and strict, seldom allowing students' responsibility and freedom, seldom uncertain or dissatisfied, and seldom admonishing. Another result concerned the association between cognitive achievement on an external science examination and the QTI scales. The data showed significant simple correlations between three of the eight QTI scales with students's achievement on their science examination. Helping/friendly and understanding behaviours were positively correlated with achievement and uncertainty was negatively correlated. However, a multiple regression showed that six of the eight scales had very little impact on students' achievement. The two that did have an impact were Helping/Friendly, and Uncertainty scales.

Fisher and Waldrip (2002) reported that there were associations between teacher-student interactions measured with the QTI and the CLEQ scales from an investigation with a sample of 3,785 science students in 186 classes in 67 Australian secondary schools. The findings indicated that most of QTI scales were associated with CLEQ scales. There was least associations for the scale of Student Responsibility while most associations with Admonishing, Dissatisfied and Strict scale.

It was concluded that because of the reliability, validity and suitability of this instrument for the research described in this thesis, the QTI should be translated and

modified into the Thai language. The translation and modification of this questionnaire is addressed in Chapter 3.

2.7 ALTERNATIVE FORMS OF LEARNING ENVIRONMENT INSTRUMENTS

Having different forms and versions of learning environment instruments make them available for use in a variety of research studies. In the early days of the study of learning environments in classrooms, questionnaires such as the LEI and the CES asked students for their perceptions of the learning environment of the class as a whole. They were used extensively for a variety of research purpose and most of the instruments were available both in an Actual Form and a Preferred Form (Fraser, McRobbie, & Fisher, 1996). The Actual Form was concerned with asking respondents questions about the experienced learning environment whereas the Preferred Form focused on the learning environment ideally preferred by respondents or students (Fraser, McRobbie, & Fisher, 1996).

Generally, item wording is almost identical for Actual and Preferred Forms. However, slight wording changes are made to make it clearer to students (Fraser, Giddings, & McRobbie, 1992a). For example, in one item of the Student Cohesiveness scale of the SLEI the equivalent statements are, 'I work cooperatively in laboratory sessions' (for the Actual Form) and 'I would work cooperatively in laboratory sessions' (for the Preferred Form).

An early assumption that a common learning environment was experienced by all students within a classroom was later challenged. For instance, gender differences were noted when studying differences between the perceptions of boys and girls in the same classroom. Therefore, personal forms of learning environment questionnaires were developed and these assessed students' own perceptions of the class rather than what the class' perception might be (Fraser & Tobin, 1991).

Personal forms of learning environment questionnaires uses the same scales and items as the class version, but the wording is altered to elicit the students' perception of his or her individual role within the classroom. For example, an item of the SLEI,

Student Cohesiveness scale is that: 'Students are able to depend on each other for help during laboratory classes' in the Class Form and, 'I am able to depend on other students for help during laboratory classes' in the Personal Form.

Moreover, Fraser and Tobin (1991) suggested that personal forms of classroom environment scales are more valid, especially in research which involves case studies of individual students or which investigates differences in the perceptions of within-classroom subgroups of students, such as gender differences.

Obviously, using personal form of questionnaires can provide private perceptions of students and also can be used to identify differences between subgroups within a classroom, such as males and females. Consequently, because differences between groups were an interest in this study, the personal forms of the questionnaires (the SLEI and the QTI) were used to investigate students' actual and preferred/ideal perceptions. The details of how these forms were used and the versions used in the present study are described in Chapter 3.

2.8 ASSOCIATIONS BETWEEN STUDENTS' PERCEPTIONS OF LEARNING ENVIRONMENT IN SCIENCE CLASS AND STUDENT ACHIEVEMENT

Numerous past classroom environment research studies have shown that students' perceptions account for appreciable amounts of variance in both cognitive and affective learning outcomes (Fraser, 1986; Haertel, Walberg, & Haertel, 1981). However, during the past three decades, research studies on science education have involved students' outcomes focused primarily on educational objectives in the cognitive domain, however, more recently, attention has been paid to outcomes in the affective domain (Weinberg, 1995). Writers have concluded that affective outcomes in education are as important as cognitive outcomes (Shulman & Tamir, 1972).

2.9 RESEARCH ON LEARNING ENVIRONMENT

Nolen (2003) studied the relationship between high school students' perceptions of their learning environments using a sample of 377 students in 22 introductory science classrooms in the USA. The results indicated that perceptions of classroom climate played a significant role in both students' science achievement and satisfaction with learning in science.

She and Fisher (2002) employed an interaction questionnaire named the *Teacher Communication Behaviour Questionnaire* (TCBQ) in the Chinese language to survey teacher communication behaviour and associations with students' cognitive and attitudinal outcomes in secondary science classes in Taiwan. This questionnaire has five scales: Challenging, Encouragement and Praise, Non-Verbal Support, Understanding and Friendly, and Controlling. The finding showed that female students perceived their teachers as more understanding and friendly than did boys, and teachers in biological science classrooms exhibited more favourable behaviour toward their students than did those in physical science classrooms. It was also found that there was a positive relationship between students' perceptions of their teachers' communication behaviours and their attitudes toward science. Students' cognitive achievement scores were higher when students perceived their teachers as using more challenging questions, as giving more nonverbal support, and being more understanding and friendly.

2.9.1 Factors Influence Students' Perceptions of Classroom Learning Environment

Although most reviews of students' perception of learning environment have paid attention to outcome variables, some classroom environments scores have been used as dependent measures to investigate associations with factors like, type of school, school situations, and gender.

2.9.1.1. Gender Differences

A number of research studies on gender-related differences suggest that females at both primary and secondary levels view their teachers as more dominant and more

positive (Goh & Fraser, 1998; Henderson, Fisher, & Fraser, 2003). Fisher and Rickards (1997) used the QTI to investigate gender differences in students' perceptions of interpersonal behaviour in science classes in schools of Australia. They showed that female students perceived greater leadership, helping/friendly and understanding behaviours in their teachers but male students perceived their teachers as being more uncertain, dissatisfied, admonishing and strict. Overall, females perceived their teachers in a more positive way than did males.

Poh (1996) reported on a study of biology laboratory learning environments in Brunei Darussalam. The SLEI was used with 255 Year 10 students from nine secondary schools. The results showed that there were gender differences in student perceptions of biology laboratory learning environments on the two forms (Actual and Preferred). An examination using t-tests indicated that there were significant differences on the scales of Student Cohesiveness, Rule Clarity and Material Environment in which the female students perceived higher scores than did the males. The females also preferred classes that were more student cohesive and in which there were sufficient materials than did males. The mean scores of all scales, except Rule Clarity, for the female students were higher than that of their male counterparts.

Henderson, Fisher, and Fraser (2003) reported the first use of classroom learning environment questionnaires involving senior high school Environmental Science classes. They investigated students' perceptions of their learning environment by using a 35-item questionnaire, namely the *Environmental Science Learning Environment Inventory* (ESLEI) that contained the scales derived from the SLEI (Fraser, McRobbie, & Giddings, 1993) (Student Cohesiveness, Integration, and Material Environment) and the WIHIC (Fraser, Fisher, & McRobbie, 1996) (Involvement and Task Orientation). In the study, gender differences were examined for all scales using a one-way multivariate analysis of variance (MANOVA). The results indicated that there were statistically significant differences in students' perceptions of their learning environments, with females perceiving greater levels of student cohesiveness, integration, task orientation, and involvement, and a more favourable material environment.

Because of consistent gender differences in previous studies it was decided to examine these differences in this research.

2.9.1.2 Type of Schools

Waxman and Huang (1998) investigated students' perceptions of learning environment by using a questionnaire developed from the Classroom Environment Scale (CES) (for the scales of Involvement, Affiliation, Teacher Support, Task Orientation, Order Organization, and Rule Clarity) and the *Instruction Learning Environment Questionnaire* (ILEQ) (for the scales of Satisfaction and Student Aspirations). The sample of students that responded to the questionnaire was 7,075 elementary school students, 4,286 middle school students, and 2,141 high school students. The findings from this study suggested that there were differences among students' perceptions of elementary schools, middle schools, and high schools. The middle school students perceived their classroom learning environment less favourably than did elementary and high school students. The high school students perceived their learning environment with higher mean scores than did elementary and middle school students on the scales of Orientation, and Order and Organization.

2.9.1.3 School Situations

Fisher and Waldrip (2002) developed an instrument for assessing culturally-sensitive factors of learning environments namely the Cultural Learning Environment Questionnaire (CLEQ). They noted that students' perceptions of culturally sensitive factors were different in school situations that were in metropolitan, provincial, rural and mining areas. Mining students were more likely to model teachers than were metropolitan students, but were more likely to perceive congruence between home and school. Metropolitan students were the most competitive and significantly more so than rural students. However, the students in classrooms in rural, provincial, and mining towns generally had similar perceptions of culturally sensitive factors of the learning environment.

Ferguson and Fraser (1999) reported research on the change in learning environment during the transition from primary to secondary school. This research used the QTI and the My Class Inventory (MCI) and investigated change in students' learning environment perceptions across transition, and the role of student sex and change in

school size and other influencing factors in changing perceptions as students transfer from primary to secondary school. The sample comprised 1,040 students from primary schools and their 10 linked secondary schools in Tasmania, Australia. Both quantitative and qualitative methods of data collection were used. This research showed that there were both positive and negative changes in learning perceptions during the transition. They also found that changes in learning environment across transition are related to student sex and school size. They suggested that students from small size primary schools experienced larger deteriorations in learning environment perceptions than did the students from medium-size primary schools. Also, they noted that students whose secondary schools were on the same site as their primary school reported the most favourable changes in learning environment during transition.

2.9.1.4 Students' Attitude toward Science

In the last decade, it is known that there has been a decline in students' positive attitudes toward science, especially declining from the junior to the senior high school (Osborne, Simon, & Collins, 2003). As noted in the previous sections attitudinal measures have frequently been used as measures of student outcomes. In keeping with this tradition in learning environment research, it was decided to explore this aspect for possible use in this study.

Eagly and Chaiken (1993) defined an attitude as a psychological tendency that is expressed by evaluating a particular entity with some degree of favour or disfavour. Similarly, Garrison and Magoon (1972) defined an attitude to be an individual tendency to respond to an object, symbol, concept, or situation in a certain way. Attitude can be classified into five types according to Katz and Stotland (1959): affective associations (the extent to which attitudes become fixed and relatively stable); intellectual attitudes (the extent to which attitudes that may have a heavy cognitive component without a strong affective core); action-oriented attitudes (the extent to which attitudes that exist ready-made in the environment); balanced attitudes (the extent to which attitudes that have cognitive content, an action orientation, an affective core, and serve one's basic accepted needs); and ego-defensive attitudes (the extent to which attitudes are different from balanced attitudes in that they serve arise from internal conflict).

For science education, Klopfer (1971) categorized a set of affective behaviours that consisted of the manifestation of favourable attitudes towards science and scientists: the acceptance of scientific enquiry as a way of thought; the adoption of scientific attitudes; the enjoyment of science learning experiences; the development of interests in science and science-related activities; and the development of an interest in pursuing a career in science or science related work.

Osborne, Simon, and Collins (2003) concluded that the components of measures of attitudes to science consisted of: the perception of the science teacher; anxiety toward science; the value of science; self-esteem at science; motivation on towards science; enjoyment of science; attitudes of peers and friends towards science; attitudes of parents towards science; achievement in science; fear of failure on course; and the nature of the classroom environment.

Ebenezer and Zoller (1993) measured students' attitudes in relation to the interrelationships and interdependencies of science, technology, and society. The results showed that students' attitudes toward science declined in positive attitudes toward science and that the female students' attitudes toward science in society were less favourable than their male counterparts.

In Australia, Henderson, Fisher and Fraser (2000) studied associations between students' perception of their laboratory learning environments and their attitudinal outcome including attitude toward class and attitude toward laboratory work. The SLEI was administered to 489 students from 28 senior biology classes in eight schools in Tasmania, Australia. The findings showed that all SLEI scales, except the Open-Endedness scale, were associated with attitudinal outcomes. The Integration scale was the scale most strongly associated with attitudinal outcomes when other SLEI scales were mutually controlled.

In Asia, Wong and Fraser (1996) studied the relationships between students' perceptions of the psychosocial aspects of their chemistry laboratory classroom environment and their attitudes towards chemistry. The two questionnaires, namely the Chemistry Laboratory Environment Inventory (CLEI) and the *Questionnaire on Chemistry Related Attitudes* (QOCRA), were used with 1,592 final-year secondary

school chemistry students from 56 classes in 28 government schools in Singapore. The QOCRA that was used in this study was adapted from the TOSRA (Fraser, 1981) and consists of three scales, Attitude to Scientific Inquiry in Chemistry, Adoption of Scientific Attitudes to Chemistry, Enjoyment of Chemistry Lessons. The findings showed that rule clarity and material environment were strong and consistent predictors of attitudinal outcomes. It was concluded that there are positive associations between learning environments in chemistry laboratories where knowledge is integrated and the students are provided with clear rules to follow.

Riah and Fraser (1997) reported on a study involving 644 final-year upper-secondary students in 35 classes in 23 schools of Brunei Darussalam using the CLEI and student attitude outcomes. Simple and multiple correlations were used with the individual student as the unit of analysis, and it was found that all scales of the CLEI were significantly correlated with attitudes to chemistry class. Standardised regression coefficients revealed that four of the five scales were independent predictors of students' attitudes towards chemistry laboratory classes. However, the Material Environment scale did not significantly enhance students' attitude towards chemistry laboratory classes.

In addition to research studies on associations between laboratory learning environments and attitudinal outcomes, several research studies have paid attention to associations between students' perceptions of classroom interactions. Henderson, Fisher and Fraser (2000) used the QTI with senior biology classes in high schools in Australia. The results from the study indicated that there was a favourable attitude toward class and laboratory work. All QTI scales showed associations with attitudinal outcomes except for Student Responsibility/Freedom. There was a more favourable attitude toward the class where the students perceived greater leadership and helping/friendly behaviours in their teachers.

Koul and Fisher (2003) administered the QTI to 1,021 students from 31 science classes from years 9 and 10 in seven private co-educational schools in Jammu, India. In this study, the result showed that all scales of the QTI were significantly associated with students' attitudes. There were positive associations between Leadership, Helping/Friendly, Understanding, and Student Responsibility/Freedom

and students' attitudes while negative association occurred with the Uncertain, Dissatisfied and Admonishing scales.

Fisher and Rickards (1997) reported associations between students' perceptions of teacher-student interpersonal behaviour and students' attitudinal outcomes. The results indicated that seven out of eight QTI scales were significantly correlated with students' attitudes to the class and achievement scores. The scales of Leadership, Helping/Friendly and Understanding were positively and significantly correlated with the attitude to class and achievement scores. The scales of Uncertain, Dissatisfied, Admonishing and Strict, had negative associations with attitude to science class.

Furthermore, a study of students' perceptions on interpersonal teacher behaviour in secondary classrooms was conducted in a comparison between Australia and Singapore (Fisher, Rickards, Chiew, & Wong, 1997). This study involved 720 students in 20 grades 8 and 9 science classes in Singapore and 705 students in 29 grades 8 and 9 science classes in Australia. An examination of simple correlation coefficients indicated that there were eight significant relationships between teacher-students interaction and student attitudinal outcomes for the students from both countries. An examination of the beta weights following a multiple regression analysis revealed that five out of eight scales (positive relationship for Leadership, Helping/Friendly, Understanding, Student Responsibility/Freedom; negative relationships for the scales of Dissatisfied, and Strict) for the Singapore student sample, and four out of eight (positive relationship for Leadership, Helping/friendly, Understanding; negative relationships for the scales of Dissatisfied, and Strict) for the Australian sample. The country differences in teacher-student interpersonal behaviour were not large when examined using a two-way MANOVA. However, the results indicated that Australian students perceived greater helping/friendly and understanding behaviour in their teachers, received more responsibility and freedom from their teachers, and perceived their teachers as being more uncertain, dissatisfied and admonishing. Singapore students perceived their teachers as being stricter.

In the work of Fisher and Poh (1997), comparisons of students' perceptions between two groups were investigared. They used the QTI with a student sample that came

from classes who undertook a national science competition in Australia. The sample included 63 Competition Winners and 441 Competition Non-Winners. The results showed that there were relationships between the scales of the QTI and attitudinal scales (Interest in and Enjoyment of Science, Perceived Usefulness of Science, and Application to Science Work). Associations of the QTI scales and attitudinal outcomes for Competition Winners differed from those of Competition Non-Winners. They noted that there were positive associations for Competition Non-Winners with Leadership, Helping/Friendly and Understanding with the two attitudinal scales. But only the Leadership scale was associated with all the attitudinal scales for Competition Winners.

The correlation between students' attitude and classroom learning environment is necessary for effective teaching and learning. The research cited above indicates that using attitude scales is suitable for research studies on learning environments. Therefore, it was decided to use a measure of students' attitude to biology classes, in this study in Thailand. To accomplish this, the Attitude to Biology Class questionnaire (ABC) was developed based on the *Test of Science Related Attitudes* (TOSRA) (Fraser, 1981). Details about the ABC are addressed in Chapter 3.

2.9.2 Research on Learning Environment in Thailand

In Thailand, there are few research studies concerning the learning environment of science classes and there is little evidence of teachers' use of questionnaires in the schools. Sripho (1992) evaluated students' perception of their social environments in science classrooms in Mathayomsuksa 1 (Grade 7) in Samut Prakan province. The questionnaire, namely the ICEQ was translated into Thai and employed with 709 students. The results showed that there was no difference between boys and girls' perception of social environment in their science classroom. Also, there was no difference between students' perception in rural schools and students in urban schools. In 1996, Pranharn investigated the learning environment and its associations with attitude towards science in science classroom. This study involved Mathayomsuksa 3 (Grade 9) science students of schools in Pathum Thani province in Thailand. Students' perceptions of the classroom environment of science classrooms were gathered by using a Thai version of the LEI modified by Fraser

(1982). The findings indicated that students had high levels of positive attitudes towards science but students' perceptions of social environment were at a moderate level. There were an association between attitude towards science and social environment in science classroom.

In 2004, Puacharearn and Fisher modified the 25-item of the CLES into a Thai version. It was used with 606 students in science classes of secondary schools. This version of the CLES showed that it was a valid and reliable instrument for use in Thailand based on a factor analysis and internal consistency measures.

2.10 RESEARCH ON BIOLOGY CLASSES

Harrison, Fisher and Henderson (1997) used the SLEI to study students' perception of senior high school biology, chemistry and physics students of their actual science laboratory learning environments of 370 students of 20 classes in Tasmania, Australia. The findings showed that biology was less integrated than either physics or chemistry; chemistry had more rule clarity than biology and physics; and both of chemistry and physics had more integrated laboratory work with theory than in biology.

Weinburgh and Englehard (1994) investigated the attitude of students toward biology laboratory experiences in 294 students from grades 10, 11 and 12 at a Catholic school in a major metropolitan area in the southeast of Georgia, USA. An attitude scale was developed to measure whether students liked or disliked their laboratory experience. They found that gender had a significant effect on attitudes, with females having more positive attitudes toward their biology laboratory than did the males. Furthermore, the finding indicated that students' belief had the strongest correlations with attitudes in that students who believed laboratory experiences were beneficial had more positive attitudes.

Barba and Cardinale (1991) studied the interaction between the teacher and the students in a secondary school in central Pennsylvania. The sample included students who enrolled were enrolled in five science courses, including general science, biology, earth science, chemistry, and physical science. The results showed that

female students had fewer interactions with science teachers and received less attention. Males received more teacher interaction including more questions. The study concluded that teachers, regardless of their gender, tended to interact more with male students than with female students. Female students tended to provide on-task responses, while male students more frequently provided off-task responses to their teachers. Teachers tended to systematically disengage female students in science classes, while actively eliciting the involvement of male students.

Tsai, Wang, and Huang (2000) investigated how secondary biology teachers used their everyday experiences in planning and practising teaching and how this influenced students' learning. They showed that a group of experienced teachers performed better than a group of beginning teachers on the achievement post and delayed tests. Moreover, on the attitude score, the group of students with the beginning teachers scored higher than did the group of students with the experienced teachers. It was also clear that the experienced teachers were more capable of transferring knowledge to the students than were the beginning teachers, however, the beginning teachers put more effort into arranging learning contexts for student learning than did the experienced teachers.

2.11 CLASSROOM ENVIRONMENT OF TECHNOLOGY-BASED CLASSROOM LEARNING

Today, one of the most important factors that has changed in education, both lower education and higher education, is the technology that influences information and communication. In addition to using media, such as audio and video, multimedia involving the use of computers has developed teaching and learning resulting in changes from the traditional, such as chalk and talk, to an online approach. Web-based learning is an example of this approach. Furthermore, there is a new subject named computer science in which students learn about computers as well as educational media, integrated web-based media.

In the last few years, there has been an increase in the use of technology-based approaches in teaching and learning, while there has been an increasing a number of studies in technology-rich environments in many countries, such as the USA,

Canada, Australia, Singapore, Korea, and Taiwan. These technologies affect the classroom environment and consequently, there has been development in the assessment of technology-based classroom learning environments. A number of these questionnaires are based on the existing questionnaires described previously.

For example, in Australia, Newby and Fisher (1996) developed an instrument based on the SLEI for assessing computer laboratory environment, namely, the *Computer Laboratory Environment Inventory* (CLEI). This instrument has five scales which are Student Cohesiveness, Open-Endedness, Integration, Technology Adequacy and Material Environment, using seven items per scale. The CLEI was used with a sample of 50 Business students to investigate relationships between the students' perceptions of their laboratory environments and their attitudes towards using computers. Each scale was found to have adequate reliability and the attitude towards using computers was found to be higher in those classes perceived as having good Technology Adequacy.

Churach and Fisher (1999) examined the extent and nature of Internet usage and its impact on the constructivist learning environment and students' attitudes toward science by using the CLES questionnaire and an Inventory of Student Internet Usage with students in five Hawaii Catholic high schools. They found that there were positive correlations between student Internet usage and four of the CLES scales (Uncertainty, Critical Voice, Share Control, and Student Negotiation).

Chang and Fisher (2003) developed a new questionnaire to assess student perceptions of the web-based learning environment, namely, the *Web-Based Learning Environment Instrument* (WEBLEI). It was designed for tertiary teachers who have their courses delivered as dependent and/or fully-developed web-based learning applications. This questionnaire contains four scales: Access, Interaction, Response, and Results. Each scale contains eight items and each item is responded to on a five-point Likert scale with the alternatives of Almost Never, Seldom, Sometimes, Often, and Almost Always. The WEBLEI was used first with 344 Electronics Commerce students from the Curtin Business School at Curtin University of Technology, Australia. The findings showed that the instrument has factorial validity and the four scales have acceptable reliability and discriminant

validity from a statistical perspective. The majority of students (95.3%) were new to the concept of studying a unit in an online mode and the use of electronic mail was a popular method of interacting with other students and tutors. The use of bulletin boards and remote library access also indicated that assistance was sought online. Furthermore, it was shown that students spent most of their time studying at home.

In Asia, She and Fisher (2003) examined the learning environment created during the use of an online web-based learning to help students develop an understanding of water pressure in Taiwan. The sample in this study consisted of 459 grades 7 to 9 students from 11 middle schools in Taiwan who provided their perceptions through the use of two questionnaires. The WIHIC, *Web-based Computer Assisted Learning* WBCAL, and the *Satisfaction of Web-based Learning* (SWBL) were the questionnaires used. Additional scales, namely, Challenging, Differentiation, and Students' Self-Efficacy scales also were used in the study. The WBCAL explored students' perception of the web-based computer assisted learning environment consisted three scales, namely, the Attitude to Using Computers, adapted from the TOSRA (Fraser, 1981), Computer Usage, and Web Usage scales. The SWBL questionnaire consisted of three scales, namely, the Attitude toward www Learning, Reasoning toward www Learning, and Challenging www Learning scales. The findings indicated that students viewed their learning environments positively and the environments were characterized by relatively high levels of student cohesiveness, task orientation, cooperation, equity and differentiation. Overall, students perceived their teacher as using more challenging questions. Students rated their satisfaction about learning in this web-based science learning program as highly positive and students' attitudes toward using computers and web usage were very favourable.

Lang and Wong (2003) developed the *E-learning Classroom Environment Questionnaire* (ELCEQ) from the *Computer Classroom Environment Inventory* (CCEI) (Maor & Fraser, 1996) to assess students' perceptions of their e-learning classroom learning environments. In the modification, the statements in the CCEI were just changed to words to describe the context of e-learning in the ELCEQ. For example, 'this class' was changed to 'this module' and 'computers' was changed to 'web-based tools' (Lang & Wong, 2003, p. 298). The ELCEQ consists of 30 items in

five scales: Investigation (the extent to which the skills and processes of inquiry are used in investigation and problem solving), Open-Endedness (the extent to which the learning activities emphasise on open-ended, divergent approach to experimentation), Organisation (the extent to which the learning activities are presented in an organised manner), Material Environment (the extent to which, and Satisfaction (the extent to which students enjoy learning). It used a 5-point Likert scale with response options of Almost Never, Seldom, Sometimes, Often, and Almost Always. The ELCEQ was used to assess 134 students in lower secondary science classrooms in Singapore (Lang & Wong, 2003). The results suggested that the students perceived the learning environment with e-learning incorporated into face-to-face interaction to be positive.

Clayton (2003) explored the concepts and procedures of online learning and used these in the development and validation of an online learning environment perceptual measure. The instrument, namely, the *On Line Learning Environment Survey* (OLLES) consists of eight scales: Computer Competence (extent to which the student feels comfortable and enjoys using computers in the online environment), Material Environment (extent to which the computer hardware and software are adequate and user friendly), Student Collaboration (extent to which students work together, know, help, support, and friendly to each other), Tutor Support (extent to which the tutors guide students in their learning and provide sensitive, ongoing and encouraging support), Active Learning (extent to which the computer activities support students in their learning and provide ongoing and relevant feedback), Order and Organization (extent to which class activities are well organized and assist student comprehension), Information Design and Appeal (extent to which class materials are clear, stimulating and visually pleasing to the student), and Reflective Thinking (extent to which reflective activities are encouraged and how students enjoyed learning and participating in this environment). Typical items in the OLLES are: 'I have no problems using a range of computer technologies' (Computer Competence), 'The feedback I receive from activities/ quizzes are meaningful' (Active Learning), and 'The material presented is visually appealing' (Information Design and Appeal).

In addition to such studies of learning environments in classes using technology, there are other research studies focused on an association between technologies and teaching and learning in a science classroom. For example, Chandra and Fisher (2003) studied the impact of a teacher-designed website on students. The website, namely *Getsmart,* was conducted with classes Year 10 science and Years 11 and 12 physics. The website was designed to assist students' learning of science concepts by providing students with the opportunity for research and for further enhancing their understanding. Moreover, the website gave students an opportunity to email a question or query, and access a private chat room (for Year 11 and Year 12). After accessing the *Getsmart,* the students expressed their perceptions by sending an email to their teacher. The results suggested that the website did have a positive impact on students learning.

Overall, it can be observed that results obtained with these new questionnaires designed for use in technology-rich environments are similar to those obtained previously in more traditional learning environments.

2.12 SUMMARY

It has been found through significant literature that there have been an increasing number of classroom learning environment research studies employing student perceptual data over the past 30 years in Western countries including Australia and some countries in Asia such as Japan (Hirata & Sako, 1998), Korea (Kim, Fisher, & Fraser, 1999), Taiwan (She, 1998; She & Fisher, 2000; 2002), Singapore (Goh & Fraser, 1998; Wong & Fraser, 1995), Brunei (Majeed, Fraser, & Aldridge, 2002; Riah & Fraser, 1997; Scott & Fisher, 2001), and Indonesia (Soerjaningsih, Fraser, & Aldridge, 2001). However, rarely has there been a classroom learning environment study in science classes in Thailand, especially in biology classes. So this study is important and breaks new ground on classroom-learning environment research in science education in Thailand.

Following an examination of all previous questionnaires, it was decided that this study would be concerned with two instruments for use in evaluating classroom environment, namely, the QTI and the SLEI. They were administered to gather

students' perceptions in secondary school biology classes in Thailand. How this was achieved is addressed in the next chapter which describes the methodology selected for this research.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

The previous chapters provided an introduction to the study (Chapter 1) and a review of related literature in the field of classroom learning environments (Chapter 2). This chapter describes the methodology adopted in order to achieve the objectives of this study.

As discussed in Chapter 1, the objectives of this study were:

- to validate the Thai version of the QTI;
- to validate the Thai version of the SLEI;
- to investigate students' perceptions of teachers' interpersonal behaviours in biology classes in Thailand;
- to investigate students' perceptions on laboratory learning environments in biology classes in Thailand;
- to determine associations between teacher-student interactions and students' perceptions of their biology laboratory learning environments;
- to determine associations between teacher–student interactions and students' attitudes to biology classes; and
- to determine associations between students' perceptions of laboratory learning environments and their attitudes to biology classes.

The method of research consisted of two phases. The first phase, the *Preparation Phase*, is described in Section 3.2 and involved selection of the instruments (Section 3.2.1), selecting the random sample (Section 3.2.2), and preparation for the administration of the questionnaires by obtaining permission (Section 3.2.3). The second phase, the *Implementation Phase* (Section 3.3), involved the data collection (Section 3.3.1) and data analysis (Section 3.3.2).

3.2 PREPARATION PHASE

This research was conducted with biology classes in secondary schools in Thailand. The government schools in the three provinces, that are the service areas of the Rajabhat Institute Udon Thani, were chosen to be involved in the investigation. These provinces are Udon Thani, Nong Khai, and Nong Bua Lumphu. The government schools of these provinces are administered, managed and controlled by the same committee, namely, the Committee of General Education. This is one of nine educational regions in Thailand. It was considered that the schools in these three provinces would have similar learning environments.

3.2.1 Selection of the Instruments

As described in Chapter 1, this study used two instruments for assessing students' perceptions of learning environments in secondary biology classes in Thailand, namely, the QTI for assessing teacher-student interactions and the SLEI for measuring student perceptions of their biology laboratory environments. Furthermore, the Attitude to Biology Class questionnaire (the ABC) was used to assess students' attitudes to their biology classes. The instruments were translated into the Thai language and adapted to make them suitable for use in secondary schools in Thailand, and then back translated into English. Brislin (1983) suggested that there are four basic translation techniques that can be used in survey research. These are back translation, bilingual method, committee procedure and pretest technique. He suggested that the process of back translation ensures literacy, and facilitates the recognition of mistakes. However, Bulmer and Warwick (1983) suggested that the back translation might lead the investigator to assume that equivalence has been achieved when it has not. Some concepts may not have equivalents in another language, and even when they do, the exact meaning may be utterly different. However, mindful of these possible concerns, this procedure was selected and carefully used in this study.

The instruments were initially field tested with a sample of 45, Grade 10 students from one class in one school, to ensure that the translated items were interpreted by Thai students in the same way as the meaning of the original items. Moreover, the

appropriate amount of time for students to answer all questionnaires was also checked in the field test. The results of the field test were used to modify the questionnaires for the main study. The following sections describe the questionnaires in more detail.

3.2.1.1 The QTI

To assess teacher-student interactions in biology classes, The Questionnaire on Teacher Interaction (QTI) was selected. The QTI was developed originally in Dutch to study secondary classrooms in the Netherlands (Wubbels, Brekelmans, & Hermans, 1987). It was translated into an English version consisting of 64 items in the eight scales of Leadership (DC), Helping/Friendly (CD), Understanding (CS), Student Responsibility/Freedom (SC), Uncertain (SO), Dissatisfied (OS), Admonishing (OD), and Strict (DO). This English version was used widely in the USA and this indicated that it was a reliable and valid instrument. Seven of the eight scales had reliabilities in excess of 0.90 when used in The Netherlands and the USA (Wubbels & Levy, 1991, 1993).

The QTI was modified to form an Australian 48–item version (Fisher, Fraser, & Wubbels, 1993). This version has also been used in many research studies as described in the literature review in Chapter 2. However, a most interesting and relevant research study was done by Fisher, Henderson, and Fraser (1995); the QTI was used to examine associations between student perceptions of learning environments in senior biology classes with a sample of 489 students in 28 biology classes in Tasmania, Australia. The result of this study showed that the alpha reliability for different scales ranged from 0.63 to 0.83 when the individual student was used as the unit of analysis. Furthermore it was found that the dimensions of the questionnaire were associated significantly with student attitude scores, in particular attitude scores were higher in classroom in which students perceived greater leadership, helpful/friendly, and understanding in their teachers' interpersonal behaviours.

Besides these English versions, the QTI has also been translated into other languages for particular use in assessing student perceptions in countries where English is not the native language. For instance, Scott and Fisher (2003) modified the QTI into a

Malay language version, called the QTIP and used it to assess student perceptions in primary schools in Brunei. Soerjaningsh (2003) modified the QTI into an Indonesian version for use at the university level for identifying which types of interactions were most likely to promote attitudinal outcomes at the university level. Lee (2003) modified the QTI into a Korean version. In each of these studies the reliability figures were satisfactory. For example, Lee provided a reliability analysis (Cronbach alpha coefficient) for different scales ranging from 0.55 for Dissatisfied to 0.81 for Uncertain. Furthermore, she reported the eta^2 ranging from 0.07 to 0.17 indicating that the QTI was able to differentiate significantly between students' perceptions in different classes. Also, the pattern of scale intercorrelations from the Korean version, showed the highest correlation with the adjacent scale Understanding of 0.65 (r) and the highest negative correlation with the opposite of the Helping/ Friendly scale was Dissatisfied scale of 0.42 (r).

In this study, the modified Australian 48–item version of QTI was selected for use in investigating student perceptions in Thailand because of its previous validation, its economy as described, and because it has been translated into other languages without a consequent loss of validity.

3.2.1.2 The SLEI

This instrument was initially developed in a Class Form to measure learning environment in science laboratories (Fraser, Giddings & McRobbie, 1992, 1995). It consists of 35 items validated with both students in schools and universities from six countries: USA, Canada, Australia, England, Nigeria, and Israel. The Personal Form, however, was developed from that Class Form (Fraser, Giddings, & McRobbie, 1995). Notably, not in Thailand. It was decided to use the Personal Form in this study because the researcher believed that the Thai students would understand the individual aspects in the meaning of the items in this form better than they would in the Class Form. The Personal Form has been validated in studies involving students in Australian secondary chemistry classes (Fraser, Giddings, & McRobbie, 1995), in Singapore (Wong & Fraser, 1995) and Brunei (Riah & Fraser, 1997b). Importantly, the validity and usability of this form was confirmed with Australian secondary biology students (Fisher, Henderson, & Fraser, 1997). Moreover, this form had been used in other translated versions in other countries where English is not the mother

language. For instance, Lee (2003) developed a 23-item Korean version of the SLEI by deleting twelve items from an original version and showed that the reliability, in terms of Cronbach alpha coefficients ranged from 0.62 to 0.72 when using the individual student as the unit of analysis, and from 0.58 to 0.97 when using the class mean as the unit of analysis.

The 35-item version of SLEI contains both of positive and negative items as shown in Table 3.1. The negative items needed to be reverse scored as described in section 3.3.2 Data Analysis.

Table 3.1

Positive and Negative Items in Each Scale of the SLEI

Scale	Item Number		Total Items
	Positive Items	Negative Items	
Student Cohesiveness (SC)	1, 11, 16, 21, 31	6, 26,	7
Open-Endedness (OE)	2, 7, 12, 17, 22, 32	27	7
Integration (I)	13, 18, 28	3, 8, 23, 33	7
Rule Clarity (RC)	4, 14, 19, 29, 34	9, 24,	7
Material Environment (ME)	10, 30, 35	5, 15, 20, 25	7

3.2.1.3 The ABC

The ABC is a questionnaire used to assess students' attitudes to biology classes in order to investigate associations with scales of the QTI and SLEI. It consisted of seven items drawn from items in the attitudinal questionnaire, TOSRA. The TOSRA was developed by Fraser (1981) to measure students' attitude in secondary science classes. It consisted of 70 items within seven attitude scales based on Klopfer's rationale: Social Implication of Science (S), Normality of Scientists (N), Attitude to Scientific Attitudes (A), Enjoyment of Science Lessons, Leisure Interest in Science (L), and Career Interest in Science (C).

Fisher, Henderson, and Fraser (1997) later added one more item. Therefore, this study used a seven-item from Enjoyment of Science Lessons scale that has been previously validated. To measure students' attitude in biology classes in Thailand, it was translated into a Thai version to ensure its suitability for Thai students. However, the original version was developed for science classes, therefore replacing the word 'science' with the word 'biology' provided a more suitable wording for each item in this study.

3.2.1.4 Response Format

The response sheets of the SLEI, QTI, and ABC use a 5-point Likert scale format. Scoring involves the numbers 1, 2, 3, 4, and 5 for the responses: from Never to Always, for the QTI and the ABC and Almost Never, Seldom, Sometimes, Often, and Very Often for the SLEI. However, some items had a negative meaning and the scoring was reversed, as described in Section 3.5 (Data Analysis). Students who responded to the questionnaire were asked to put the student identity number of their classes and their names if they preferred.

The students' responses of the QTI, the SLEI and the ABC were transposed to five-point number scales from 1 to 5. Responses of the QTI were transposed so that Strongly Agree rated 5 and Strongly Disagree rated 1. Responses of the SLEI were transposed so that Very Often rated 5 and Almost Never rated 1.

The responses to the ABC items were scored in the same way as the QTI. Some of the items were reversed-scored.

The students' gender, the school size, and class identity were entered by denoting numbers as: 1 (male) and 2 (female); 1(small school), 2(medium school) and 3 (large school); and 1 to 37 for classes. For school size, large schools were defined as having more than 1,500 students, medium schools had between 500 and 1,499 students, and small schools had less than 500 students (MOE, 2003).

3.2.2 Random Sampling Procedures

The sample for this study was composed of grade 10 students who studied in secondary government schools of Thailand. There were two reasons why grade 10 students were selected. Firstly, grade 10 is the first year of upper-secondary education in Thailand so most students have transferred from other lower secondary schools. These students have to adapt themselves to such new schools including new friends, new teachers, and especially new styles of teaching and learning. It is of interest to study the information from students who come from several different places and backgrounds with different basic knowledge. Secondly, teachers who teach students regarding this research have been provided information from the results and can used this to manage the learning environments in their classes and make it more suitable for students when they continue their studies in Grade 11 or 12.

The government schools in three provinces, which are the service areas of the Rajabhat Institute Udon Thani were chosen to be involved. These provinces are in Udon Thani, Nong Khai, and Nong Bua Lumphu. The government schools of these provinces are administered, managed and controlled by the same committee, namely, the Committee of General Education for the educational region that supervise this level of education all these provinces (the ninth educational region) of Thailand. It was considered that these three provinces are similar in nature.

The size of the sample was calculated by the procedure of random stratified sampling which is a modification of simple random sampling and systematic sampling designed to produce a more representative and accurate sample of the total population (Berg, 2001; De Vaus, 1991). The population was divided into subgroups and independent samples of each stratum were selected. There were three subgroups that were the three provinces. Table 3.2 indicates the number of sample schools in the three provinces that were selected by a stratified sampling method. The number of schools in each province amounted to 25% of all the schools in that province.

The total number of government secondary schools in the provinces was 150 (cited in Committee of General Education Department of Thailand). The number of classes

size selected from the provinces was 17 of 71 classes from Udon Thani, 13 of 57 classes from Nong Khai, and 7 of 22 classes from Nong Bua Lumphu. After permission was received, the total student sample that completed the questionnaires was composed of 1,194 students in 37 biology classes in Thailand in the academic year 2002. In addition, five students from each school were allowed by their teachers to be interviewed which was the qualitative method used in the study and described in Section 3.3.1.2.

The students who participated in this study came from 37 government schools in three provinces of Thailand. Table 3.2 indicates the number of classes and students from each province who participated.

Table 3.2

The Number of Classes and Students from Three Provinces

Provinces	No. of Classes	No. of Students
Udon Thani	17	598
Nong Khai	14	439
Nong Bua Lam Phu	6	157
Total	37	1,194

3.2.3 Administration Permission

Letters, approved by the President of the Rajabhat Institute Udon Thani, requesting permission to conduct the research were sent, on behalf of the Institute, to the Committee of General Education of these provinces and then further letters were sent to the schools' directors or principals. These letters were written in the Thai language and an example is provided in Appendix J. In addition to this request for permission, the objectives of the research were also described. The possible impact of the research on the schools was described and an assurance given that the names of students, teachers and schools would not be referred to in the study. The teachers were provided with a form on which to indicate their willingness to take part in this research. Follow-up letters were sent to them requesting them to reply and indicate

what date was suitable for the administration of the questionnaires and the interviews with their students. The teachers were also requested to provide their names to facilitate the process. Where necessary follow-up letters were sent to the schools.

3.3 IMPLEMENTATION PHASE

To collect data, according to Anderson (1998), there are four approaches: Non-personal interaction with a subject who provides data, personal interaction with a subject who provides data, observation of a setting and examination of documents and artifacts. He addressed the strengths of questionnaires that are highly efficient for data collection with a large number of respondents. Furthermore, use of a questionnaire lends itself to quantitative analysis and shows the use of powerful descriptive and inferential statistics.

Its weakness is that it lends itself to response bias if people who respond it do not understand. However, whereas this involves non-personal interactions with subjects who provide data, the interview is a personal interaction with the person.

Traditionally, quantitative research methods are based on the collection and analysis of numerical data, obtained from questionnaires, tests, checklists, and other formal paper-and-pencil instruments. Gay and Airasain (2003) stated quantitative research method, called *positivist*, is the assumption that the coherent world can be measured, understood and generalized. It implies that the worlds and laws that govern it are relatively stable and predictable. However, it involves both the hypotheses to be examined and the research procedures that will be carried out in the study. The approaches concern data collection and the use of large samples of participants to provide statistically valid data.

Conversely, qualitative research approaches are based on the collection and analysis of non-numerical data such as observations, interviews and focus groups. The qualitative researchers do not believe the assumption that we can view a stable, coherent or uniform world, but they accept that different people and groups often have different perspectives and contexts (Gay & Airasain, 2003).

Although, the quantitative and qualitative research methods are different in meaning they have been conducted to present complementary components. Fraser and Tobin (1991) recommended the approach of combining qualitative and quantitative methods providing data with more depth than using only one of the methods. Bryman (1992) suggested qualitative data help to partly explain patterns that are established by the quantitative data.

It was decided to accept the advice of Fraser and Tobin, and in keeping with many recent learning environment research studies, combine both quantitative and qualitative approaches in this study. An approach that combines several research methodologies in the same study is called *triangulation* (Denzin, 1988).The quantitative and qualitative research methods used in this study were questionnaires and the interviews. The details of quantitative method and qualitative method are described in section 3.3.1.1 and section 3.3.1.2, respectively.

3.3.1 Data Collection

Data collection occurred during the second term of the academic year 2002 in Thailand (November 2002 – March 2003). The researcher confirmed the appropriate venue and physical arrangements with teachers who were in charge of the timetable. On the day of the administration, the questionnaires were brought to each school by the researcher to ensure that all students were given the same information. The objectives of the research and instructions were read to students before they started responding to the questionnaires.

3.3.1.1 Quantitative methods

The three questionnaires, the QTI, the SLEI, and the ABC were taken to the sample schools around the tenth week, which is in the mid-term academic year. The questionnaires comprised two parts: Part One involved the Actual Forms of the QTI and the SLEI and the ABC; and Part Two involved the Ideal Form of the QTI and the Preferred Form of the SLEI, as shown in Table 3.3.

Table 3.3

Summary of Questionnaires Used in the Quantitative Method

Part I		Part II	
Questionnaires	No of Items	Questionnaires	No of Items
• The QTI (Actual Form)	48	• The QTI (Ideal Form)	48
• The SLEI (Actual Form)	35	• The SLEI (Preferred Form)	35
		• The ABC	7
Total	83		90

The administration of each part of the questionnaire lasted about one hour. The students were requested to answer Part One first. The response sheets were collected at the end of answering the questionnaires and then the student representatives from each class were interviewed in another room provided by the school.

3.3.1.2 Qualitative methods

A qualitative method was used in the classrooms to refine the questionnaires, to seek explanations of why students responded in the way they did, and to obtain a better understanding of the typical biology classroom learning environments in Thailand. This method required that the interviews accompanied the administering of the questionnaires.

Fontana and Frey (1994) stated that interviewing is the most common and most powerful way for researchers to try to understand his/her follows human beings. There is an interaction between interviewer and interviewee. Moreover, it can be used for the purpose of investigating the understanding from both an individual or group perspective. The common types of interviewing are individual, face-to-face verbal interchange; face-to-face group interviewing, mailed or self-administered

questionnaires and telephone surveys. Also, interviews can be structured,semi-structured, or unstructured. Rosnow and Rosenthal (2002) addressed the advantages of a face-to-face interview and suggested that it provides for the trust and cooperation of the participants, helps the researcher to interpret the questionnaire, and is flexible in that the sequence of questions can be varied.

In this study the interviews were also used to confirm the construct validity of the SLEI and the QTI in biology classes. The follow-up student interviews were conducted with about 10% of students from each class. This procedure was a group interview and took about one hour. Each group contained both male and female students from each class. The interview was audio-taped, later transcribed in Thai and then translated into English for this report.

Anderson (1998) stated that when this procedure has been followed few respondents refuse to be interviewed leading to a 100 per cent response rate and good validity for the sample interviewed. However, this procedure may lead to interviewees saying things to please, rather than speaking truthfully. Care needs to be taken to make sure the message given is true. Overall, this procedure is inexpensive, data rich, flexible, stimulating, and elaborative of individual responses and was utilized in the study.

The reliability of this qualitative method can be regarded as a fit between what researcher's record as data and what actually occurs in the natural setting while collecting the data (Cohen, Manion, & Morrison, 2000). The audio-taping and consequent analysis of the interviews was an attempt to ensure the qualitative data reported were reliable.

The interview guide was prepared in relation to answering the following questions about the questionnaires.

- What are the student perceptions of the scales that the statements are examining?
- Does the concept of each scale appear to be important to students?

- Do the scales of this questionnaire (the QTI) reflect characteristics of interaction between teacher and students?
- Do the scales of this questionnaire (the SLEI) reflect characteristics of learning environments in your laboratory biology classes?
- How do students interpret each scale of this questionnaire (the QTI)?
- How do students interpret each scale of this questionnaire (the SLEI)?

From this interview guide, the following protocol was developed and used with each group of students in Thai:

Hello every one. Thank you for participating in the interview.
My name is Duangsmorn Kijkosol.
I am a teacher at the Rajabhat Institute Udonthani.
It is the first year for you to study the upper secondary school, isn't it?
Do you mind if I record the interview by tape recorder?
Could you tell your name for me? Please.

Questions about the QTI:

What do you think about this questionnaire? Is it useful for improving teaching and learning biology?

What kinds of the interaction between you and your teacher do you think are important in biology class?

Is the questionnaire (QTI) clear to you?

Do you think anything should be added to the interaction questionnaire?

Questions about the SLEI:

What do you think about this questionnaire? Is it useful for improving biology laboratory?

What kinds of environments do you think are important when you do biology practicals (working in the biology laboratory)?

Is the questionnaire (SLEI) clear to you?

Do you think anything should be added to the learning environment questionnaire?

The answers from the interviews were transcribed in Thai and then translated into English for the report that is presented in Chapter 4.

3.3.2 Data Analysis

The students' responses were checked for errors and then were entered class-by-class onto Microsoft Excel spreadsheets. The data in the spreadsheets were subsequently transferred to SPSS Version 11 for statistical analyses as recommended by Morgan, Griego, and Gloeckner (2001) and Coakes and Steed (2003).

The statistical analyses used in this study are related to the research questions in the following discussion.

Research question 1: Is the Thai version of the QTI a valid and reliable instrument for use in Thailand?

To measure the reliability of both forms (actual and ideal) of the QTI, the Cronbach alpha coefficients (Cronbach, 1951) were computed for each scale by using both the individual student and class mean as units of analysis. The alpha validity coefficients can vary from 0.00 to 1.00: the value 0.00 indicates no reliability and 1.00 perfect ability. Another value, 0.60, is considered as a sufficient level of scale internal consistency for scales like those used in the QTI and SLEI (Nunnally, 1967). To provide a satisfactory validated version of the QTI, some items were deleted following these analyses.

DeVellis (1991, p. 25) observed that the internal consistency was concerned with the homogeneity of the items comprising a scale. He stated 'relationships among items are connected to the relationships of items to the latent variable. If the items of a scale have strong relationships to their latent variable, they will have a strong relationship to each other.'

Another important feature is the ability of a scale to differentiate between students' reactions to questionnaires from different classrooms (Fisher, Henderson, & Fraser, 1997; Fisher, McRobbie, & Giddings, 1993).

The eta^2, the ratio of the between group sum of squares and the total sum of squares, was analysed to indicate the ability to differentiate between classrooms. These statistical figures indicated whether the scales of the questionnaires were able to differentiate between perceptions of students in different classes: students in the same class should have perceived their teachers fairly similarly but differently from students in other classes. In keeping with previous research, an ANOVA was thus performed.

In addition, the correlation between these scales of Actual Fom of the QTI, by using the Pearson's coefficient (r) was computed. The strength of correlation values were range between -1 and +1, and the positive or negative signs in front of the correlation indicated only the direction of the relationship (Lutz, 1983; Walsh, 1990). If the value was zero, it could be interpreted as having no association. Lutz's (1983) example of the interpretation for the 'r' was the value of .65, .40 and .15 which would be called strong, moderate and weak, respectively.

The value of correlation between scales of the QTI was related to its nature as a circumplex model. This model presented eight sectors arranged in a circular fashion in which the scales tended to merge slightly into the scales next to them. It is assumed that the correlation of a scale should be highest with the scale next to it and show the lowest correlation with the opposite scale and this fits into the circumplex Leary model (Wubbel et al., 1993).

Research question 2: Is the Thai version of the SLEI a valid and reliable instrument for use in Thailand?

Similar to the QTI, Cronbach's coefficients were computed and analysed by using both individual student and class mean as the unit of analysis to determine the reliability of the Actual and Preferred Forms of the SLEI, In order to provide a

satisfactory validated version of the SLEI, some items that had low reliability value were deleted.

In addition, the discriminant validity of both forms was computed using Pearson's coefficient (r). The SLEI mean correlation of one scale with all the other scales was used to estimate its discriminant validity. Cohen, Manion, & Morrison (2000) suggested that the discriminant validity can be used when researching different constructs, as assessed by different scales, and should yield relatively low inter-correlations.

And the value of the eta^2 was also analysed to indicate the ability of the SLEI to differentiate between classrooms.

Research question 3: What are students' perceptions of interactions between them and their teachers in biology classes?

To discover students' perception of interactions between themselves and their teachers in biology classes, the data were collected using the Actual and Ideal Forms of the QTI in which all the means and standard deviations were calculated. The difference between the two means was tested for statistical significance by using t tests and effect sizes.

Effect size refers to the difference between the variables (two means) in the scale means of actual and ideal perceptions. According to Cohen (1988), the effect size is calculated by dividing the difference in the two group means by the pooled standard deviation. If the effect sizes are 0.10, 0.25, and 0.40, the differences are small, medium, and large, respectively.

Research question 4: What are students' perceptions of their learning environments in biology classes?

To investigate students' perception of their learning environment in biology classes, the data were collected using the Actual and Preferred Forms of the SLEI. The next step was statistical analyses as previously described for the QTI using the

significance testing between the mean scales in the actual and preferred perceptions. The strength of difference was also analysed using effect sizes as Cohen (1988) had suggested.

Research question 5: How do students' perceptions of their learning environment relate to teacher-student interactions?

Simple and multiple correlations were used to find associations between (1) each of the QTI scales and (2) each of the SLEI scales.

Data collected by using the Actual Forms of the QTI and SLEI were employed to answer this question. Associations between the SLEI scales and the QTI scales were explored by using simple and multiple correlation analyses. To determine the simple correlations, the Pearson correlation coefficient (r) was used to investigate the strength of associations between the scale mean of the QTI and the SLEI. Regression which is a statistical technique involving the prediction of one variable from another was conducted by measuring the regression coefficients (β).

Research question 6: What associations exist between teacher-student interactions and student attitudes to their biology classes?

Similarly, data collected from the Actual Form of the QTI and the ABC were used to compute simple and multiple correlations.

To find the simple correlations, the Pearson correlation coefficient (r) was used to investigate the strength of association between each of QTI scale and the attitudes. For the simple correlations, interpretation was based on Borg's (1963) suggestion that values of 0.20 to 0.35 show only a very slight relationship between variables although it may be statistically significant. If the correlation is around 0.40, it may be possibly used for prediction. Borg noted that correlation within the range 0.35 to 0.65 is useful when combined with other correlations in a multiple regression. The range from 0.65 to 0.85 is accurate enough for most application purposes and makes possible group predictions. Values over 0.85 indicate a close relationship between

the two variables correlated. Similarly, Lutz (1983) and Walsh (1990) suggested, if the value is zero, it can be interpreted that there is no association, and values of 0.65, 0.40, and 0.15 would be called strong, moderate and weak, respectively.

The regression coefficients (β) were computed to investigate which of the QTI scales most contributed to the variance in student attitudes to biology when the effects of other scales were controlled all together. The multiple correlation (R) and the R^2 value, were computed to indicate how much of the variance in students' attitudes to their biology class can be attributed to their perceptions of their interactions with their teachers.

Research question 7: What associations exist between laboratory learning environments and student attitudes to their biology classes?

To describe associations between the actual learning environment and student attitudes to biology, data collected by using the Actual Form of the SLEI and the ABC were analysed in a similar manner to the QTI and then they were used to compute simple and multiple correlations.

The multiple correlation (R) and regression coefficients (β) were then computed to find out which of the SLEI scales contributed to the variance in the attitudes to biology classes when the effects of other scales were controlled all together.

A One-way Analysis of Variance (ANOVA) was used to compare the means of more than two groups of an independent variable. If the ANOVA results showed a significant difference and exist between the values, such as three school types, post hoc (Tukey post hoc) analysis was employed to identify between which types the difference occurred.

It was also considered important to determine the unique and joint contributions made by the QTI and the SLEI to students' attitudes to biology classes. This was conducted by using a commonality analysis. This analysis is a method to estimate

the unique and confounded components of variance explained in criteria by two or more sets of predictors (Fraser & Fisher, 1982; Fisher, Henderson, & Fraser, 1995).

The uniqueness for each instrument is computed simply by subtracting the squared multiple correlation (R^2) for a model containing the scale in two instruments as predictors measured by the QTI and the SLEI.

The commonality, which is confounded contribution to criterion variance made by instruments, is simply the variance explained by the full model containing the QTI and the SLEI minus the sum of the uniqueness for QTI and SLEI. The results of these analyses are shown in Chapter 5.

Research question 8: What are the characteristics of biology classes in Thailand?

Finally, the results from the use of the questionnaires were considered together to describe the characteristics of biology classes in Thailand. Also, to determine what these classes are like the pattern of teacher-student interaction was compared with the typologies described in Chapter 2.

3.4 SUMMARY

The review of literature was addressed in Chapter 2. It concerned the theory and concepts and development of instruments of learning environment, especially in science classes.

Following on from the review of all the literature in Chapter 2, this chapter has provided the description of the methodology used in the study including the selection of the sample, the instruments which were employed to assess student perceptions of teacher-student interactions (QTI), learning environment in biology laboratory (SLEI), and student attitudes to their biology classes (ABC). Interviewing, the qualitative research approach, has also been described.

The validation of the instruments and descriptive information of the QTI and SLEI are presented in Chapter 4 and their application is discussed in Chapter 5.

CHAPTER 4

VALIDATION AND DESCRIPTIVE INFORMATION OF LEARNING ENVIRONMENTAL MEASURES

4.1 INTRODUCTION

The first objective of this study was to validate the questionnaires that were used to collect data from 1,194 grade 8 students in biology classes in Thailand. The data from each of the QTI, SLEI and ABC were statistically analysed and then interpreted for reliability and validity as described in this chapter.

4.2 RELIABILITY AND VALIDITY OF THE INSTRUMENTS

As mentioned previously in Chapter 3, the QTI and the SLEI were used to assess students' perceptions in this study and were modified slightly when translated into a Thai version. Therefore, it was necessary to check the reliability and validity of each scale, even though the original versions have proved to be good valid instruments. The QTI was used in two forms, the Actual and Ideal, and consisted of 48 items in each of eight scales: Leadership, Helping/Friendly, Understanding, Student Responsibility, Uncertain, Dissatisfied, Admonishing, and Strict. Each scale of the QTI contained six items. The SLEI also was used in the two forms of actual and preferred each of which consisted of five scales: Student Cohesiveness (SC), Open-Endedness (OE), Integration (I), Rule Clarity (RC), and Material Environment (ME). Each scale of the SLEI consisted of seven items. In keeping with previous learning environment studies, statistics relating to the two instruments' internal consistency, discriminant validity and ability to differentiate between the perceptions of students in different classrooms are reported to demonstrate the validity of the instruments. The internal consistency reliability of the ABC is also reported in this chapter.

4.2.1 The QTI

Cronbach alpha coefficients were calculated for both of the Actual and Ideal Forms of the QTI, to assess the internal consistency of each scale of this instrument. The first reliability results showed that the lowest reliabilities where 0.49 for the Strict scale and 0.55 for the Student Responsibility/Freedom scale. A standard acceptable level of reliability has been stated as 0.5 (De Vellis, 1991). However, if some items were deleted, items 16 and 28 from the Student Responsibility/Freedom scale, and item 32 of the Strict scale, the reliabilities of both the Actual and Ideal forms increased. It was decided to delete these three items from these two scales. Items 16, 28, and 32 were: 'This teacher is impatient'; 'This teacher is strict'; and 'We have to be silent in this teacher's class'; respectively. According to the interviews, some students suggested that they preferred teachers who were strict and maintained silence in their classes. Such a situation allowed them to concentrate on their lesson. Some showed sympathy with their teachers and suggested that teachers work hard so they can be expected to become impatient. These factors may have caused difficulties with these three items.

Table 4.1 shows that the Cronbach alpha reliability, after adjusting by deleting the items, ranged from 0.55 (Strict scale) to 0.81 (Leadership scale) when using the individual student as the unit of analysis, and ranged from 0.44 (Strict scale) to 0.95 (Leadership scale) when using the class mean as the unit of analysis for the Actual Form. For the Strict Scale, applications using the class mean as the unit of analysis should be treated with caution. For the Ideal Form, it ranged from 0.59 (Strict scale) to 0.76 (Dissatisfied scale) when using the individual student as the unit of analysis, and from 0.76 (Student Responsibility/Freedom scale) to 0.91 (Dissatisfied scale) when using the class mean as the unit of analysis. The highest reliability coefficients were different with the Leadership scale being highest on the Actual Form while the Dissatisfied scale was highest for the Ideal Form. It can be concluded that both versions of the QTI are reliable as all the modified scales are consistently above 0.50 (DeVellis, 1991). In particular, this result is comparable with other studies. For example a range of 0.61 to 0.83 for the Actual Form, and from 0.59 to 0.76 for the

Ideal Form, was reported by Fisher, Henderson, and Fraser (1995) and from 0.50 to 0.72 by Koul and Fisher (2003) in India. In an Indonesian study, Soerjaningsih (2003) reported a range of 0.65 to 0.87 for a 39 item version of the QTI.

Table 4.1

Internal Consistency (Cronbach Alpha Coefficient) for Actual and Ideal Forms of the QTI and Ability to Differentiate Between Classes of the Actual QTI

Scale	Alpha Reliability				*ANOVA*
	Actual		Ideal		*(Eta²)*
	Before	After	Before	After	(actual)
Leadership (DC)		0.81		0.68	0.35***
(Class mean)		*(0.95)*		*(0.83)*	
Helping/Friendly (CD)		0.79		0.75	0.28***
(Class mean)		*(0.93)*		*(0.86)*	
Understanding (CS)		0.76		0.71	0.23***
(Class mean)		*(0.92)*		*(0.84)*	
Student Responsibility/ Freedom (SC)	0.55	0.63	0.56	0.63	0.15***
(Class mean)		*(0.85)*		*(0.76)*	
Uncertain (SO)		0.63		0.61	0.13***
(Class mean)		*(0.84)*		*(0.83)*	
Dissatisfied (OS)		0.80		0.76	0.13***
(Class mean)		*(0.92)*		*(0.91)*	
Admonishing (OD)		0.65		0.64	0.15***
(Class mean)		*(0.77)*		*(0.80)*	
Strict (DO)	0.49	0.55	0.48	0.59	0.10***
(Class mean)		*(0.44)*		*(0.85)*	
Total Item	48	45	48	45	

***p< 0.001 **p<0.01 *p<0.05 n = 1,194Note:

Before = before deleted items; After = after deleted items

SC scale: deleted item 4; DO scale: deleted items 2 & 4

In summary, the Thai version of the QTI, both in its Actual and Ideal versions, has good reliability and consists of 45 items as shown in Table 4.2.

Table 4.2

Items Retained in the Scales of the 45-item Thai Version of the QTI

Item No.	Item Number of the questionnaire (QTI)							
Of the Scale	DC (Lea)	CD (Help)	CS (Und)	SC (StdR)	SO (Unc)	OS (Diss)	OD (Ad)	DO (St)
1ST Item	1	25	2	26	3	27	4	28
2nd Item	5	29	6	30	7	31	8	*
3rd Item	9	33	10	34	11	35	12	36
4th Item	13	37	14	*	15	39	16	*
5th Item	17	40	18	42	19	43	20	44
6th Item	21	44	22	46	23	47	24	48
Total	6	6	6	5	6	6	6	4

* *Deleted item*

This 45-item Thai version of the QTI was then utilised to compute the following analyses, the ANOVA (eta^2) and interscale correlation, and then descriptive statistics.

In order to determine whether the Actual Form of each scale of the QTI is able to differentiate between student perceptions between classrooms, an analysis of variance (ANOVA) was calculated. Table 4.1 indicates that the eta^2 statistic, as the ratio of "between" to "total" sums of squares, ranged from 0.10 (Strict scale) to 0.35

(Leadership scale) for the Actual Form of the QTI. The result of computing a one-way ANOVA shown in Table 4.1 indicates that each QTI scale differentiated significantly (p <0.001) between classes.

The correlation of one scale with the other seven scales for the Actual Form and Ideal Form are presented in Table 4.3 and Table 4.4, respectively. According to the Leary model (Wubbels & Levy, 1993), the eight scales can be arranged in a two-dimensional circular arrangement. Each scale should correlate highest with the scale next to it in the model and scales opposite in the model should correlate the lowest.

Table 4.3

Correlations Between Scales of the Actual Form of the QTI

Scale	CD	CS	SC	SO	OS	OD	DO
Leadership (DC)	0.66**	0.75**	0.49**	-0.30**	-0.27**	-0.27**	-0.10**
(Class Mean)	*(0.83*)*	*(0.91*)*	*(0.72*)*	*(-0.50*)*	*(-0.40*)*	*(-0.32)*	*(-0.42*)*
Helping/ Friendly (CD)		0.66**	0.67**	-0.18**	-0.26**	-0.18**	-0.15**
(Class Mean)		*(0.89*)*	*(0.86*)*	*(-0.41*)*	*(-0.44*)*	*(-0.30)*	*(-0.49*)*
Understanding (CS)			0.52**	-0.28**	-0.33**	-0.29**	-0.14**
(Class Mean)			*(0.81**)*	*(-.44**)*	*(-.46**)*	*(-0.31)*	*(-0.49*)*
Student Responsibility/Freedom (SC)				0.01	-0.04	-0.01	-0.05
(Class Mean)				*(-0.18)*	*(-0.23)*	*(-0.05)*	*(-0.47*)*
Uncertain (SO)					0.63*	0.68**	0.29**
(Class Mean)					*(0.81***)*	*(0.82**)*	*(0.50**)*
Dissatisfied (OS)						0.68**	0.42**
(Class Mean)						*(0.90*)*	*(0.65*)*
Admonishing (OD)							0.33**
(Class Mean)							*(0.44*)*

**p<0.01 *p<0.05 (n=1,194)

Table 4.4

Correlations Between Scales of the Ideal Form of the QTI

Scale	CD	CS	SC	SO	OS	OD	DO
Leadership (DC)	0.45**	0.70**	0.38**	-0.23**	-0.24**	-0.28**	0.07*
(Class Mean)	*(0.53**)*	*(0.88**)*	*(0.49**)*	*(-0.40*)*	*(0.18)*	*(-0.56**)*	*(-0.17)*
Helping/ Friendly (CD)		0.56**	0.67**	-0.16**	-0.24**	-0.17**	-0.28**
(Class Mean)		*(0.73**)*	*(0.77**)*	*(-0.47**)*	*(-0.37*)*	*(-0.35)*	*(-0.67)*
Understanding (CS)			0.48**	-0.21**	-0.28**	-0.29**	-0.15**
(Class Mean)			*(0.66**)*	*(-0.40*)*	*(-0.28)*	*(-0.49**)*	*(-0.39*)*
Student Responsibility/ Freedom (SC)				0.02	-0.01	0.00	-0.12**
(Class Mean)				*(-0.03)*	*(0.10)*	*(0.01)*	*(-0.27)*
Uncertain (SO)					0.58**	0.65**	0.35**
(Class Mean)					*(0.80**)*	*(0.87**)*	*(0.65**)*
Dissatisfied (OS)						0.61**	0.48**
(Class Mean)						*(0.81**)*	*(0.71**)*
Admonishing (OD)							0.34**
(Class Mean)							*(0.54**)*

**$p<0.01$ *$p<0.05$ (n=1,194)

For example, for the Actual Form of the QTI (see Table 4.3), the Helping/Friendly Scale shows the greatest correlation value (0.66) with the Understanding scale and the lowest value with the Dissatisfied (-0.26) which is the opposite scale in the model. Figure 4.1 illustrates these distinctive patterns of interscale correlation on the circumplex model with correlations between the Helping/Friendly scale and the seven other scales of the Actual Form of the QTI.

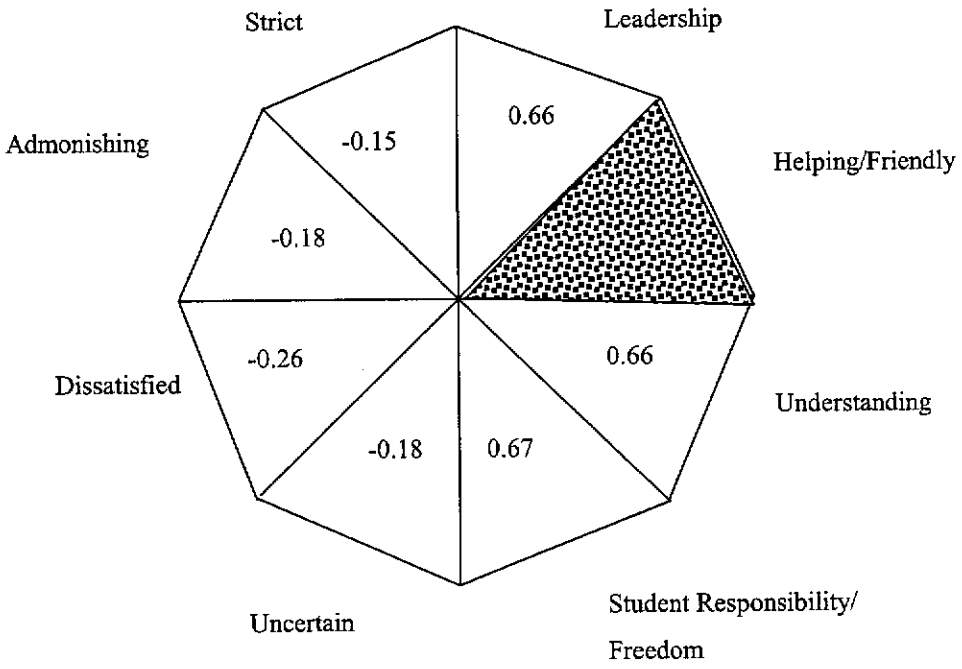


Figure 4.1. Profile of scale intercorrelations of the Helping/Friendly scale of the Actual Form of the QTI.

Overall, the Thai version of the QTI, in both its Actual and Ideal Forms, consists of 45 items each, and is a good valid instrument than can be used to assess students' perceptions in secondary school biology classes.

4.2.2 The SLEI

Similarly to the QTI, for both of the Actual and Preferred Forms, statistics relating to the SLEI internal consistency, discriminant validity and ability to differentiate between the perceptions of students in different classes are reported.

Cronbach alpha reliabilities again were calculated to determine the internal consistency of the scales of the SLEI. The alpha reliability for the Actual Form of the SLEI shows the lowest values of 0.52 (Open-Endedness) and 0.61 (Rule Clarity) when using the individual student as the unit of analysis, and 0.85 (Open-Endedness) and 0.84 (Rule Clarity scale) when using the class mean as the unit of analysis. The

lowest of reliabilities, for the Preferred Form of the SLEI, are 0.41 (Open-Endedness) and 0.45 (Rule Clarity) when using the individual student as the unit of analysis, and 0.57 (Open-Endedness) and 0.63 (Rule Clarity) when the using class mean as the unit of analysis.

Table 4.5

Internal Consistency (Cronbach Alpha Coefficient), Discriminant Validity (Mean Correlation with other Scales) and Ability to Differentiate Between classrooms (ANOVA results) for the Actual Form of the SLEI

Scale	Alpha Reliability		Discriminant Validity	ANOVA (Eta^2)
	Before	After		
Student Cohesiveness		0.69	0.34	0.09**
(Class mean)		*(0.75)*	*(0.38)*	
Open-Endedness	0.52	0.59	0.21	0.18**
(Class mean)		*(0.84)*	*(0.30)*	
Integration		0.65	0.33	0.14**
(Class mean)		*(0.79)*	*(0.42)*	
Rule Clarity	0.61	0.64	0.40	0.17**
(Class mean)		*(0.86)*	*(0.54)*	
Material Environment		0.65	0.34	0.15**
(Class mean)		*(0.70)*	*(0.40)*	
Total	35	32	35	32

**$p<0.01$ (n = 1,194)

Before = before deleted items, After = after deleted items

Again, it was clear that the reliability of these scales could be improved by deleting some items. Item 6 of the Open-Endedness scale, and items 2 and 5 of the Rule Clarity scales were deleted. Therefore, the total number of items in the Thai version of the SLEI was 32 as shown in Table 4.7. Once the selected items were deleted, the Cronbach alpha reliabilities were again calculated as shown in the column After in Table 4.5. The Table 4.5 shows that the alpha reliabilities of the Actual Form of the SLEI scales ranged from 0.59 to 0.69 when using the individual student as the unit of analysis and from 0.70 to 0.86 when using the class mean as the unit of analysis. For the Preferred Form of the SLEI, the alpla reliabilities ranged from 0.54 to 0.71 when using the individual student as the unit of analysis and ranged from 0.64 to 0.89 when using the class mean as the unit of analysis.

Table 4.6

Internal Consistency (Cronbach Alpha Coefficient), Discriminant Validity (Mean Correlation with other Scales) and Ability to Differentiate Between Classrooms (ANOVA results) for the Preferred Form of the SLEI

Scale	Alpha Reliability		Discriminant Validity	ANOVA (Eta^2)
	Before	After		
Student Cohesiveness		0.67	0.46	0.09**
(Class mean)		*(0.78)*	(0.60)	
Open-Endedness	0.41	0.54	0.22	0.17**
(Class mean)		*(0.64)*	*(0.13)*	
Integration		0.71	0.44	0.13**
(Class mean)		*(0.79)*	*(0.56)*	
Rule Clarity	0.45	0.63	0.46	0.16**
(Class mean)		*(0.86)*	*(0.63)*	
Material Environment		0.70	0.44	0.16**
(Class mean)		*(088)*	*(0.58)*	

**$p<0.01$, *$p<0.05$ (n=1,194)

Before = before deleted items; After = after deleted items

These figures are similar to those given by Fisher, Henderson, and Fraser (1995), who reported a range from 0.58 to 0.85 for the Actual Form, and from 0.58 to 0.76 for the Preferred Form when using the individual as the unit of analysis.

In keeping with previous learning environment validation studies, information supporting the discriminant validity through the mean correlation of a scale with other scales was computed. The mean correlation of a scale with other scales ranged from 0.21 to 0.40 for the Actual Form (Table 4.5) and from 0.22 to 0.46 for the Preferred Form (Table 4.6) of the SLEI when using the individual student as the unit of analysis. When using the class mean as the unit of analysis they ranged from 0.30 to 0.54 for the Actual Form (Table 4.5) and from 0.13 to 0.63 for the Preferred Form (Table 4.6). These figures indicate that the SLEI measures distinct aspects of the laboratory environment, although somewhat overlapping.

Table 4.7

Items Retained in the Scales of the 32-item Thai Version of the SLEI

Item of	Item Number of the questionnaire				
Each scale	SC	OE	I	RC	ME
1st	1	2	3	4	5
2nd	6	7	8	*	10
3rd	11	12	13	14	15
4th	16	17	18	19	20
5th	21	22	23	*	25
6th	26	*	28	29	30
7th	31	32	33	34	35
Total	7	6	7	5	7

* Deleted Item

Similarly, as with the QTI, the eta^2 statistic was calculated to determine whether the Thai version of the SLEI was capable to differentiating between the perceptions of students in different classes. The eta^2 value ranged from 0.09 (Student Cohesiveness) to 0.18 (Open-Endedness) for the Actual Form. Table 4.6 also indicates that each SLEI scale differentiated significantly (p <0.01) between classes.

Overall, the results suggested that the Thai version of the SLEI is a valid and reliable questionnaire for use in investigating students' perception of learning environments in biology laboratories in secondary schools in Thailand.

4.2.3 The ABC

As mentioned previously, the ABC, was used to assess student attitudes to biology classes in this study, and consisted of seven items. This scale was found to have an alpha reliability of 0.83 with the individual student as the unit of analysis. This figure indicates that this scale in its Thai version has acceptable internal consistency.

4.3 VALIDATION OF THE QUESTIONNAIRES BY INTERVIEWING

As mention previously in Chapter 3, the questionnaires that were used in this study for assessing students' perceptions, the QTI and the SLEI, needed to be examined for reliability and validity. The previous section has reported on the quantitative results of this process. This section presents the results of using qualitative data obtained from interviews to support the data gathered by the QTI and SLEI which are presented in Sections 4.3.1 and 4.3.2, respectively. This process has been suggested by Fisher and Waldrip (1997).

4.3.1 The QTI

The student interviewees indicated their responses to each of the following questions. A selection of typical and relevant responses is presented for each question.

For the first question, What do you think about this questionnaire? Is it useful for improving teaching and learning biology?

Some students expressed their responses as follows:

A: *I think that this questionnaire is for measuring teacher's behaviour. It is very useful for our classes if our teacher knows what climate in the class we need.*

B: *It is a questionnaire used to ask about environments in classrooms. It is useful if teachers know the information from the questionnaire and use it for planning their teachings.*

C: *It is a questionnaire that asks about the relationship between teachers and their students in their classes. They should consider if there is a big difference between actual and ideal students' perception. They should improve that point; it may make students enjoy learning biology more.*

D: *In my opinion, it may be a form to measure the teacher's characteristics and emotions which concern students' attitude to biology. If the relationship between teacher and students is good, students should learn biology better as well.*

The second question was, What kinds of interactions between you and your teacher do you think are important in biology class?

Students' responses included:

A: *The teacher should understand his/her students. Students could consult him/her anytime if they have some problems.*

B: *The teacher should be kind. He/she should make a joke while he/she is teaching.*

C: *I think a good teacher should accept the students' perceptions.*

D: *The teacher should be a person that students can consult about problems and also help students to solve their problems.*

The third question was, Is the questionnaire (QTI) clear to you? and the students responded in the following ways:

A: *Yes, it's very clear.*

B: *Yes, it's clear and fine.*

C: *I think it contains items covering all topics of relation between a teacher and student.*

D: *The questionnaire is quite clear but some items made me consider, such as Item No.31. Its statement means 'The teacher thinks that student don't know anything in the topic which they are studying, doesn't it?'*

The final question was, Do you think anything should be added to the interaction questionnaire? The students' responses were:

A: *I think that it covers all topics. It's enough.*

B: *It should ask what and how teachers use instructional media in their teaching.*

C: *In my opinion a question, such as the teacher should consider the suitability of assignments for his/her students, could be added.*

D: *I think it should be asking about students' behaviours too.*

Overall, most students viewed that the QTI is a questionnaire that asks them about the behaviour of their teacher occurring in their biology classes. Some statements of items made a few of the students take time to consider before making their choice. However, this is not a big problem for using the questionnaire. So it can be concluded that the Thai version of both forms of the QTI (Actual and Ideal) each consisting of 42 items, is valid and can be used to assess biology classes in Thailand.

4.3.2 The SLEI

Likewise, the students provided their perceptions concerning the SLEI by answering questions during the interviews. Again, selected typical responses are given in this section.

To the first set of questions, What do you think about this questionnaire? Is it useful for improving teaching and learning biology? They typically responded in the following ways.

A: *I think this is a questionnaire used to obtain information about the environment in a laboratory class. It may be better if a teacher knows what the students' perceptions are. If the climate in the lab activity is perfect; we should enjoy working in the lab.*

B: *It is a questionnaire to investigate students' needs in the laboratory. The teacher should be assessed like students have examinations. The results will show whether the lab activities managed by teachers correspond with students' needs or not.*

C: *Generally, it asks about the actual laboratory situation, doesn't it? It will be useful for us if you tell our teacher the results. The teacher should improve the activity by consider the things that students prefer and make students enjoy learning.*

D: *It asks about climate students needs in the biology laboratory. I think it could help improve our learning if the rules in the lab are clear; the lab equipment works; and students can do their lab work anytime. Just like that would be great.*

The second question was, What kinds of the learning environment that you think they are important in biology laboratory class? Typical responses were:

A: *In my opinion, everyone in my class should have a chance to do the lab because this will help improve his/her get scientific skills.*

B: *I like to do lab activities with my friends, so I think the students' cooperation is very important.*

C: *I think the most important thing for laboratory work, is the equipment that it is good condition.*

D: *I think a teacher is still the most important factor in the lab class, he/she should give students clear assignments.*

The third question was, Is the questionnaire (SLEI) clear to you?

Typical responses were:

A: *I think this questionnaire is clear, I understand all items.*

B: *The questionnaire is perfectly clear for me.*

C: *It's O.K. although the negative items made me confused.*

D: *It's fine, I like it very much. Could you let my teacher know our response?*

The final question was, Do you think anything should be added to the learning environment in biology laboratory questionnaire? Again typical responses are provided:

A: *I think you should ask another their own group members or not.*

B: *Is there an opportunity for students to ask the teacher during the lab session because there might be problems about the process.*

C: *There should be a question about the adequacy of the laboratory equipment because what happens now is there is not enough equipment so that some students do not have any chances to do the lab activities.*

D: *There should be a question about noises from outside of the classroom that affect students' concentration on the lesson.*

Overall, similar to the QTI, the SLEI was viewed by students as a useful questionnaire, although some responses showed that some students did not really understand the term "learning environment". This is possibly because it was the first time that many of the students had studied biology. Moreover, some students came from small schools located in small towns and were accustomed to do the lab activity by following teacher's lead. Interestingly, most students wanted their teachers to know the results of this research so that they might realize what their students needed

from biology laboratory class. The interviews confirmed the reliability and validity of the SLEI measured by the quantitative methods as addressed in section 4.2.2.

4.4 DESCRIPTIVE INFORMATION FOR ENVIRONMENTAL MEASURES

In this section, biology classroom learning environment is described in terms of students' perceptions on the QTI and the SLEI. The 45 items of the QTI and the 32 items of the SLEI were used to compute average item means (obtained by dividing the scale mean by the number of items in that scale). The average item means of each item needed to be computed because the numbers of items in each scale of both the QTI and the SLEI are not equal: the QTI varied from six to eight items, and the SLEI varied from three to seven items.

The standard deviations of each scale were computed and then the differences between students' actual and ideal/preferred perceptions using the *t* test and effect sizes were compared. The information obtained from the teacher-student interactions and laboratory learning environments in biology classes are reported in sections 4.4.1 and 4.4.2, respectively. Descriptive information on students' attitudes to their biology classes is also presented in section 4.4.3.

4.4.1 Student Perceptions of Interpersonal Teacher Behaviour

Students responded to each item of the Actual and Ideal Forms of the QTI and the results are presented in Table 4.8. As described in Chapter 3, the scoring of student perceptions of the instruments was obtained by means of uses a five-point Likert-type scale ranging from 1 to 5 corresponding with 'Never' to 'Always' for rating scale of the QTI. Moreover, the graph in Figure 4.2 is presented to demonstrate the comparison between scale means in students' actual and ideal perceptions.

Table 4.8

Scale Means and Standard Deviations for Actual and Ideal Forms of the QTI

Scale	Actual		Ideal		Difference	
	Mean	S.D.	Mean	S.D.	(Ideal-Actual)	Effect Size
Leadership (DC)	4.05	.60	4.48	.47	0.33***	0.61
Helping/Friendly (CD)	4.00	.62	4.21	.56	0.21***	0.35
Understanding (CS)	4.05	.56	4.43	.48	0.27***	0.52
Student Responsibility/(SC)	3.57	.60	3.81	.59	0.24***	0.40
Uncertain (SO)	2.57	.59	2.44	.63	-0.13***	0.21
Dissatisfied (OS)	2.22	.71	2.10	.72	-0.12***	0.17
Admonishing (OD)	2.28	.61	2.16	.59	-0.12***	0.20
Strict (DO)	3.06	.71	2.71	.76	-0.36***	0.49

***$p < 0.001$ (n = 1,194)

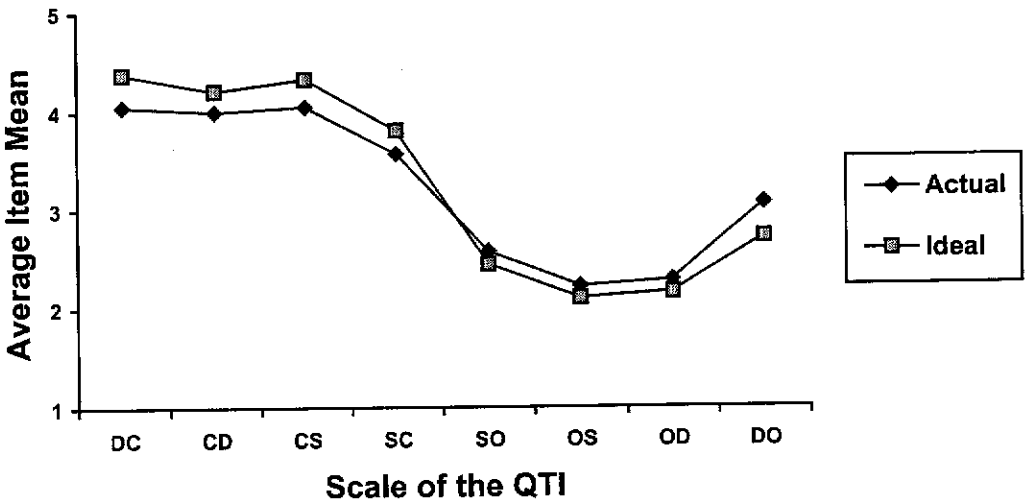


Figure 4.2. Differences between average item means of Actual and Ideal Forms of the QTI.

The data indicate that students prefer teachers who show strong leadership, are more supportive and understanding, encourage their students, and give greater responsibility and freedom. These differences are all statistically significant ($p<0.001$). The differences between students' actual and ideal perceptions of student responsibility/freedom are similar to those reported by Fisher, Henderson, and Fraser (1995) from the Australian student sample. According to Cohen (1988), the interpretations of the effect sizes vary: 0.61 for Leadership is large, 0.52 for Understanding quite large, 0.40 for Student Responsibility/Freedom quite large and 0.35 for Helping/Friendly is medium.

Students also prefer teachers who are less uncertain, dissatisfied, admonishing and strict. When compared with their Dutch and American counterparts, according to Fisher, Henderson, and Fraser (1995), Thai students preferred more independence. Again, according to Cohen's (1977) suggestion, the interpretations of the effect sizes vary: 0.17 for Dissatisfied, 0.21 for Uncertain, and 0.20 for Admonishing are small, but 0.49 for Strict quite large.

4.4.2 Student Perceptions of their Biology Laboratory Learning Environments

The class means and standard deviations for student responses to both versions of the SLEI were calculated and are shown in Table 4.9. Similar to the QTI, for facilitating comparison between the actual and preferred student responses, the results are presented graphically in Figure 4.2. It shows that students prefer a biology laboratory environment with higher levels on four of the scales; Open-Endedness, Integration, Rule Clarity and Material Environment. With consideration to the effect size, it was found that there were big differences in Rule Clarity and Material Environment, medium in Open-Endedness, and a small effect size in Student Cohesiveness and Integration, as shown in Table 4.9.

Table 4.9

Scale Mean and Standard Deviations for Actual and Ideal Versions of the SLEI

Scales	Actual		Ideal		Difference	
	Mean	S.D.	Mean	S.D.	(Preferred-Actual)	Effect Size
Student Cohesiveness (SC)	4.00	0.55	4.04	0.53	0.04	0.07
Open – Endedness (OE)	3.40	0.53	3.67	0.52	0.27***	0.51
Integration (I)	3.59	0.55	3.70	0.62	0.11***	0.19
Rule Clarity (RC)	3.73	0.58	4.05	0.57	0.32***	0.97
Material Environment (ME)	3.45	0.63	3.93	0.65	0.48***	0.75

***p= 0.00, **p<0.01, *p<0.05 (n = 1,194)

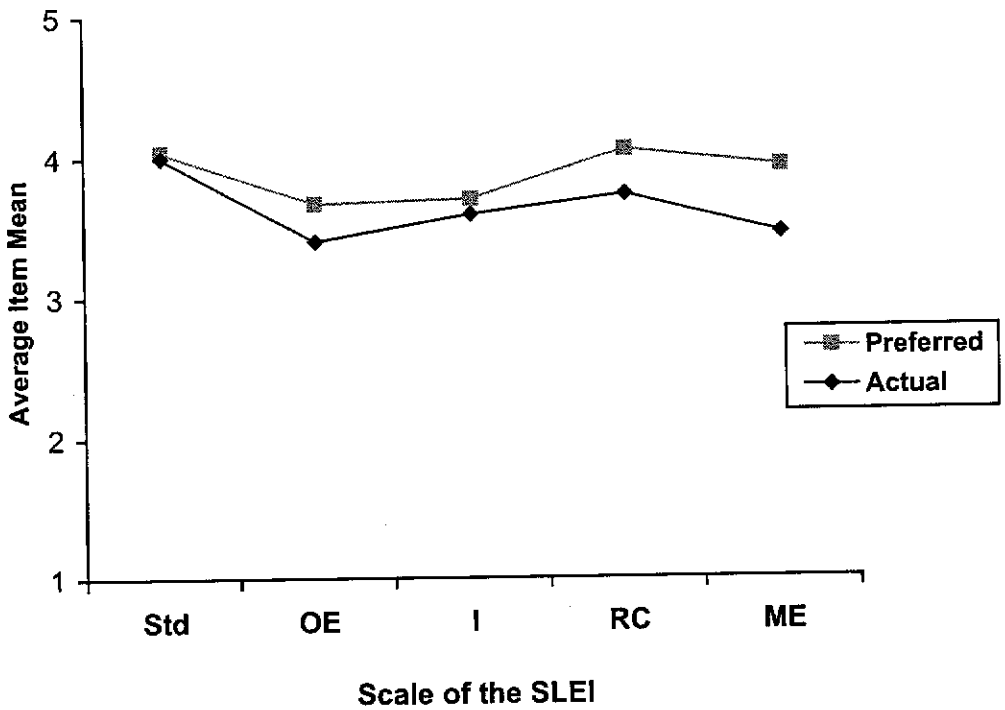


Figure 4.3. Differences between average item means of Actual and Preferred Forms of the SLEI.

These results seem to replicate the findings of previous studies using the SLEI by Fisher, Henderson, and Fraser (1995), which showed the students' preference for a more positive learning environment on all five scales of the SLEI.

4.4.3 Student Attitudes to Biology

As previously mentioned, students' attitudes to their biology classes were described using the results from the ABC questionnaire. The results showed that the average item mean was around 3.84 with a standard deviation of 0.55. The minimum and maximum scores were 3.59 and 4.41, respectively.

Table 4.10

Number of Students for each Rating Category Score of the ABC

Rating Score				
Almost Never	Seldom	Sometime	Often	Almost Always
(1.00-1.99)	(2.00-2.99)	(3.00-3.99)	(4.00-4.99)	(5.00)
2	55	579	527	31

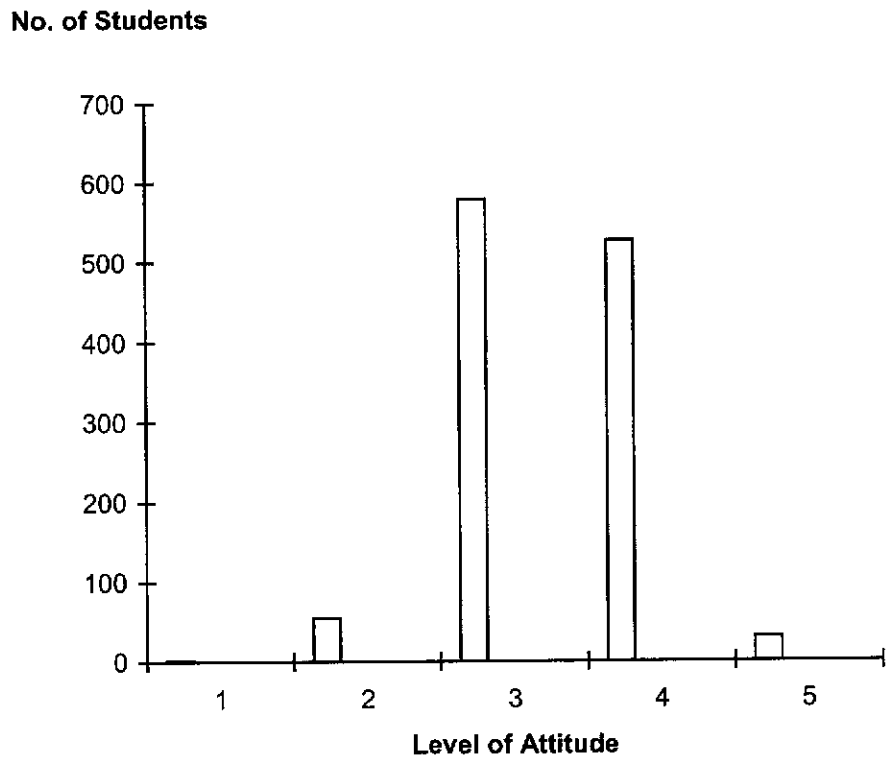


Figure 4.4. Number of students in each rating category of the ABC.

The results indicated that students had positive attitudes towards their biology class as distinctively displayed in Figure 4.4.

4.5 SUMMARY

This chapter reports the validation and descriptive statistics of the two learning environment instruments, the QTI and the SLEI, and the Attitude to Biology Class questionnaire, the ABC.

The results indicate that three instruments modified into Thai versions, the 45-item QTI, the 32-item SLEI and the 7-item ABC were good valid instruments and can be used to investigate students' perceptions in secondary schools in Thailand. A

commonality analysis was conducted to determine the unique and joint contributions of the QTI and SLEI and is described in Chapter 5.

The next chapter describes associations between students' perceptions of learning environment, as measured by the QTI and the SLEI, and their attitudes to biology classes. In addition, the differences between students' perceptions of actual learning environments and their attitudes to biology classes, according to gender, school situation and school size are presented.

CHAPTER 5

STUDENTS' PERCEPTIONS OF LEARNING ENVIRONMENT

5.1 INTRODUCTION

Chapter 4 presented the validation of the two learning environment instruments used in the study, the Questionnaire on Teacher Interaction and the Science Laboratory Environment Inventory, and the Attitude to Biology Class. For Thailand's biology classes, descriptive statistics for teacher-student interactions, students' perceptions of their laboratory learning environments and students' attitude to biology were also provided.

In this chapter the results from the validated questionnaires are used to determine associations between students' perception of the classroom learning environment and their attitude (section 5.2). The associations are reported between: students' perceptions of teacher-student interactions and attitude to biology; laboratory learning environments and students' attitude to biology; and students' perceptions of teacher-student interactions and their laboratory learning environments.

5.2 ASSOCIATIONS BETWEEN ENVIRONMENTS AND STUDENTS' ATTITUDES

To examine associations between two aspects of classroom environments, interpersonal teacher behaviour and laboratory learning environments, and students' attitude towards biology, simple correlations, multiple correlations and regression coefficients were analysed using the individual student as the unit of analysis. The results of these analyses are presented in sections 5.2.1 (for the QTI) and 5.2.2 (for the SLEI). In addition, a commonality analysis was used to examine the joint and unique contributions of students' perceptions of interpersonal teacher behaviour and

laboratory learning environment to variance in students' attitude and is reported in section 5.2.3.

5.2.1 Associations between Teacher-Student Interactions and Attitudes to Biology Class

Table 5.1 shows the results of the simple correlation analysis using the individual student as the unit of analysis and indicates that statistically significant correlations ($p<0.01$) exist between students' attitudes towards biology and all scales of the QTI except the Student Responsibility/Freedom and Strict scales. There are positive associations with the Leadership, Helping/Friendly, and Understanding scales, and negative associations with the Uncertain, Dissatisfied, and Admonishing scales. The significance level for the scales of Leadership, Helping/Friendly and Admonishing was 0.01 while for the Uncertain and Dissatisfied scales it was 0.05.

The multiple correlation (R) data in Table 5.1 indicate that there was a significant association between students' perceptions of teacher interpersonal behaviour and their attitudes to biology classes. The R^2 value indicates that 3% of the variance in students' attitudes to their biology class can be attributed to their perceptions of their interactions with their teachers.

Standard regression weights (β) were used to identify which of the eight QTI scales contributed to the variance in student attitudes when the effects of other scales were controlled. The beta weights presented in Table 5.1 suggest that positive attitudes to biology class were evident in classes where the students perceived greater leadership and less admonishing behaviour in their teachers.

The results of this study are similar to those reported by Fisher, Henderson, and Fraser (1995) for a sample of senior secondary biology classes in Tasmania, Australia in that student attitudes were more associated with variation in teacher behaviour on the proximity dimension than on the influence dimension of the QTI.

For the scale of Student Responsibility/ Freedom, student perceptions were the same as for Thai students in that student attitudes were not associated with variations in teacher behaviour.

Table 5.1

Significant Associations between Actual QTI Scales and Attitude to Biology Class in Terms of Simple Correlations (r) and Standardised Regression Coefficients (β)

Scales	*r*	*β*
Leadership (DC)	.15**	.16***
Helping/friendly (CD)	.11**	.06
Understanding (CS)	.09**	-.06
Student responsibility/freedom (SC)	.05	-.03
Uncertain (SO)	-.07*	.02
Dissatisfied (OS)	-.06*	.04
Admonishing (OD)	-.11**	-.11**
Strict (DO)	-.02	.00
Multiple correlation, R	.18***	
R^2	.03	

***p< 0.001 **p<0.01 *p<0.05 (n = 1,194 from 37 classes)

5.2.2 Associations between Laboratory Learning Environment and Attitude to Biology Class

Table 5.2 shows the results of the simple correlation analysis between the SLEI scales and students' attitude using the individual student as the unit of analysis. Statistically significant correlations ($p<0.01$) exist between students' attitudes towards biology and three scales of the SLEI. There were no relationships with either the Student Cohesiveness or Integration scales. The significance level was $p<0.01$ for the Open-Endedness and Rule Clarity scales, and $p<0.05$ for the Material Environment scale.

Standard regression weights (β) were used to identify which of the five SLEI scales contributed to the variance in student attitudes when the other scales were controlled. The standard regression weights (in Table 5.2) suggest that no statistically significant relationships between laboratory learning environment and student attitude to biology class.

Table 5.2

Significant Associations between Actual SLEI Scales and Attitude to Biology Class in Term of Simple Correlations (r) and Standardised Regression Coefficients (β)

Scales	Mean	S.D.	r	β
Student Cohesiveness (SC)	4.00	0.55	0.03	-0.02
Open – Endedness (OE)	3.40	0.53	0.08**	0.06
Integration (I)	3.59	0.55	0.05	0.02
Rule Clarity (RC)	3.73	0.58	0.09 **	0.05
Material Environment (ME)	3.45	0.63	0.06*	0.03
Multiple correlation	R = .12**	R^2 = .01		

**$p<0.01$ *$p<0.05$

The R^2 value indicates that only 1% of the variance in students' attitudes of their biology class could be attributed to their perceptions of their biology laboratory learning environments.

The result of this study was quite similar to previous studies, such as Henderson's (1995) study that reported there was only one scale (Integration) that related to student attitude to biology class when the beta regression weights were examined.

5.2.3 Associations between Teacher-Student Interactions and Laboratory Learning Environment

In order to examine associations between students' perceptions of teacher-student interactions and their perceptions of the laboratory learning environment in biology classes, the data were analysed using both simple and multiple correlation. Table 5.3 shows the results of simple and multiple correlations.

An examination of the simple correlations (r) in Table 5.3 indicates that all scales of the SLEI were significantly related to the scales of the QTI. There were 39 (two at $p<0.05$ and 37 at $p<0.01$) significant relationships, out of 40 pairs. The only non-significant association was between the pair of Rule Clarity and Strict Scale.

The standard regression weights (β) indicate that the association between particular SLEI and QTI scales when the effect of other scales are controlled. The results in Table 5.3 illustrate that there were 22 (seven at $p<0.05$, four at $p<0.01$, and 11 at $p < 0.001$) significant relationships.

Table 5.3

Correlations Between Scales of Actual QTI and Scales of Actual SLEI

Scale	Student Cohesive		Open Endedness		Integration		Rule Clarity		Material Environments	
	r	*β*	*r*	*β*	*r*	*β*	*R*	*β*	*r*	*β*
Leadership	.19**	-.05	.29**	.18***	.20**	-.09*	.38**	.16***	.27**	.06
Helping/ Friendly	.24**	.12**	.24**	-.04	.21**	.05	.32**	-.04	.23**	-.03
Understanding	.25**	.12**	.29**	.16***	.27**	.16***	.40**	.22***	.30**	.14**
Student Responsibility/ Freedom	.16**	.03	.30**	.16***	.13**	.05	.32**	.15***	.17**	.08*
Uncertain	-.17**	-.03	.08**	.08*	-.32**	-.15***	-.10**	.02	-.26**	-.04
Dissatisfied	-.24**	-.17***	.08**	.09*	-.36**	-.23***	-.14**	-.09*	-.32**	-.15***
Admonishing	-.18**	-.02	.07*	.04	-.30**	-.03	-.10**	.03	-.29**	-.09*
Strict	-.60*	.06	.08**	.05	-.10**	.08	.01	.08**	-.19**	-.07*
Multiple R, R^2	.32*** .10		.40*** .16		.42*** .18		.44*** .20		.40*** .16	

***$p < 0.001$, **$p<0.01$, *$p<0.05$ (n=1,194)

An examination of the multiple correlations (R^2), which were all significant, indicates that how much of the percentage of the variance in SLEI scales could be attributed to students perceptions of teacher-student interactions in biology classes. These were 10% for Student Cohesiveness, 16% for Open Endedness, 18% for Integration, 20% for Rule Clarity, and 16 % for Material Environments. Overall, it is clear that students' perceptions of their teachers' interactions with them do influence their perceptions of their learning environment.

5.2.4 Commonality Analysis of Use of QTI and SLEI

When considering the use of the QTI and the SLEI with the same sample, it is possible to determine whether each makes a unique contribution to the variance in students' outcomes such as attitude to biology class. These unique and common contributions of the QTI and the SLEI to the variance in students' attitude to biology can be calculated using commonality analysis.

Table 5.4

Commonality Analysis (R^2) of the Unique and Common Contribution made by the QTI and SLEI to Variance in Attitudes to Biology Class

Variance component	R^2
Uniqueness	
QTI	0.03
SLEI	0.01
Commonality	0.04
Total	0.08

Commonality analysis involves the calculation of the coefficient of determination (R^2), using the attitude measure as the dependent variable separately on the whole set of QTI scales, the whole set of SLEI scales, and all the QTI and SLEI scales together as the independent variables. The uniqueness in this context would be the variance in attitude to either the QTI or the SLEI.

Table 5.4 indicates that the QTI and the SLEI each assessed different aspects of classroom learning environment as illustrated in Figure 5.1. Therefore, both can be used in the one study to investigate students' perceptions of classrooms.

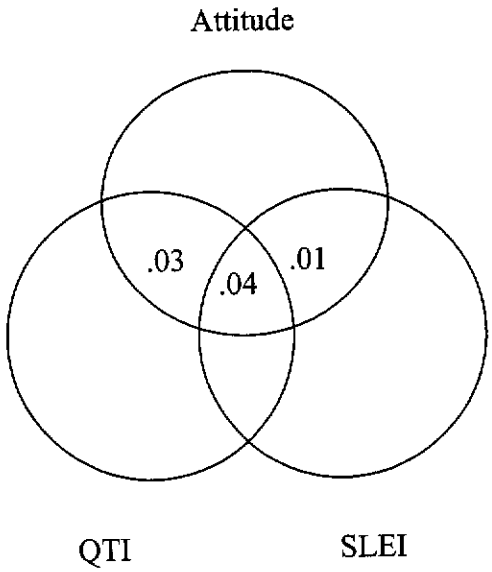


Figure 5.1. Contribution of the QTI and the SLEI to the variance in attitudes to biology classes.

5.3 DIFFERENCES IN PERCEPTION OF LEARNING ENVIRONMENTS

5.3.1 Gender Differences

The student sample in this study consisted of 424 (35.51%) males and 770 (64.49%) females. Gender differences were examined using the Actual Forms of the QTI and the SLEI using a one-way multivariate analysis of variance (MANOVA) with the set of QTI scales or the set of SLEI scales as dependent variables. When the F test was found to be statistically significant ($p<0.05$), a univariate analysis of variance (ANOVA) was computed.

5.3.1.1 Gender Differences: The QTI

An examination of gender differences in student perceptions of teacher-student interactions was calculated using a two–way ANOVA with the eight QTI scales as dependent variables. Table 5.5 illustrates the differences in value of the average item

means (mean of females minus mean of male) and the level of statistical significance. The F values shown in Table 5.5 indicate that there were three, out of eight, statistically significant differences. These results are illustrated graphically in Figure 5.2.

Table 5.5

Scale Means, Standard Deviations and Differences between Male and Female Students Perceptions for Actual Form of the QTI

Scale	Male		Female		Difference	F value	Effect size
	Mean	S.D.	Mean	S.D.	(F-M)		
DC Leadership	4.05	.59	4.05	.61	0	.07	0
CD Helping/ Friendly	4.01	.62	4.00	.62	-0.01	.15	0.02
CS Understanding	4.05	.57	4.05	.55	0	.01	0
SC Student Responsibility/	3.59	.61	3.56	.60	0.03	1.00	0.05
SO Uncertain	2.63	.62	2.54	.57	-0.09	6.30**	.15
OS Dissatisfied	2.35	.75	2.15	.69	-0.2	21.33***	.28
OD Admonishing	2.38	.66	2.22	.58	-0.16	16.41***	.26
DO Strict	3.03	.69	3.08	.73	.05	1.19	.07

***p<0.001 **p<0.01 *p<0.05 (No. of students: Male = 424, Female = 770)

Male students perceived greater uncertain, dissatisfied, and admonishing behaviours in their teachers than did female students. In addition, effect sizes were calculated to confirm the magnitude of differences. Based on Cohen's (1988) suggestion that they are small (0.10), medium (0.25), and large (0.40), the results were confirmed in that the Dissatisfied and Admonishing scales have medium effect size but the Helping/Friendly, Student Responsibility, Uncertain, and Strict scales have small effect sizes.

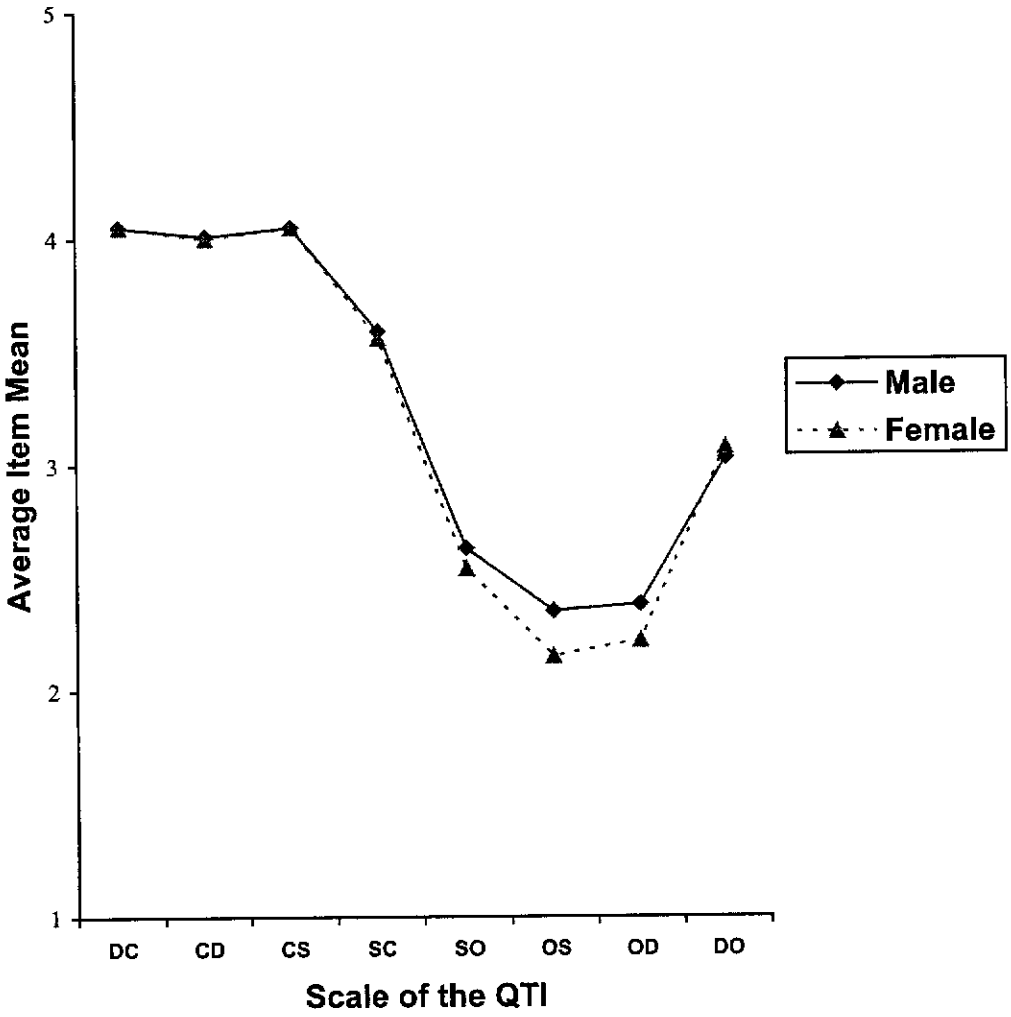


Figure 5.2. Average item means for QTI scale scores for male and female students.

Previous research has indicated that there are gender differences in students' perceptions of their classroom-learning environment. For instance, Henderson (1995) who studied senior biology classes in Tasmania, Australia, found that female students preferred a more positive learning environment than did male students. The results showed that females preferred more leadership and understanding behaviour and less uncertain, dissatisfied and admonishing behaviour in their teachers. They also preferred to be given less freedom and responsibility.

Rickards (1998) indicated from an examination of gender differences with 1,592 male students and 1,623 females in Australian schools that the differences between males and females were significantly different on all scales except for the Leadership

scale. In regard to effect sizes, there was a small effect for Admonishing but medium effect for the Uncertain and Dissatisfied scales. Generally, girls perceived a more positive teacher-student interaction in their classes than did the boys.

5.3.1.2 Gender Differences: The SLEI

Gender differences in students' perceptions of laboratory learning environments were investigated using the Actual Form of the SLEI. Significant F tests and effect sizes were again used to determine whether differences were statistically significant. Table 5.6 shows that there were significant gender differences in students' mean scores on three scales of the SLEI. These indicated that females perceived greater student cohesiveness and integration in their biology laboratory learning environments than did the males. However, an examination of the effect sizes indicated that these were only small effects. Figure 5.3 presents these comparisons graphically.

Table 5.6

Scale Means, Standard Deviations and Differences between Male and Female Students Perceptions for Actual Form of the SLEI

Scale	Male		Female		F Values	Effect Size
	Mean	S.D.	Mean	S.D.		
Student Cohesiveness (SC)	3.94	0.55	4.03	0.52	9.06***	0.17
Open-Endedness (OE)	3.47	0.52	3.36	0.53	12.54***	0.21
Integration (I)	3.50	0.54	3.63	0.55	16.24***	0.24
Rule Clarity (RC)	3.71	0.58	3.74	0.58	0.81	0.05
Material Environment (ME)	3.40	0.63	3.47	0.63	2.86	0.11

***$p<0.001$ (No. of students: male = 424, female = 770)

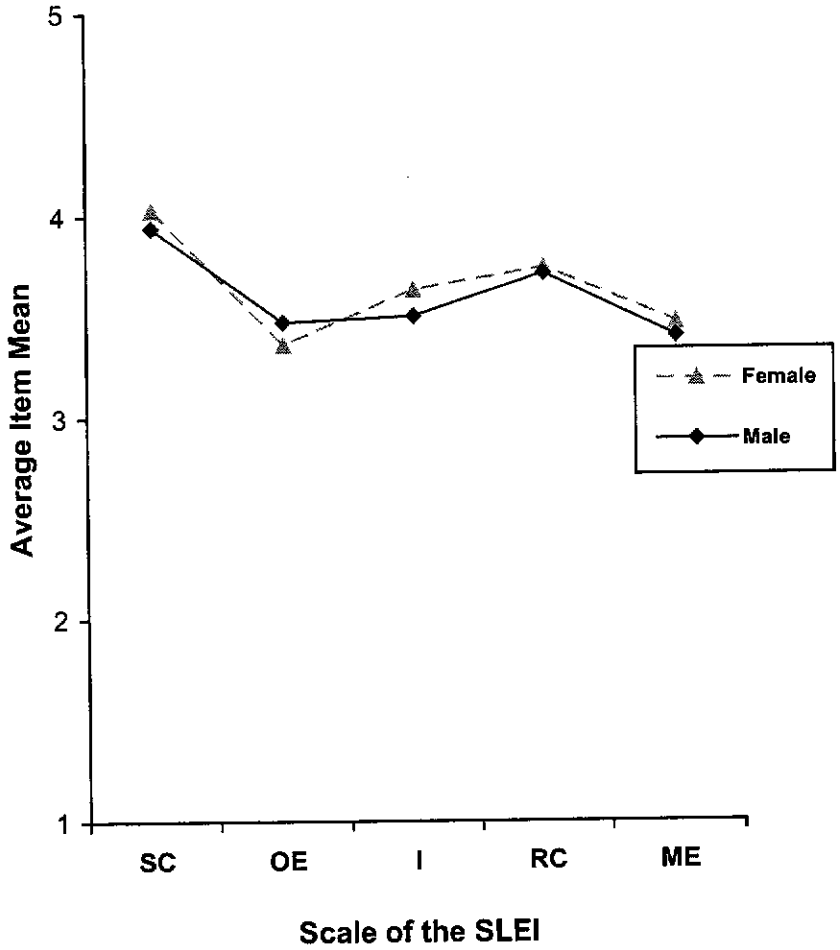


Figure 5.3. Mean differences between male and female students on the Actual Form of the SLEI.

5.3.2 School Situation Differences

It was also of interest in this study whether there were any differences resulting from the school's situation. In the sample concerned of 1,194 students, 419 (35.09%) students were from 14 schools situated in the city while 775 (64.91%) students were from 23 schools situated in rural area. Therefore, this gave rise to two different school situations which could be compared. The differences were examined using the Actual Forms of the QTI and the SLEI using a one way multivariate analysis of variance (MANOVA) with the set of QTI scales or the set of SLEI scales as dependent variables. A univariate analysis of variance (ANOVA) was computed if the F test was found to be statistically significant ($p<0.05$).

5.3.2.1 School Situation Differences: The QTI

The F values in Table 5.7 indicate that there were only two scales, the Helping/Friendly and Strict scales, in which there was a statistically significant difference. Students in rural schools perceived greater degrees of helping/friendly and strict behaviours in their teachers than did students from city schools. However, the effect sizes of both scales were small (0.11).

Table 5.7

Scale Means, Standard Deviations and Difference between School Situations for the Actual Form of the QTI

Scale	City (C)		Rural (R)		Difference	F value	Effect size
	Mean	S.D.	Mean	S.D.	(C-R)		
Leadership	4.03	.58	4.06	.62	-0.03	0.69	0.05
Helping/ Friendly	3.96	.61	4.03	.63	-0.07	3.84*	0.11
Understanding	4.02	.55	4.07	.57	-0.05	1.48	0.9
Student Responsibility/	3.57	.62	3.57	.59	0.00	0.05	0
Uncertain	2.57	.63	2.57	.57	0.00	0.00	0
Dissatisfied	2.23	.75	2.21	.69	0.02	0.18	0.03
Admonishing	2.30	.66	2.26	.58	0.07	1.23	0.11
Strict	3.01	.77	3.09	.68	0.08	4.20*	0.11

*$p<0.05$ (n: Students of City School = 419, Students of Rural School= 775)

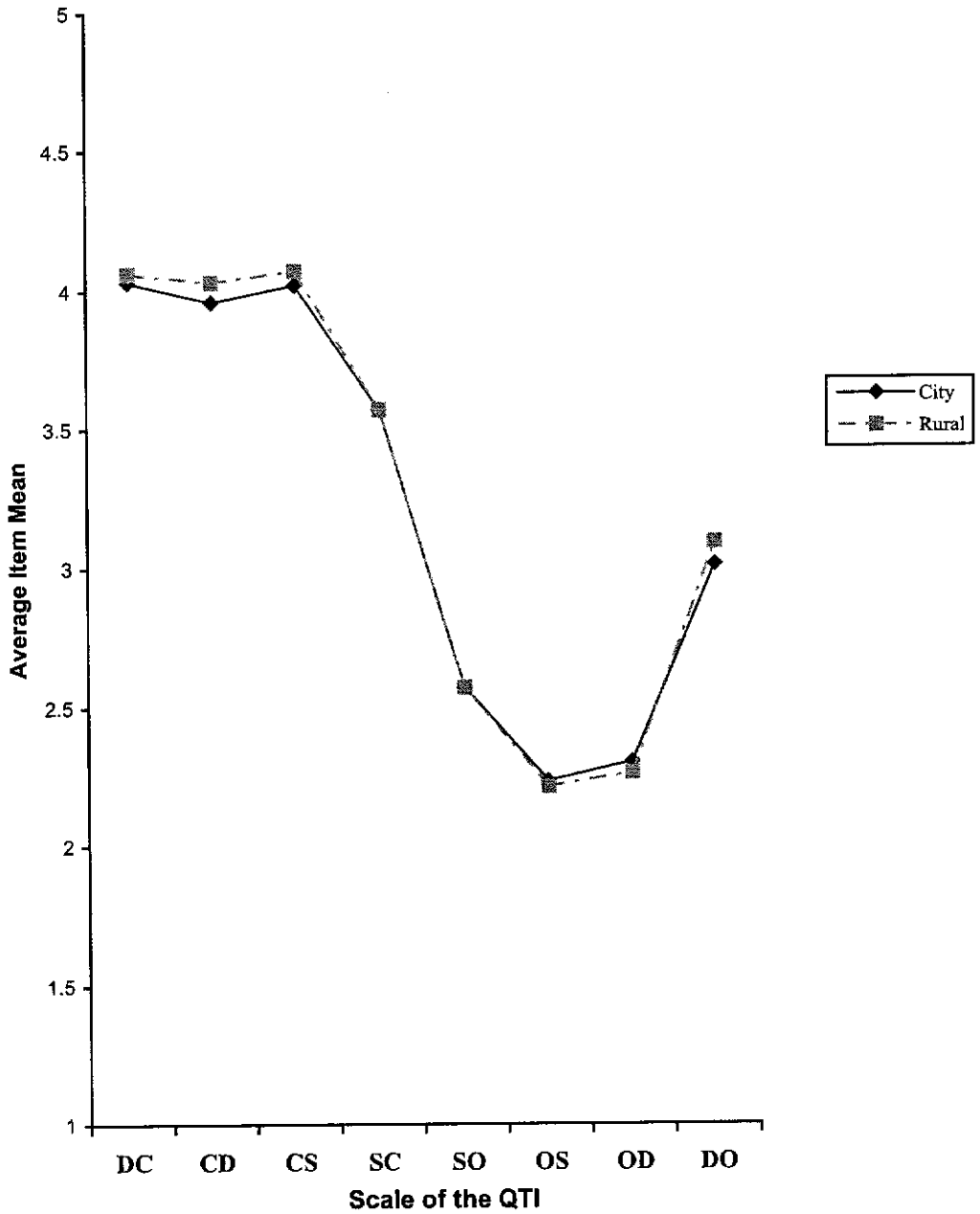


Figure 5.4. Mean differences between city and rural school students on the Actual Form of the QTI.

Figure 5.4 illustrates a comparison of city and rural schools on the QTI. The results indicate that both city students and rural students perceive quite similar teacher-student interactions in their biology classes.

5.3.2.2 School Situation: The SLEI

For the scale of laboratory learning environment, the F values were again calculated and are reported in Table 5.8. The results indicate that there were two statistically significant differences between students from city school and rural schools.

Table 5.8

Scale Means, Standard Deviation and Differences between City and Rural Schools for Actual Form of the SLEI

Scale	City (C)		Rural (R)		Differences	F value	Effect
	Mean	S.D.	Mean	S.D	C – R		size
Student Cohesiveness	4.02	.51	3.99	.54	0.03	0.55	0.06
Open-Endedness	3.47	.55	3.36	.52	0.11	10.64***	0.21
Integration	3.58	.57	3.59	.54	-0.01	0.04	0.02
Rule Clarity	3.73	.61	3.73	.58	0.00	0.01	0.00
Material Environment	3.50	.65	3.41	.61	0.09	5.72*	0.14

***p< 0.001, **p<0.01, *p<0.05 (No. of students: City = 419, Rural = 775)

Figure 5.5 illustrates this comparison of city and rural schools on the SLEI. The results indicate that both city students and rural students perceive quite similar learning environment in their biology laboratory, except that the activities in city school laboratories are more open-ended than in rural schools and they appear to be better equipped than rural schools. However, these are small to medium effect sizes.

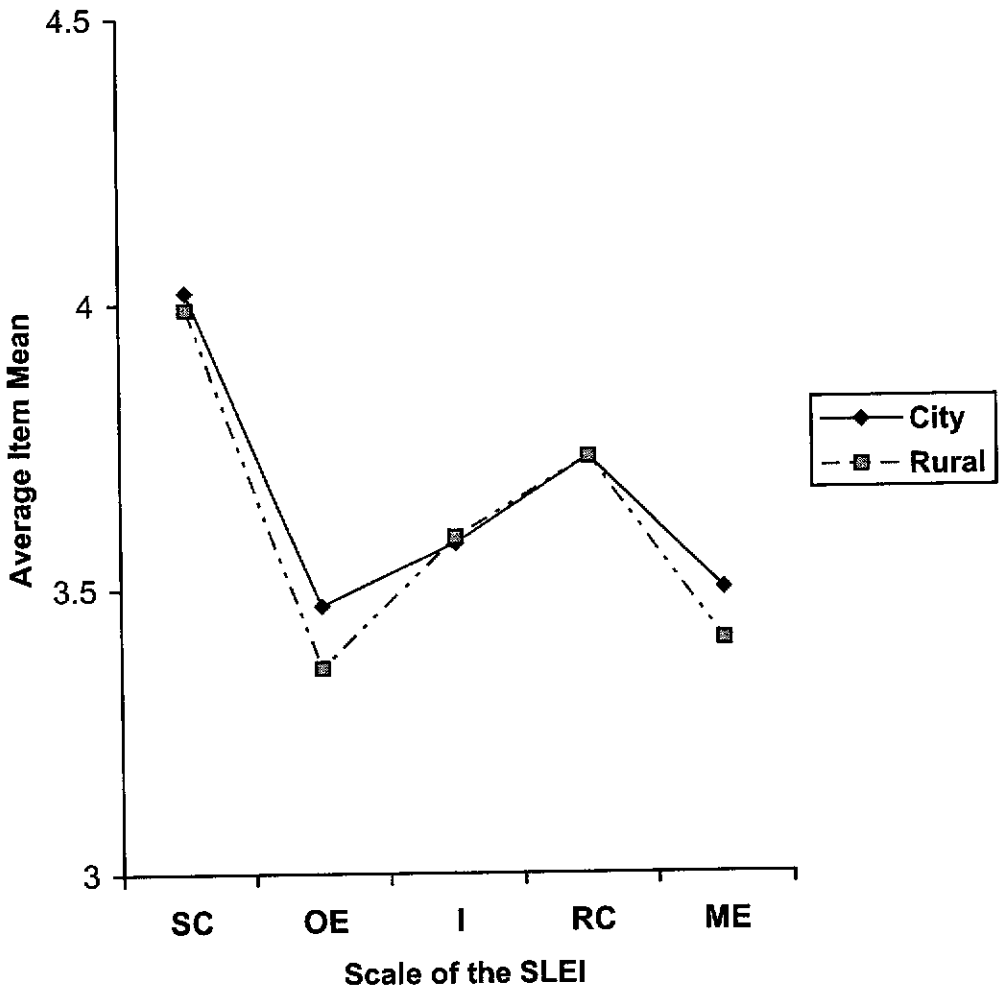


Figure 5.5. Mean differences between city and rural schools students for Actual Form of the SLEI.

5.3.3 School Size Differences

The 1,194 students, who provided their perceptions of teacher-student interaction and laboratory learning environments in biology classes, came from three school-size groups. In the total sample, 330 students came from 14 small schools, 486 students were in 15 medium schools, and 378 students were in 9 large schools. Large schools were defined as having more than 1,500 students, medium schools had between 500 and 1,499 students, and small schools had less than 500 students.

School size differences were examined using the Actual Forms of the QTI and the SLEI using a one-way multivariate analysis of variance (MANOVA) with the set of QTI scales or the set of SLEI scales as dependent variables.

5.3.3.1 School Size Differences: The QTI

Table 5.9 presents the differences in mean scores on the QTI scales for the three different school sizes, small, medium and large, as addressed in section 5.3.3, large schools had more than 1,500 students, medium schools had between 500 and 1,499 students, and small schools had less than 500 students. These differences were statistically significant on three of the eight scales, namely, the Uncertain, Dissatisfied and Strict scales.

Table 5.9

Scale Means and Standard Deviations and Difference Small, Medium and Large Schools for Actual Form of the QTI

Scale	Small		Medium		Large		F value
	Mean	S.D.	Mean	S.D.	Mean	S.D.	
Leadership	4.10	.50	4.02	.66	4.04	.59	1.46
Helping/ Friendly	4.02	.54	4.00	.68	3.99	.60	0.24
Understanding	4.06	.51	4.02	.61	4.08	.54	1.07
Student Responsibility/	3.58	.56	3.56	.62	3.58	.62	0.18
Uncertain	2.63	.57	2.59	.58	2.48	.61	6.70***
Dissatisfied	2.29	.76	2.25	.68	2.11	.71	6.27***
Admonishing	2.35	.67	2.30	.59	2.19	.59	6.05***
Strict	3.10	.68	3.06	.68	3.03	.78	0.65

***$p < 0.001$ (No. of students: Large = 378, Medium = 486, Small = 330)

It can be noted in Table 5.9, that teachers in large schools were perceived as less admonishing, uncertain and dissatisfied than their colleagues teaching in small schools. It is possible, that because most large schools are located in big towns or cities, they are more successful in recruiting qualified biology teachers than are medium and small schools and these teachers show more confidence in their teaching.

To investigate which of the differences were statistically significant, a post hoc Tukey analysis was performed with the scales as dependent variables. Table 5.10 shows that large-school students perceived their biology teachers as displaying less uncertain, dissatisfied, and admonishing behaviours than did students in both the other school types. However, students from all three school sizes had similar perceptions of leadership, helping/friendly, understanding, student responsibility, and strict behaviour. Figure 5.6 illustrates these results graphically.

Table 5.10

ANOVA and Significance Post-hoc test Results for Three School Sizes on the QTI

Scale	F value	Significant (Mean Different)		
		S & M	M & L	L & S
Leadership	1.46			
Helping/ Friendly	0.24			
Understanding	1.07			
Student Responsibility	0.18			
Uncertain	6.70***	.03	.12*	-.15*
Dissatisfied	6.27***	.04	.14*	-.18*
Admonishing	6.05***	.05	.010*	-.15*
Strict	0.65			

***$p<0.001$, *$p<0.05$

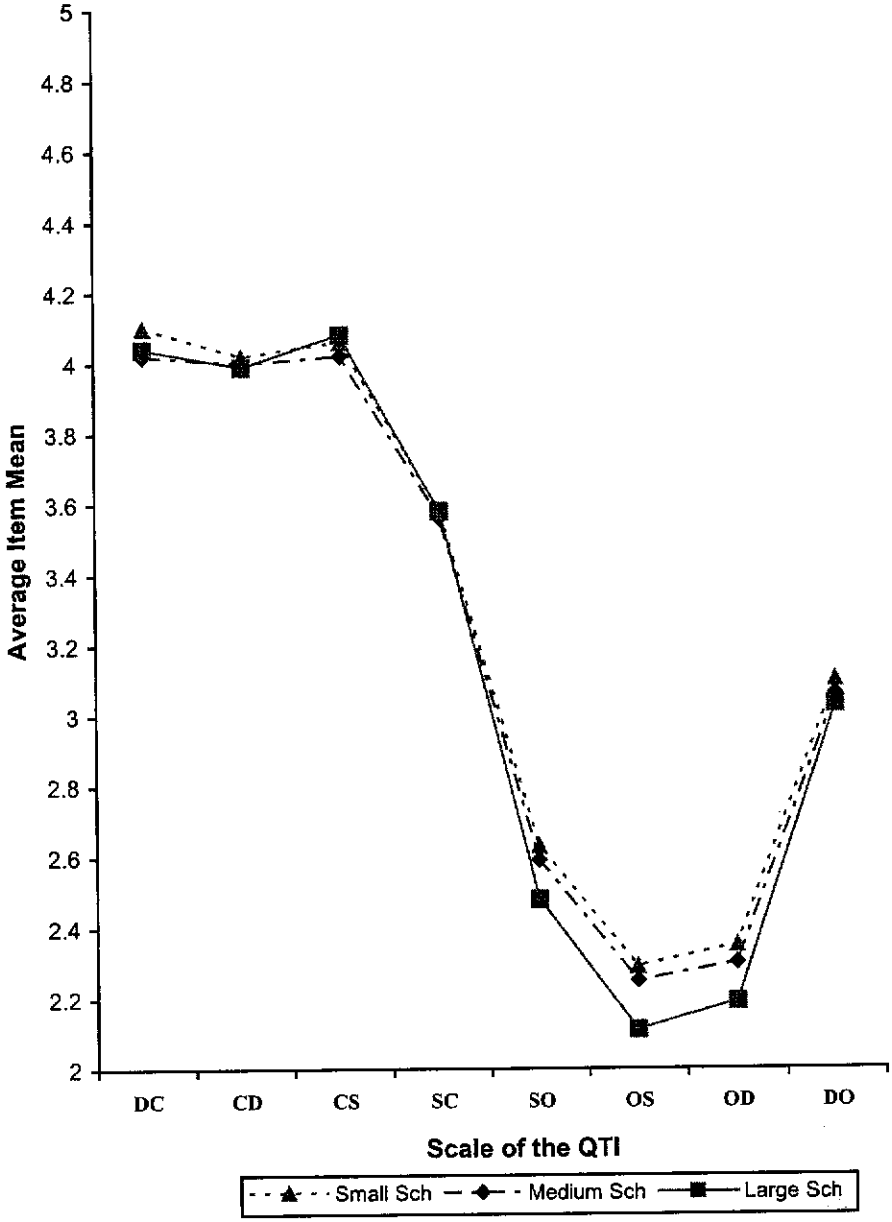


Figure 5.6. Mean differences between small, medium and large school students on the Actual Form of the QTI.

5.3.3.2 School Size Differences: The SLEI

Table 5.11 and Figure 5.7 show the results when the Actual Form of the SLEI was answered by students in small, medium and large schools. There were statistically significant differences on all scales of the SLEI, except for Student Cohesiveness. To determine between which schools these differences occurred, post-hoc analyses were again used and are shown in Table 5.12.

Table 5.11

Scale Means, Standard Deviations, and Difference on Small, Medium and Large Schools for Actual Form of the SLEI

Scale	Small		Medium		Large		F value
	Mean	S.D.	Mean	S.D.	Mean	S.D.	
Student Cohesiveness (SC)	3.95	0.50	4.01	0.56	4.03	0.51	2.65
Open- Endedness (OE)	3.41	0.54	3.33	0.53	3.48	0.53	8.17***
Integration (I)	3.47	0.49	3.60	0.55	3.68	0.57	13.60***
Rule Clarity (RC)	3.68	0.55	3.70	0.58	3.82	0.58	6.42***
Material Environment (ME)	3.37	0.60	3.38	0.63	3.59	0.63	15.86***

***$p < 0.001$ (n: small school = 330, medium school = 486, large school = 378)

For the scale of Integration students in large schools perceived their laboratories more favourably than did students in medium and small schools. Also, students in medium schools perceived their laboratories more favourably than did students in small schools.

For the scale of Open Endedness, students in large schools perceived more open-ended activities in the laboratory than did students in medium size schools.

For the scales of Rule Clarity and Material Environment, students from large schools showed more favourable perceptions of their biology laboratory class than did students from small schools and medium schools; however, students from medium schools perceived their laboratory more favourably than did students in small schools.

Table 5.12

ANOVA and Significance Post-hoc test Results for Three School Sizes on the SLEI

Scale	F value	Significant *t* Values		
		S & M	M & L	L & S
Student Cohesiveness (SC)	2.65			
Open- Endedness (OE)	8.17***	.08	-.15*	.06
Integration (I)	13.60***	-.13*	-.08	.21*
Rule Clarity (RC)	6.42***	-.03	-.12*	-.14*
Material Environment (ME)	15.86***	-.01	-.22*	.22*

*$p<0.05$ (n: small school = 330, medium school = 486, large school = 378)

For the scale of Integration, students from medium schools and large schools perceived that there were no significant differences, but students from both schools perceived this scale more favourably than did students from small schools.

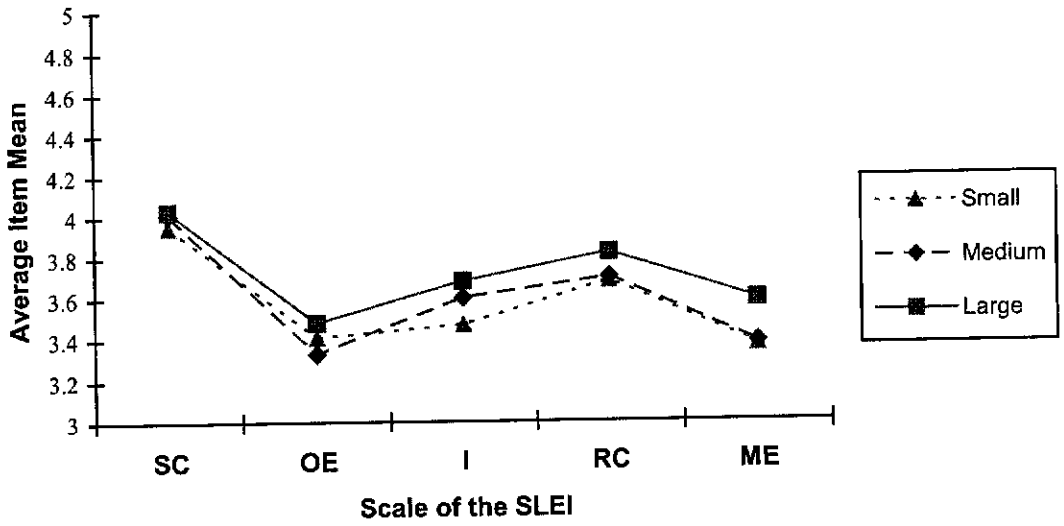


Figure 5.7. Mean differences between small, medium and large school students on the Actual Form of the SLEI.

It is noteworthy that there were no significant differences between the three school sizes on Student Cohesiveness. Apparently, students in schools get on well together no matter what the size of the school.

Overall, the results suggest that large-school students perceived the perceptions of their biology laboratory classes more favourably than did students from both small school and medium school size. In addition, students from large schools considered that their learning environments were much more open-ended than did students from medium schools, but the students from small schools and students from large schools responded similarly on this scale.

5.4 DIFFERENCES IN ATTITUDES TO BIOLOGY

Average means of students' perception on attitude to biology classes were examined between gender, school situation, and school sizes. The F values were used to examine the statistical significances. When the F test of gender and school situation were found to be statistically significant ($p < 0.05$), univariate analysis of variances were computed. For school size differences, pos-hoc analyses were again used to determine between which schools these differences occurred.

Table 5.13 presents the average mean scores of students' attitude to their biology classes. The results suggest that Grade 10 students in secondary schools in Thailand have a moderately positive attitude to biology class. Differences between students' attitudes according to gender, school situation and school size were also examined. These results are depicted graphically in Figure 5.8.

Table 5.13

Average Mean and Standard Deviation of Students' Perception on Attitudes to Biology Classes

	Average Mean	Standard Deviation	F value	Effect size
Gender:				
Male (N = 424)	3.76	0.55	15.28***	0.24
Female (N = 770)	3.89	0.54		
School Situation:				
City (N = 419)	3.80	0.57	4.88*	0.13
Rural (N = 775)	3.87	0.53		
School Size:				(Pos Hoc Test) (S-M)
Small (N = 330)	3.79	0.53	3.97*	-0.1*
Medium (N = 486)	3.89	0.55		
Large (N = 378)	3.82	0.56		
Total Students (N =1,194)	3.84	0.55		

****p*<0.001, ***p*<0.01, **p*<0.05*

Note: S = small schools; M = medium schools; L = large schools

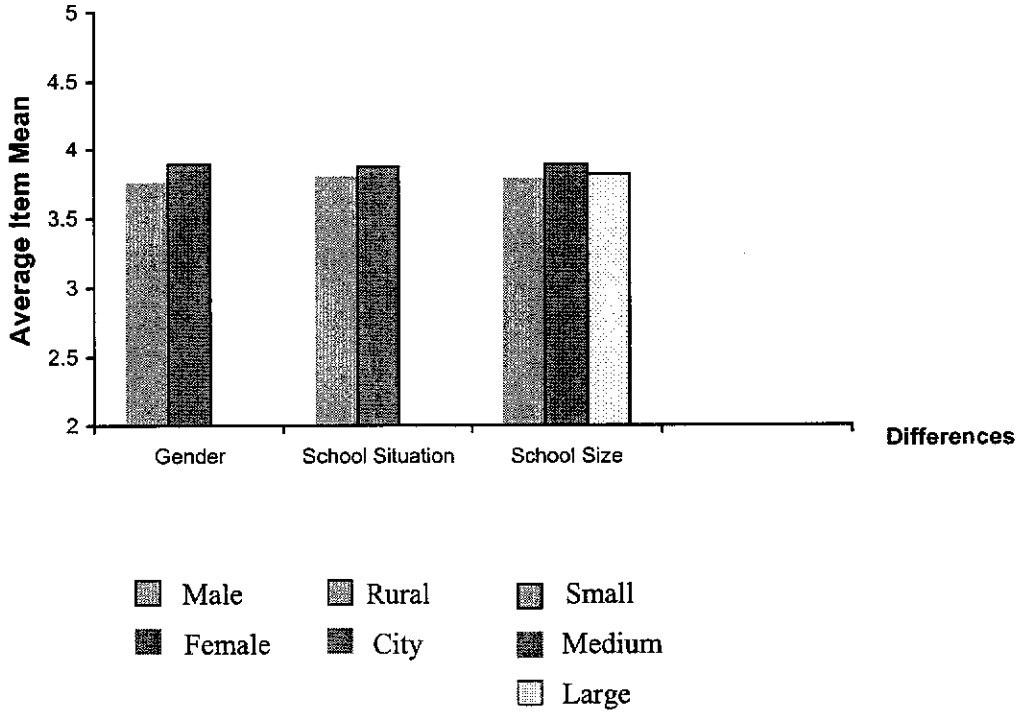


Figure 5.8. Mean differences between gender, school-situation and school-size on students' attitude.

The results suggest that females had more favourable attitudes to biology than did males, and students in rural schools had more favourable attitudes to their biology classes than did students in the city schools. There was a difference of attitudes to biology class between students in small and medium schools. The students in medium schools have a better attitude to biology than do students in small schools.

5.5 SUMMARY

This chapter has reported the results of analyses of the quantitative data that were collected to examine associations between learning environment and students' attitudes to biology classes, differences of perceptions (gender, school situations, and school sizes) on the Actual Form of the QTI, SLEI and ABC are also reported.

The results suggest that there are associations between: teacher-student interaction and students' attitude, biology laboratory learning environments and students' attitude, teacher-student interaction, biology laboratory learning environments and students' attitude.

For differences in student perceptions, the results presented indicated that there are different perceptions of learning environments between gender, school-situation and school-size. Similarly, for students' attitude, there are different perceptions between gender, school-situation and school-size. The next chapter, Chapter 6, presents conclusions and limitations of this study, and suggestions for the future research.

CHAPTER 6

CONCLUSION

6.1 INTRODUCTION

The research study described in this thesis was the first investigation concerning teacher-student interactions and laboratory environments in biology classes in secondary schools in Thailand. Associations of learning environment measures and students' attitude to biology were also investigated.

This final chapter consists of six sections. The next section (6.2) describes an overview of the study in relation to the objectives, methodology and analysis of the data collected during the study. The major findings are presented in Section 6.3 and implications, from the major findings for the teaching and learning of biology in secondary schools in Thailand are suggested in Section 6.4. The limitations of the study are described in Section 6.5, this is following by suggestions for future research in Section 6.6, and a summary of this chapter is given in section 6.7.

6.2 OVERVIEW OF THE STUDY

The major aim of this study was to describe biology classrooms in secondary schools in Thailand. As described previously, in order to do this, questionnaires on teacher-student interaction and laboratory learning environments for use in secondary school biology classes in Thailand were validated and then used to examine associations between students' perceptions and attitudes to their classes.

The sample of this study was composed of students who studied in biology classes at the grade 10 level of secondary schools in Thailand. The total sample involved 1,194 students who completed questionnaires in their biology classes in the academic year 2002. The instruments used in this research were the QTI, the SLEI, and the attitudes to biology were measured with a scale based on an adaptation of the Test of Science Related Attitudes (TOSRA) (Fraser, 1981). It was adapted, specifically for this

subject, and named Attitude to Biology Class (ABC). Students completed two forms of the QTI. The first form was the Actual Form used to assess students' perceptions of the teacher whose class the students actually were attending while responding to the questionnaire. The second was the Ideal or Preferred Form that was used to ask students to rate teacher-student classroom interactions that they would prefer to occur in their biology classes. For the SLEI, students rated their current laboratory environments with the Actual Form and their preferred laboratory environment with the Preferred Form.

The questionnaires were Australian versions that were modified and translated into Thai versions. The QTI, the SLEI, and the ABC consist of 48 items, 35 items, and 7 items, respectively. Students indicated their perceptions on response sheets, using a five-point Likert scale format.

For examination of the validation of questionnaires, Cronbach alpha reliability coefficients as indices of scale internal consistency were estimated. Mean correlations between the scales for the SLEI, and the circumplex nature of the QTI were also investigated. Analysis of variance (ANOVA) was used to determine the ability of each of the scales of the SLEI and QTI to differentiate between the perceptions of students in different classes. Simple and multiple correlations were computed to find associations between: each of the QTI scales and each of the SLEI scales; each of the QTI scales and attitude to biology; each of the SLEI scales and attitude to biology.

The difference between the two means of the Actual and Ideal (Preferred) forms was tested for statistical significance using *t* tests and effect sizes.

Gender, school situation and school size differences between the Actual Forms were examined using a one-way multivariate analysis of variance (MANOVA) with the set of QTI scales as dependent variables. When the *F* test was found to be statistically significant ($p<0.05$), a univariate analysis of variance (ANOVA) was computed.

An Analysis of Variance (ANOVA) was used to compare the means of more than two groups of an independent variable. If the ANOVA result of more than two values, such as three school sizes, was significant, post hoc (Tukey) analysis was employed to determine between which of the variables the difference occurred.

6.3 MAJOR FINDINGS OF THE STUDY

The major findings of the present study are presented in three parts in relation to the research questions proposed in Chapter 1. Firstly, the validations of the questionnaires, the QTI, the SLEI, are reported (see Section 6.3.1). Secondly, the general features of biology classroom in Thailand are described (see Section 6.3.2). Finally, associations between teacher-students interactions, laboratory learning environments and students' attitude to biology class are also described (see Section 6.3.3).

6.3.1 Validation of the Questionnaires

The results, as shown in Chapter 4, were used to answer the following research questions:

Research Question 1: Is the Thai version of the QTI a valid and reliable instrument for use in Thailand?

Research Question 2: Is the Thai version of the SLEI a valid and reliable instrument for use in Thailand?

Both the QTI and SLEI were translated and modified into Thai versions and then validated with 1,194 grade 10 students from 37 classes in secondary schools of Thailand.

In order to provide a satisfactory validated version of the QTI, it was necessary to delete three items. The items deleted were item 4 of the Student Responsibility/Freedom scale and items 2 and 4 of the Strict scale. This was done following an examination of the Cronbach alpha reliabilities of the scales. The items

then were deleted from all further calculations. It is very interesting to consider the wordings of these deleted items.

The following reasons are suggested about why these items may not have been suitable for use in the Thai context. Item 4 of the Student Responsibility/Freedom scale (item 38 in the questionnaire as presented in Appendix A) is: *This teacher lets us get away with a lot in class.* It is possible, that students do not want to be punished when they make mistakes, however, some students may think that they should be punished to maintain control in their class, thus adding to their confusion.

Item No 2 of the Strict scale (item 32 in the questionnaire as presented in Appendix A) is: *I have to be silent in this teacher's class.* There are previous research studies, especially in Asia, showing that good classrooms should be silent (Scott, 2003). It is part of Thai culture that a younger person should believe that an older person is in a higher authority position and would expect to be silent in their presence. Furthermore, the principal of the school would expect most classes to be silent because there are at least 40 students in each class. These reasons may have made students hesitate when they considered this item, and respond in a different way from the other items in the scale.

Item 4 of the Strict scale (item 40 in the questionnaire as presented in Appendix A) is: *This teacher's standards are very high.*

I, as the researcher in this study, talked about this situation with students when they finished their responses to the questionnaires. Some students told me that they hesitated to give the answer. Some asked me what are the teacher's standards. The good students (those with a high Grade Point Average) said that they needed teachers who had very high standard of teaching and scoring. However, the students, who received a poor Grade Point Average, said that the teacher who had high standards was severe when marking papers. These issues may result in confused perceptions by different groups of students.

However, it can be concluded that the Thai version of the QTI, both Actual and Ideal Forms, that consist of 45 items each, are good valid instruments that can be used to assess students' perceptions in secondary school, particularly in biology classes. The questionnaire can now be used with confidence by researchers and teachers in Thailand.

For the SLEI, the three items deleted from the SLEI questionnaire after considering the Cronbach alpha reliability coefficients figures were item 6 of the Open-Endedness scale, and items 2 and 5 of the Rule Clarity scale. Possible reasons why it was necessary to delete these items are now given.

Item 6 of the Open-Endedness scale (item 27 in the questionnaire presented in Appendix B) is *In my laboratory sessions, the teacher decides the best way for me to carry out the laboratory experiments.* In my opinion, most students are accustomed to learning with a teacher-centred approach and therefore some students do not worry if they do not decide on their laboratory experiments by themselves. In addition, they have not been taught to indicate their own ideas in their classes. Thus, they would accept that their teachers should make such decisions. However, it is hoped that they will change this thinking now that educational reform has begun in Thailand emphasising a student-centred approach.

Item 2 of the Rule Clarity scale (item 9 in the questionnaire as presented in Appendix B) is *This laboratory class is rather informal and few rules are imposed.* And item 5 of the Rule Clarity scale (item 24 in the questionnaire as shown in Appendix B) *is There are few fixed rules for students to follow in laboratory sessions commence.*

These two items in the Rule Clarity scale are describing a similar situation. After talking about this issue with students, some told me that they were not sure whether it is the rule for the laboratory room, or for the general class, or for the school. A lot of laboratory rooms in Thailand, especially in the classes in this study, have no rules

to show students. In addition, punishments are still given to students in some schools causing students to worry about this. These thoughts could have made the students hesitate and make different responses.

However, similar to the QTI, the Thai version of the SLEI in both its Actual and Preferred Forms, consisting of 32 items each, is a good valid instrument that now can be used with confidence to assess students' perceptions of biology laboratory learning environments in Thailand.

6.3.2 General Features of Biology Classroom in Thailand

Once the validated versions of the QTI and SLEI had been achieved, they were used to describe the nature of the learning environment of biology classroom in Thailand. To achieve this, the following three research questions were proposed and then answered.

Research Question 3: What are students' perceptions of interactions between themselves and their teachers in biology classes?
Research Question 4: What are students' perceptions of their biology laboratory learning environments?
Research Question 5: How do students' perceptions of their learning environments relate to teacher -student interactions?

This study found that students perceived their teachers as being moderately positive in terms of the Student Responsibility and Strict scales, while highly positive in terms of Leadership, Understanding, Helping/Friendly scales.

A high level of leadership as perceived by students suggested that most teachers were good leaders and could hold students' attention in their classes. Moreover, they act confidently and talk to students enthusiastically about biology. This is reinforced by students' low levels of perception of uncertain, dissatisfied and admonishing behaviour in their teachers.

Furthermore, a high level of understanding indicated that teachers are patient while listening to their students and are willing to explain anything that impedes their students' understanding.

Meanwhile, a moderately favourable positive response in terms of giving students responsibility suggests that teachers sometimes encourage students to make their own decisions.

However, it was found that gender, school situation, and school size had significant roles in differentiating students' perceptions. In terms of leadership, helping/friendly, and understanding teacher behaviour, the responses of the male and female students and the students from three different-sized schools (small, medium and large) were not different. However, students from rural schools responded more positively to helping/friendly behaviour than did those from city schools. This suggested that teachers in city schools might work harder because there are 40 to 50 students in each class. Thus, they had limited time to talk to all of students in their classes.

In terms of laboratory environment, students responded positively to student cohesiveness, but negatively to open-endedness and integration of the theory and practice. They considered the rules were unclear and the materials impracticable and insufficient. Females' responses on the Student Cohesiveness and Integration scales were higher than were males.

A possible reason for high level of student cohesiveness in the biology laboratories in Thailand is that students are usually asked by their teachers to do their laboratory work in groups. Normally, there are four to six students in each group. Because of time limitations, it is necessary that each group has to assign each member one task. Anyone not fulfilling his or her duty results in, the group assignment not being completed resulting in failure.

However, there was less open-endedness in laboratory classes as perceived by students. Normally, most students do the experiments that their teacher has designed. They have no chance to experiment about what they are interested in nor to design

an experiment to answer their questions. Although the class is divided into groups, they receive the same information and do the same experiments.

Similarly to the Open-Endedness scale, students' responses to the scale of Integration indicated that there was little integration in their biology classes. The students lack integration of their science in the laboratory with what occurs in normal classes. Students have little chance to use theory learnt in their class with their laboratory work.

One possible reason for the lower levels of open-endedness and integration in Thailand is that most teachers are worried that they can not teach students all the topics in their prescribed course syllabus. Moreover, most principals expect that the teachers should teach their students as much knowledge content as they can. They also expect their students to pass the exam in order to study at the university.

It was interesting to note that students in large and small schools perceived a more open-ended learning environment than did students in medium schools. To the scale of Integration, students from medium and large schools displayed no significant difference. Yet the students from both schools considered this scale more favourable than did students from small schools. This difference might result from the fact that most medium and large schools are situated in a large town or city. These schools are more successful in recruiting qualified biology teachers than are small schools, as described in Chapter 1. Such teachers tend to be more skilled at promoting students' integration in their works after their class (study hour).

To the scales of Rule Clarity, the finding of the study suggests that most students do not know how they practise safety in the laboratory. Also, the teachers have no guide lines for students to follow on this matter. This issue is most important and the teachers should improve laboratory safety aspects for their students.

This study is also found, for the scale of Material Environment, that the biology laboratory classes are crowded. Also, students need more equipments and materials for use in their practical work.

When considering the difference of school-size, students from large schools responded more favourably in their perceptions of their biology laboratory classes than did students from small and medium schools for the scales of Rule Clarity and Material Environment.

Other differences occurred between students' perceptions in different school situations and sizes. Students in rural schools perceived greater helping/friendly and strict behaviours in their teachers than did students from city schools. However, the effect sizes of both scales were small. Both city and rural students had quite similar perceptions on teacher-student interactions in their biology classes.

Students from large schools perceived their biology teachers as displaying less uncertain, dissatisfied, and admonishing behaviours than did students in the other school types. However, all three groups had similar perceptions of leadership, helping/friendly, understanding, student responsibility, and strict behaviours. Similar to the result for the Integration scale, this suggested that teachers in large schools might have more expertise in biology than do teachers from small and medium schools.

Overall, the general features of biology classrooms in Thailand were described in terms of teachers' interaction and the learning environment in biology laboratory classes. Apparently, the Thai teachers are good leaders, supportive and friendly, understanding, sometimes strict and give the students responsibility and freedom. Such teachers are seldom uncertain, dissatisfied or admonishing. The learning environment in Thai biology classes is viewed as having good student cohesiveness but less open- endedness, and integration of the theory and practical work, unclear rules and the materials to carry out practical work are insufficient. The female students perceived greater level of student cohesiveness and integration in their biology laboratory learning environments than did the males.

Although learning environments in biology classes were viewed as positively favourable, there were differences in students' perceptions of their actual and preferred classroom. In particular, the students would prefer more leadership and clearer rules in their classrooms.

Moreover, in this study it was found that the variance of all SLEI scales could be attributed to students' perception of teacher-student interactions in biology classes, as presented in Chapter 5. It is suggested that teachers who wish to improve the learning environment in their biology classes should be aware of the teacher-student interactions that are occurring in their regular classes as well.

Despite the overall favourable perceptions of the differences in actual and preferred results would suggest that the learning environment could be improved further. It is hoped that this situation might improve following the educational reform that started in 2003. Some other steps that could be taken in Thailand are that the Rajabhat University and agencies concerned with the development of the teaching profession should provide training in teaching methodology, especially use of a students-centred approach, for biology teachers. Also, activities could be provided to make those teachers realize that it is necessary to indicate clearly to their students what the rules are for working in a laboratory. Moreover, the government and agencies concern should support the provision of more material and equipment that can be used in the teaching and learning of biology.

6.3.3 Associations between Teacher-Student Interactions, Learning Environments and Attitude to Biology Classes

Previous studies have demonstrated the presence of associations between students' perceptions of learning environments and attitudinal outcomes (Henderson, 1995; Riah, 1998; Rickards, 2000). This study also attempted to identify aspects of classroom environment that influenced students' attitude to biology classes. The following two research questions were proposed and subsequently answered.

Research Question 6: What associations exist between teacher-student interactions and student attitudes to their biology classes?

The results from simple correlation analysis indicated that there were associations between students' perceptions of teacher interpersonal behaviours and their attitudes to biology classes. There were positive associations with the Leadership, Helping/Friendly, and Understanding scales, and negative associations with the

Uncertain, Dissatisfied, and Admonishing scales. With consideration to the regression analysis, it was found that it was the Leadership and Admonishing scales that contributed to the students' attitude to biology classes.

This finding was quite similar to previous studies, such as the study of Koul and Fisher (2003) who reported that the greatest influences of the scales of the QTI on students' attitude to class were the Leadership and Helping/Friendly scales. Furthermore, the finding of this study replicated previous studies such as the studies of Fisher and Rickards (1997), She and Fisher (2000), Waldrip and Fisher (2000) and Koul and Fisher (2003).

Research Question 7: What associations exist between laboratory learning environments and student attitudes to their biology classes?

In this study, it was found that biology laboratory learning environment was significantly associated with student attitudes to biology. For analysing in term of simple correlation, the scales of Open-Endedness, Rule Clarity and Material Environment were significantly associated with students' attitudes to biology. However, there was no relationship with the three scales of the SLEI when examined by the regression analysis. Previous studies involving the use of the SLEI generally had yielded quite similar results. In Australia, Henderson (1995) found only the scale of Integration to be positively associated with student attitude to their classes. In Korea, Lee (2001) found that only two scales of the SLEI, Integration and Rule Clarity were associated with students' attitudes to science, namely students' interest in science.

The following discussion suggested the reason why there was no association between learning environment in biology laboratory and students' attitude' in this research.

Firstly, there were 48.49% of students who perceived their attitude at the medium level, while 2.6% of students perceived this at the high level. This finding supported the previous research that demonstrated students' attitude towards science (Osborne, Simon, & Collins, 2003). Secondly, due to the education system that is examination-

oriented, students have to focus on theory than practice or experiment. Both assumptions were supported by Henderson (1995)'s finding that only the scale of the SLEI, the Integration, was associated with students' attitude' to biology classes.

However, the R^2 value showed that only 1% of the variance in students' attitudes of their biology classes could be attributed to their perceptions of their biology laboratory learning environments. The results of simple correlation analysis indicated that there were correlations between students' attitudes and learning environment in biology laboratory classes, especially with open-endedness, rule clarity, and good instruments.

6.3.4 Characteristics of Biology Classes in Thailand

To describe the characteristics of Biology Classes in Thailand, the last research question formulated (Research Question 8) was, What are the characteristics of biology classes in Thailand? It is described in terms of the differences between the actual and ideal students' perception of teacher-student interactions and between the actual and preferred students' perception of their learning environments in laboratory classes.

This study found that there is big difference between actual and ideal students' perception of their teacher behaviour in positive manners of leadership, understanding, student responsibility, and helping/friendly behaviour, orderly. For negative manners, there is difference in terms of strict, uncertain, admonishing, and dissatisfied, orderly.

Similarly, the findings of learning environment in laboratory classes showed that students' perceptions of their learning environments in biology laboratory were different between actual and preferred perceptions. These differences were the Rule Clarity, Material Environment, Open-Endedness, and Integration scales.

The results of the differences between the actual and preferred perceptions, Fisher and Fraser (1983b) who studied the person-environment fit research suggested that students could perform better when there is a close alignment of actual and preferred environment. So teachers and school should provide information of students' perception and then provide an approach to make classroom environment better.

On pages 38 to 39, Wubbels, Brekelmans and Hooymayers (1991) developed typologies based on students' perception of the teacher's interpersonal behaviour. Eight types of teachers emerged from their cluster analysis. In order to describe Thai biology teachers, the average teacher was matched against these typologies. The Thai teacher most closely matched type three, i.e. authoritative and tolerant teachers Figure 6.1 illustrates the profile of Thai teachers' interpersonal behaviour according to the perception of their students.

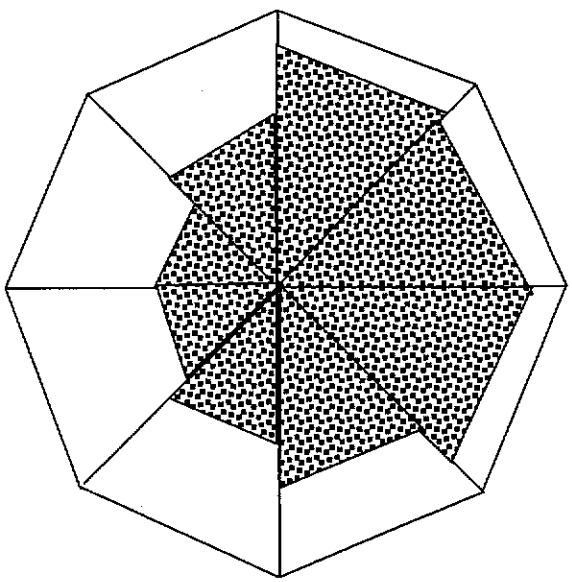


Figure 6.1. Sector profile of Thai teachers in students' perceptions.

Therefore in Thai biology classrooms the teachers maintain a structure that supports student responsibility and freedom. The teachers use a variety of methods, and

ignore minor disruptions (Brekelmans, Levy, & Rodriguez, 1993). They are understanding of the needs of their students and have the respect of their students.

6.4 IMPLICATIONS FOR TEACHING AND LEARNING OF BIOLOGY IN SECONDARY SCHOOLS IN THAILAND

According to the findings of this study, the following implications for teaching and learning of biology in secondary schools in Thailand are presented.

This study has supported the reliability and validity of the QTI and the SLEI in Thai version. Therefore, teachers who wish to improve their learning environments could use these instruments for improving their teaching.

Associations between attitude to biology class and learning environment dimensions assessed by the QTI and SLEI were relatively positive. Also, teachers wishing to improve their learning environments could use these instruments for providing basic information of students' needs, and then improve teaching and learning. Teachers can use the ABC to check whether student attitudes actually change as a result of changed approaches.

This study also found that the variance in students' attitudes to their biology class can be attributed to their perceptions of their interactions with their teachers and learning environment in laboratory classes. Therefore, teachers should be aware of the importance of their behaviour in providing learning environments that correspond to students' needs.

To provide for students' needs, the teachers could use the Actual Forms of the QTI, SLEI, and ABC to assess students' perceptions in the first week of their classes. After findings the results, they could manage their classes in response to the students' needs. Moreover, they may use the both forms (Actual and Ideal/Preferred) assess students' perceptions after they have classes around the week of midterm/mid semester. Again, they could consider taking steps to provide a learning environment preferred by the students.

6.5 LIMITATIONS OF THE STUDY

Each questionnaire consisted of two forms: the Actual and Ideal/Preferred Forms. The former contained 83 items (48 for the Actual QTI and 35 for the Actual SLEI) and the latter contained 90 items (48 for the Ideal QTI and 35 for the Preferred SLEI and 7 for the ABC). In addition to the time consumption, the excessive number of questionnaires might have caused the students to become bored so that some of them may not have read the questions at all. Moreover, the time for interviews was also limited and this might have made students unable to respond fully to all of the interviewing questions.

Finally, the number of students chosen for the interview could have been insufficient. If there were more students for the interview, more interesting ideas might have been extracted.

6.6 SUGGESTIONS FOR FUTURE RESEARCH

In my opinion as a researcher, this study has provided a number of implications for further research.

As described in Chapter 4, the finding illustrated that students preferred biology teachers who show leadership, were friendly and had less uncertain and admonishing behaviour. It would be interesting to investigate why some teachers show uncertainty and admonish students in the classroom. It is possible that their knowledge of biology may be inadequate. If this is true, they need more workshops or training about content and some skills in teaching biology. In addition, it should be studied whether students' perception of learning environments are associated with teachers' backgrounds or qualifications.

Due to the limitation of the number of students interviewed in this research, it is suggested that large-scale interviews should be considered for future research. This could provide qualitative data about learning environments in biology classes in Thailand.

6.7 SUMMARY

The results of this study indicate that the QTI, the SLEI and the ABC were valid instruments and could be used to investigate students' perceptions of teacher-student classroom interactions, biology laboratory learning environments and attitudes to biology classes, respectively, in secondary schools in Thailand.

In terms of gender differences, male students had more negative attitudes to their teachers' behaviours than female students. Both city and rural students' perceptions on teacher-student interactions in their biology classes are quite similar. Small, medium and large school-size students had similar perceptions of their biology teacher behaviours in terms of leadership, helping/friendly, understanding, student responsibility and strict behaviours.

The data indicated that students preferred teachers who show strong leadership, are more helping and understanding and who give their students more responsibility and freedom. They also preferred less uncertain, admonishing, dissatisfied and strict behaviours in their teachers.

Researchers and biology teachers can use the QTI to monitor students' views and use these instruments improve teaching and learning activities and thus promote students attitudes. Furthermore, the QTI could be used to assess the management of education in the different contexts of genders, school situations and school sizes to promote equity in education. Also, the actual and preferred students' perceptions should be compared to provide more information for practical implications.

Teachers, both in lower secondary and upper secondary school, wishing to improve their learning environments could use these instruments to improve teaching and learning activities and thus promote students' attitudes to their subjects.

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Appendix A: Student Actual Form of the QTI in English Version

Questionnaire on Teacher's Behaviour

Directions

This questionnaire you to describe the behaviour of your teacher. This is NOT a test. There are no 'right ' or 'wrong' answers. Your opinion is what is wanted. Your answers will enable us to improve biology classes in future.

This questionnaire has 48 sentences about the teacher. For each sentense, circle the number corresponding to your response. For example:

	Never				Always
This teacher talks enthusiastically about her/his subject.	1	2	3	4	5

If you think that your teacher always talks enthusiastically about her/his subject, circle the 5. If you think your teacher never talks enthusiastically about her/his subject, circle the 1. You also can choose the number 1, 2 and 3 which are in between.

If you want to change your answer, cross it out and circle a new number.
Please write your name, your school's name and your province at the top of the questionnaire.

Thank you for your cooperation

Name.....School.....Province.....

Your actual teacher's behaviours in biology class	Never				Always
1. This teacher talks enthusiastically about her/his subject.	1	2	3	4	5
2. This teacher trusts us.	1	2	3	4	5
3. This teacher seems uncertain.	1	2	3	4	5
4. This teacher gets angry unexpectedly.	1	2	3	4	5
5. This teacher explains clearly.	1	2	3	4	5
6. If I don't agree with this teacher , we can talk about it.	1	2	3	4	5
7. This teacher is hesitate.	1	2	3	4	5
8. This teacher gets angry quickly.	1	2	3	4	5
9. This teacher holds our attention.	1	2	3	4	5
10. This teacher is willing to explain things again.	1	2	3	4	5
11. This teacher acts as if she2he does not know what yo do.	1	2	3	4	5
12. This teacher is too quick to correct us when we break a rule.	1	2	3	4	5
13. This teacher knows everything that goes on in the classroom.	1	2	3	4	5
14. If we have something to say, this teacher will listen.	1	2	3	4	5
15. This teacher lets us boss her/him around.	1	2	3	4	5
16. This teacher is impatient.					
17. This teacher is a good leader.	1	2	3	4	5
18. This teacher realises when we don't understand.	1	2	3	4	5
19. This teacher is not sure what to do when we fool around.	1	2	3	4	5
20. It is easy to pick a fight with this teacher.	1	2	3	4	5
21. This teacher acts confidently.	1	2	3	4	5
22. This teacher is patient.	1	2	3	4	5
23. It's easy to make a fool out of this teacher.	1	2	3	4	5
24. This teacher is sarcastic.	1	2	3	4	5
25. This teacher help us with our work.	1	2	3	4	5
26. We can decide some things in this teacher's class.	1	2	3	4	5
27. This teacher thinks that we cheat.	1	2	3	4	5
28. This teacher is strict.	1	2	3	4	5
29. This teacher is friendly.	1	2	3	4	5
30. We can influence this teacher.	1	2	3	4	5
31. This teacher thinks that we don't know anything.	1	2	3	4	5
32. We have to be silent in this teacher's class.	1	2	3	4	5
33. This teacher is someone we can depend on.	1	2	3	4	5
34. This teacher lets us get away with a lot in class.	1	2	3	4	5
35. This teacher puts us down.	1	2	3	4	5
36. This teacher's tesrs are hard.	1	2	3	4	5
37 This teacher has a sense of humer.	1	2	3	4	5
38. This teacher lets us get away with a lot in class.	1	2	3	4	5
39. This teacher thinks that we can't do things well.	1	2	3	4	5
40. This teacher's standards are very high.	1	2	3	4	5
41. This teacher can take a joke.	1	2	3	4	5
42. This teacher gives us a lot of free time in class.	1	2	3	4	5
43. This teacher seems dissatisfied.	1	2	3	4	5
44. This teacher is severe when marking papers.	1	2	3	4	5
45. This teacher's class is pleasant.	1	2	3	4	5
46. This teacher is lenient.	1	2	3	4	5
47. This teacher suspicious.	1	2	3	4	5
48. We are afraid of this teacher.	1	2	3	4	5

Appendix B: Student Actual Form of the SLEI in English Version

Questionnaire on Learning Environment in Biology Laboratory

Directions

This questionnaire contains statements practices which could take place in this laboratory class. You will be asked how often each practice actually takes place. There are no 'right ' or 'wrong' answers. Your opinion is what is wanted.
Think about how well each statement describes what this laboratory class is actually like for you. Draw a circle around.

1	if the practice actually takes place	ALMOST NEVER
2	if the practice actually takes place	SELDOM
3	if the practice actually takes place	SOMETIMES
4	if the practice actually takes place	OFTEN
5	if the practice actually takes place	VERY OFTEN

If you want to change your answer, cross it out and circle a new number.
Please write your name, your school's name and your province at the top of the questionnaire.

Name.....School.....Province .....

Your actual biology laboratory classroom	Almost Never	Seldom	Sometimes	Often	Very Often
1. I get on well with this students in this laboratory class.	1	2	3	4	5
2.There is opportunity for me to pursue my own science interests in this laboratory class.	1	2	3	4	5
3. What I do in our regular science class is unrelated to my laboratory work.	1	2	3	4	5
4. My laboratory class has clear rules to guide my activities.	1	2	3	4	5
5. I find that the laboratory is crowed when I am doing experiments.	1	2	3	4	5
6. I have little chance to get to know other students in this laboratory class.	1	2	3	4	5
7. In this laboratory class, I am required to design my own experiments to solve a given problem.	1	2	3	4	5
8. The laboratory work is unrelated to the topics that I am studying in my biology class.	1	2	3	4	5
9. My laboratory class is rather informed and few rules are imposed on me.	1	2	3	4	5
10. The equipment and materials that I need for laboratory activities are readily available.	1	2	3	4	5
11. Members of this laboratory class work is integrated with laboratory activities.	1	2	3	4	5
12. In my laboratory sessions, other students collect different data than I do for the same problem.	1	2	3	4	5
13. My regular biology class work is integrated with laboratory activities.	1	2	3	4	5
14. I am required to follow certain rules in the laboratory.	1	2	3	4	5
15. I am ashamed of the appearance of this laboratory.	1	2	3	4	5
16. I get to know students in this laboratory class well.	1	2	3	4	5
17. I am allowed to go beyond the regular laboratory exercise and do some experimenting of my own.	1	2	3	4	5
18. I use the theory from my regular science class sessions during laboratory activities.	1	2	3	4	5
19. There is recognized way for me to do things safely in this laboratory.	1	2	3	4	5
20. The laboratory equipment which I use is in poor working order.	1	2	3	4	5
21. I am able to depend on other students for help during laboratory classes.	1	2	3	4	5
22. In my laboratory sessions, I do different experiments than some of other students.	1	2	3	4	5
23. The topics covered in regular science class work are quite different from topics with which I deal in laboratory sessions.	1	2	3	4	5
24. There are few fixed rules for me to follow in laboratory sessions.	1	2	3	4	5
25. I find that the laboratory is hot and stuffy.	1	2	3	4	5
26. It takes me a long time to get to know everybody by his/her first name in this laboratory class.	1	2	3	4	5

27. In my laboratory sessions, the teacher decides the best way for me to carry out the laboratory experiments.	1	2	3	4	5
28. What I do in laboratory sessions helps me to understand the theory covered in regular biology classes.	1	2	3	4	5
29. The teacher outlined safety precautions to me before my laboratory sessions commence.	1	2	3	4	5
30. The laboratory is an attractive place for me to work in.	1	2	3	4	5
31. I work cooperatively in laboratory sessions.	1	2	3	4	5
32. I decide the best way to proceed during laboratory experiments.	1	2	3	4	5
33. My laboratory work and regular biology class work are unrelated.	1	2	3	4	5
34. My laboratory class is run under clearer rules than my other classes.	1	2	3	4	5
35. My laboratory has enough room for individual or group work.	1	2	3	4	5

Appendix C: The Attitude to Biology Class in English Version

Attitude Towards Subject	Almost Never	Seldom	Sometimes	Often	Very Often
1. I look forward to lessons in this subject	1	2	3	4	5
2. Lessons in this subject are fun.	1	2	3	4	5
3. I dislike lessons.in this subject.	1	2	3	4	5
4. Lessons in this subject bore me.	1	2	3	4	5
5. This subject is one of the most interesting school subjects.	1	2	3	4	5
6. I enjoy lessons.in this subject.					
7. Lessons in this subject are a waste of time.	1	2	3	4	5
	1	2	3	4	5

Appendix D: Student Actual Form of the QTI in Thai Version

แบบสอบถามเกี่ยวกับพฤติกรรมครู

คำชี้แจง

1.แบบสอบถามนี้เป็นแบบสอบถามที่ต้องการถามความคิดเห็นของนักเรียนเกี่ยวกับพฤติกรรมของอาจารย์ผู้สอนชีววิทยาที่นักเรียนพบเห็นในชั้นเรียน แบบสอบถามนี้ไม่ใช่ข้อสอบ คำตอบไม่มีข้อที่ถูกหรือผิด คำตอบของนักเรียนเป็นสิ่งที่ต้องการ เพื่อผู้วิจัยจะนำไปใช้ในการปรับปรุงการเรียนการสอนวิชาชีววิทยาต่อไป

2. แบบสอบถามมี 48 ข้อ แต่ละข้อจะมีตัวเลขให้นักเรียนเลือกตอบ

ตัวอย่าง

	ไม่เคยเลย				บ่อยที่สุด
อาจารย์พูดถึงชีววิทยาอย่างกระตือรือร้น	1	2	3	4	5

ถ้านักเรียนคิดว่า อาจารย์ท่านนี้พูดถึงชีววิทยาอย่างกระตือรือร้น ให้เลือกวงหมายเลข 5 แต่ถ้านักเรียนคิดว่าอาจารย์ของนักเรียนไม่เคยพูดถึงชีววิทยาอย่างกระตือรือร้นเลย ให้เลือกวงหมายเลข 1 หรือนักเรียนอาจจะเลือกวงหมายเลข 2 หรือ 3 หรือ 4 ถ้านักเรียนคิดว่าพบเห็นนานๆครั้ง บางครั้ง บ่อยครั้ง ตามลำดับ

3.ถ้านักเรียนต้องการเปลี่ยนคำตอบ ให้ทำเครื่องหมายกากบาท (X) และวงกลมรอบตัวเลือกใหม่

4.ขอให้นักเรียนเขียนชื่อสกุลของนักเรียน ชื่อโรงเรียน และชื่อจังหวัดลงในแบบสอบถามในหน้าถัดไปด้วย

ขอขอบคุณที่ให้ความร่วมมือตอบแบบสอบถาม

ชื่อ-สกุล.....โรงเรียน.....จังหวัด.....

พฤติกรรมของอาจารย์ที่นักเรียนพบเห็นในชั้นเรียนชีววิทยา	ไม่เคยเลย	นานๆครั้ง	บางครั้ง	บ่อยครั้ง	บ่อยที่สุด
1.อาจารย์พูดถึงชีววิทยาอย่างกระตือรือร้น	1	2	3	4	5
2.อาจารย์ให้ความไว้วางใจนักเรียน	1	2	3	4	5
3.อาจารย์มีท่าทางไม่มั่นใจ	1	2	3	4	5
4.ในระหว่างสอน อาจารย์โกรธขึ้นมาทันทีทันใด	1	2	3	4	5
5.อาจารย์อธิบายสิ่งต่างๆ ได้อย่างชัดเจน	1	2	3	4	5
6.นักเรียนสามารถแสดงความคิดเห็นได้ ถ้าไม่เห็นด้วยกับอาจารย์	1	2	3	4	5
7. อาจารย์เป็นคนลังเล	1	2	3	4	5
8. อาจารย์เป็นคนโกรธง่าย	1	2	3	4	5
9. อาจารย์ทำให้นักเรียนสนใจเรียน	1	2	3	4	5
10. อาจารย์เต็มใจที่จะอธิบายซ้ำ เมื่อนักเรียนไม่เข้าใจ	1	2	3	4	5
11. อาจารย์แสดงอาการคล้ายกับว่าไม่รู้จะทำอะไร	1	2	3	4	5
12. อาจารย์แก้ไขให้ทันทีไปเมื่อนักเรียนทำผิดระเบียบ	1	2	3	4	5
13. อาจารย์รู้ทุกอย่างที่เกิดขึ้นในชั้นเรียน	1	2	3	4	5
14. อาจารย์รับฟังเมื่อนักเรียนมีเรื่องที่จะพูด	1	2	3	4	5
15. อาจารย์ให้นักเรียนรับผิดชอบงานในชั้นเรียน	1	2	3	4	5
16. อาจารย์เป็นคนไม่อดทน	1	2	3	4	5
17. อาจารย์เป็นผู้นำที่ดี	1	2	3	4	5
18. อาจารย์รู้ทันทีเมื่อนักเรียนเรียนไม่เข้าใจ	1	2	3	4	5
19. อาจารย์ไม่แน่ใจว่าจะทำอย่างไรเมื่อนักเรียนไม่ตั้งใจเรียน	1	2	3	4	5
20. อาจารย์เป็นคนที่นักเรียนโต้แย้งได้ง่าย	1	2	3	4	5
21. อาจารย์เป็นคนมั่นใจในตัวเอง	1	2	3	4	5
22. อาจารย์เป็นคนมีความอดทน	1	2	3	4	5
23. เป็นเรื่องง่ายที่จะทำให้อาจารย์ไม่มั่นใจ	1	2	3	4	5
24. อาจารย์พูดเยาะเย้ยนักเรียน	1	2	3	4	5
25. อาจารย์ช่วยเหลือนักเรียนในการทำงาน	1	2	3	4	5
26. ในชั้นเรียนของอาจารย์ นักเรียนสามารถตัดสินใจทำสิ่งต่างๆ (เกี่ยวกับเรื่องที่เรียน)ได้	1	2	3	4	5
27. อาจารย์คิดว่านักเรียนเป็นคนมีเล่ห์เหลี่ยม	1	2	3	4	5
28. อาจารย์เป็นคนเจ้าระเบียบ	1	2	3	4	5

29. อาจารย์ให้ความเป็นมิตรแก่นักเรียน	1	2	3	4	5
30. นักเรียนทำให้อาจารย์คล้อยตามได้	1	2	3	4	5
31. อาจารย์คิดว่านักเรียนไม่รู้อะไรเลย	1	2	3	4	5
32. นักเรียนต้องเงียบเมื่อเรียนกับอาจารย์	1	2	3	4	5
33. อาจารย์เป็นคนหนึ่งที่นักเรียนสามารถพึ่งพาได้	1	2	3	4	5
34. อาจารย์ให้นักเรียนตัดสินใจเองว่าจะทำงานเวลาใดในชั้นเรียน	1	2	3	4	5
35. อาจารย์ดูถูกนักเรียน	1	2	3	4	5
36. ข้อสอบของอาจารย์ยาก	1	2	3	4	5
37. อาจารย์เป็นคนมีอารมณ์ขัน	1	2	3	4	5
38. อาจารย์ปล่อยให้นักเรียนทำผิดบ่อยๆ โดยไม่ลงโทษ	1	2	3	4	5
39. อาจารย์คิดว่านักเรียนไม่สามารถทำอะไรได้ดี	1	2	3	4	5
40. อาจารย์มีมาตรฐานในการสอนสูง	1	2	3	4	5
41. อาจารย์ยอมรับเรื่องตลกๆที่พบในชั้นเรียนได้	1	2	3	4	5
42. อาจารย์ให้เวลาว่างกับนักเรียนในชั้นเรียน	1	2	3	4	5
43. อาจารย์มีท่าทางไม่พอใจนักเรียน	1	2	3	4	5
44. อาจารย์เป็นคนให้คะแนนยากเมื่อตรวจงานนักเรียน	1	2	3	4	5
45. ชั้นเรียนของอาจารย์สนุกสนาน	1	2	3	4	5
46. อาจารย์เป็นคนมีความเมตตา	1	2	3	4	5
47. อาจารย์เป็นคนช่างระแวง	1	2	3	4	5
48. นักเรียนกลัวอาจารย์	1	2	3	4	5

Appendix E: Student Actual Form of the SLEI in Thai Version

แบบสอบถามเกี่ยวกับสภาพแวดล้อมการเรียนในชั้นเรียนปฏิบัติการชีววิทยา

คำชี้แจง

1.แบบสอบถามนี้เป็นแบบสอบถามที่ต้องการถามความคิดเห็นของนักเรียนเกี่ยวกับสภาพแวดล้อมการเรียนในชั้นเรียนที่นักเรียนพบเห็นในชั้นเรียนปฏิบัติการชีววิทยา แบบสอบถามนี้ไม่ใช่ข้อสอบ คำตอบไม่มีข้อที่ถูกหรือผิด คำตอบของนักเรียนเป็นสิ่งที่ต้องการ เพื่อผู้วิจัยจะนำไปใช้ในการปรับปรุงการเรียนการสอนวิชาชีววิทยาต่อไป

2. แบบสอบถามมี 35 ข้อ แต่ละข้อจะมีตัวเลขให้นักเรียนเลือกตอบ

ตัวอย่าง

	ไม่เคยเลย				บ่อยที่สุด
ข้าพเจ้าเข้ากับเพื่อนๆในชั้นเรียนนี้ได้เป็นอย่างดี	1	2	3	4	5

ถ้านักเรียนคิดว่า นักเรียนเข้ากับเพื่อนๆในชั้นเรียนนี้ได้เป็นอย่างดี ให้เลือกวงหมายเลข 5 แต่ถ้านักเรียนคิดว่านักเรียนไม่เคยเข้ากับเพื่อนๆในชั้นเรียนนี้ได้เลย ให้เลือกวงหมายเลข 1 หรือนักเรียนอาจจะเลือกวงหมายเลข 2 หรือ 3 หรือ 4 ถ้านักเรียนคิดว่าพบเห็นนานๆครั้ง บางครั้ง บ่อยครั้ง ตามลำดับ

3.ถ้านักเรียนต้องการเปลี่ยนคำตอบ ให้ทำเครื่องหมายกากบาท (X) และวงกลมรอบตัวเลือกใหม่

4.ขอให้นักเรียนเขียนชื่อสกุลของนักเรียน ชื่อโรงเรียน และชื่อจังหวัดลงในแบบสอบถามในหน้าถัดไปด้วย

ขอขอบคุณที่ให้ความร่วมมือตอบแบบสอบถาม

ชื่อ-สกุล.....โรงเรียน.....จังหวัด.....

สภาพแวดล้อมที่นักเรียนพบเห็น ในชั้นเรียนปฏิบัติการชีววิทยา	ไม่เคยเลย	นานๆครั้ง	บางครั้ง	บ่อยครั้ง	บ่อยที่สุด
1.ข้าพเจ้าเข้ากับเพื่อนๆในชั้นเรียนนี้ได้เป็นอย่างดี	1	2	3	4	5
2.ข้าพเจ้ามีโอกาสได้ค้นคว้า/ทำการทดลองในเรื่องที่สนใจในชั้นเรียนนี้	1	2	3	4	5
3.สิ่งที่เรียนในชั้นเรียนปกติไม่สัมพันธ์กับการเรียนปฏิบัติการ	1	2	3	4	5
4.ในชั้นเรียนนี้มีแนวปฏิบัติในการทำกิจกรรมไว้อย่างชัดเจน	1	2	3	4	5
5. ห้องนี้มีนักเรียนแน่นเกินไป เมื่อทำปฏิบัติการ	1	2	3	4	5
6.ข้าพเจ้ามีโอกาสน้อยมากที่จะทำความรู้จักกับเพื่อนๆในชั้นเรียน	1	2	3	4	5
7.ข้าพเจ้าต้องออกแบบการทดลองเพื่อแก้ปัญหาหรือสิ่งที่สงสัย	1	2	3	4	5
8.กิจกรรมที่ปฏิบัติไม่สัมพันธ์กับหัวข้อที่เรียนในชั้นเรียน	1	2	3	4	5
9.ชั้นเรียนนี้ไม่เข้มงวดเรื่องระเบียบกฎเกณฑ์	1	2	3	4	5
10.วัสดุอุปกรณ์สำหรับปฏิบัติการมีพร้อมสามารถใช้งานได้ทันที	1	2	3	4	5
11.เพื่อนร่วมชั้นช่วยเหลือข้าพเจ้าในการทำปฏิบัติการ	1	2	3	4	5
12.ข้าพเจ้าและนักเรียนคนอื่นๆได้ข้อมูลต่างกันในการทดลองเรื่องเดียวกัน	1	2	3	4	5
13.งานในชั้นเรียนปกติสัมพันธ์กับปฏิบัติการ	1	2	3	4	5
14.ข้าพเจ้าจำเป็นต้องปฏิบัติตามกฎระเบียบของชั้นเรียนนี้	1	2	3	4	5
15.ข้าพเจ้ารู้สึกอับอายต่อสภาพห้องปฏิบัติการ	1	2	3	4	5
16.ข้าพเจ้ารู้จักเพื่อนๆในห้องเป็นอย่างดี	1	2	3	4	5
17.ข้าพเจ้าได้รับอนุญาตให้ทำแบบฝึกหัดเพิ่มเติมจากที่กำหนดไว้ และสามารถทำปฏิบัติการได้ด้วยตนเอง	1	2	3	4	5
18.ข้าพเจ้านำทฤษฎีที่เรียนมาใช้ในการทำปฏิบัติการ	1	2	3	4	5
19.ในชั้นเรียนนี้มีแนวทางปฏิบัติเพื่อความปลอดภัย ไว้ชัดเจน	1	2	3	4	5
20.อุปกรณ์ที่ข้าพเจ้าใช้ในปฏิบัติการใช้งานได้ไม่ดี	1	2	3	4	5
21.เพื่อนๆในห้องได้ให้ความช่วยเหลือข้าพเจ้าในห้องปฏิบัติการ	1	2	3	4	5
22.ในห้องปฏิบัติการนี้ ข้าพเจ้าได้ทำการทดลองที่แตกต่างไปจาก นักเรียนคนอื่นๆ	1	2	3	4	5
23.หัวข้อที่เรียนในชั้นเรียนปกติแตกต่างไปจากหัวข้อที่ข้าพเจ้า ทำปฏิบัติการ	1	2	3	4	5
24.ในปฏิบัติการนี้มีกฎที่ตายตัวไม่มากนักที่ข้าพเจ้าต้องปฏิบัติตาม	1	2	3	4	5
25.ข้าพเจ้าเห็นว่าห้องปฏิบัติการร้อนและอึดอัด	1	2	3	4	5
26.ข้าพเจ้าต้องใช้เวลานานกว่าจะรู้จักชื่อเพื่อนๆในชั้นเรียนนี้	1	2	3	4	5
27.ในปฏิบัติการนี้ อาจารย์เป็นผู้เลือกว่าวิธีทดลองใดดีที่สุด สำหรับข้าพเจ้า	1	2	3	4	5

28.ปฏิบัติการนี้ทำให้ข้าพเจ้าเข้าใจทฤษฎีที่เรียนในชั้นเรียนปกติได้ดียิ่งขึ้น	1	2	3	4	5
29.อาจารย์กำหนดแนวทางการทดลองที่ปลอดภัยไว้ก่อนที่จะให้นักเรียนปฏิบัติการ	1	2	3	4	5
30.ห้องปฏิบัติการจูงใจข้าพเจ้าให้อยากทำการทดลอง	1	2	3	4	5
31.ข้าพเจ้าได้ร่วมมือกับเพื่อนๆในการทำปฏิบัติการ	1	2	3	4	5
32.ข้าพเจ้าเลือกวิธีการที่ดีที่สุดในการทดลอง	1	2	3	4	5
33.งานที่ข้าพเจ้าทำในคาบปฏิบัติกับที่เรียนในชั้นเรียนปกติไม่สัมพันธ์กัน	1	2	3	4	5
34.ในชั้นเรียนปฏิบัตินี้มีกฎระเบียบให้ปฏิบัติตามชัดเจนกว่าชั้นเรียนอื่นๆ	1	2	3	4	5
35.ห้องปฏิบัติการชีววิทยามีที่ว่างเพียงพอสำหรับที่นักเรียนจะทำงานเดี่ยวหรือเป็นกลุ่มได้	1	2	3	4	5

Appendix F: The Attitude to Biology Class in Thai Version

คำชี้แจง ให้ทำเครื่องหมาย / ในช่องที่ตรงกับความคิดเห็นของนักเรียน

ความรู้สึกต่อการเรียนชีววิทยา	ไม่เคยเลย	นานๆครั้ง	บางครั้ง	บ่อยครั้ง	บ่อยที่สุด
1.ข้าพเจ้าใจจดจ่ออยากเรียนวิชาชีววิทยา	1	2	3	4	5
2.บทเรียนชีววิทยาน่าสนใจ	1	2	3	4	5
3.ข้าพเจ้าไม่ชอบบทเรียนวิชาชีววิทยา	1	2	3	4	5
4.บทเรียนชีววิทยาเป็นสิ่งที่น่าเบื่อ	1	2	3	4	5
5.ชีววิทยาน่าสนใจที่สุดวิชาหนึ่ง	1	2	3	4	5
6.ข้าพเจ้ารู้สึกสนุกสนานเวลาเรียนชีววิทยา	1	2	3	4	5
7.การเรียนชีววิทยา ทำให้เสียเวลา	1	2	3	4	5

Appendix G: Back-Translation of the Actual Form of the QTI

Desirable teachers' behaviors in classroom

1. This teacher talks about Biology eagerly.
2. This teacher trusts the students.
3. This teacher can be unconfident.
4. This teacher gets angry suddenly.
5. This teacher is able to explain things clearly.
6. The students can express their ideas contrasting to This teacher's.
7. This teacher can have hesitant manner.
8. This teacher can be hot-tempered.
9. This teacher is able to make the students to be interested in studying.
10. This teacher is willing to explain what the students don't understand again.
11. This teacher can act like he/she doesn't know what to do.
12. This teacher corrects immediately when the students break rules.
13. This teacher knows everything going on in classroom.
14. This teacher listens to what the students want to express.
15. This teacher allows the students to be responsible to their work in class.
16. This teacher is impatient.
17. This teacher is a good leader.
18. This teacher is skeptical when students don't understand their lessons.
19. This teacher does not know exactly what to do when the students don't pay attention to their study.
20. This teacher is easily protested by the students.
21. This teacher is confident.
22. This teacher is patient.
23. It is easy to make this teacher to be unconfident.
24. This teacher talks satirically to students.
25. This teacher assists student's work.
26. The students is able to decide in doing things in class.
27. This teacher think that the students are tricky.
28. This teacher is strict.
29. This teacher is friendly.
30. The students is able to convince their teacher.
31. This teacher thinks that students don't know anything.
32. The students is quiet when studying with this teacher.
33. This teacher is a person who the students can rely on.
34. The students are allowed to decide when to work in class.
35. This teacher looked down on the students.
36. This teacher made an examination to be difficult.
37. This teacher have a good sense of humor.
38. The students make mistakes repeatedly without punishment.
39. This teacher think that the students cannot do things well.
40. This teacher have high standard of teaching.
41. This teacher accept funny things found in class.
42. This teacher give a break for the students during class.
43. This teacher show that he doesn't appreciate what the students do.
44. This teacher be strict in scoring student's assignments.

45. This class is enjoyable.
46. This teacher is mercy.
47. This teacher is suspicious.
48. The students are afraid of their teacher.

Appendix H: Back-Translation of the Actual Form of the SLEI

The atmosphere desired by students in Biology Lab.

1. I am able to get along well with my classmates.
2. I have chances to research or experiment about what I'm interested in.
3. Things I usually learn in class are not related to what I do in a practical learning/ a lab.
4. There are clear disciplines in doing activities.
5. It is crowded when working in a lab.
6. I have little chance to get to know my classmates.
7. I have to design an experiment to answer my questions.
8. Activities done are not related to the topics I study in class.
9. There are not strictness on regulation enforcement.
10. All materials needed in a lab are always available.
11. My classmates help me with my lab work.
12. My classmates and I receive different information for doing the same experiment.
13. Classroom assignment is related to lab works.
14. I need to follow a classroom regulation.
15. I am ashame of the condition of a lab.
16. I know my classmates very well.
17. I am allowed to do extra exercises.
18. I use theories learnt in class with my lab works.
19. There is security regulation well.
20. Materials I use in a lab are in good condition.
21. My classmates assist me in a lab.
22. I am able to do the experiment that is different from other students' experiments.
23. Topics that are studied in class are different from the topics in a lab.
24. There are not so many permanent regulations that I have to follow in this class.
25. A lab is hot and uncomfortable.
26. It spend a long time to learn my classmates' names.
27. In a lab, the teacher is the person who considers which experiment method is the best for me.
28. Working in a lab make me understand what I learn in class clearer.
29. The teacher prescribe/set a save experiment method before allowing students to practice.
30. This laboratory room is attractive.
31. I cooperate with my classmate when working in a lab.
32. I choose the best method in an experiment.
33. The work I do in a lab have no relationship with what I usually learn in class.
34. There is more strict regulation in a lab than in other classrooms.
35. There is enough space in a lab for the students to work individual.

Appendix I: Back-Translation of the ABC

The students' Attitude toward Studying Biology

1. I'm eager to study Biology.
2. Biology lessons are interesting.
3. I don't like Biology lessons.
4. Biology lessons are boring.
5. Biology is one of the most interesting subjects.
6. I enjoy studying Biology.
7. Studying Biology wastes time.

Appendix J: Letter Requesting Permission

ที่ ศธ 1519.03/ว 034

สถาบันราชภัฏอุดรธานี

อ.เมือง จ.อุดรธานี 41000

23 มกราคม 2546

เรื่อง **ขออนุญาตเก็บข้อมูลในโรงเรียน**

เรียน ผู้อำนวยการโรงเรียน

สิ่งที่ส่งมาด้วย แบบตอบรับสำหรับอาจารย์ผู้สอน

ด้วย นางสาวดวงสมร กิจโกศล อาจารย์สังกัดคณะวิทยาศาสตร์และเทคโนโลยี สถาบันราชภัฏอุดรธานี ซึ่งกำลังศึกษาระดับปริญญาเอก สาขา Science Education ตามโครงการ ความร่วมมือระหว่างสถาบันราชภัฏอุดรธานี กับ Curtin University of Technology ประเทศออสเตรเลีย และกำลังดำเนินการวิจัยประกอบการทำวิทยานิพนธ์เรื่อง "Teacher-Student Interactions and Laboratory Learning Environments in Biology Classes in Thailand" โดยใช้กลุ่ม ตัวอย่างเป็นนักเรียนชั้นมัธยมศึกษาปีที่ 4 ที่กำลังเรียนวิชาชีววิทยา ซึ่งสุ่มตัวอย่างจากโรงเรียนสังกัดกรมสามัญศึกษา ในเขตพื้นที่บริการของสถาบันราชภัฏอุดรธานี 3 จังหวัด (หนองคาย หนองบัวลำภูและ อุดรธานี)

เพื่อให้การดำเนินงานวิจัยประกอบการทำวิทยานิพนธ์นี้ ได้ข้อมูลที่ถูกต้องและสมบูรณ์ สถาบันฯจึงขอความร่วมมือจากท่านอนุญาตให้นางสาวดวงสมร กิจโกศล ใช้นักเรียนในโรงเรียนของท่าน เป็นกลุ่มตัวอย่าง และช่วยกรุณาประสานอาจารย์ผู้สอนวิชาชีววิทยาในภาคเรียนที่2/2545นี้ เพื่อให้ผู้วิจัยแจกแบบสอบถามและสัมภาษณ์ นักเรียนชั้นมัธยมศึกษาปีที่ 4 จำนวน 1 ห้องเรียน

พร้อมนี้ได้แนบแบบตอบรับของอาจารย์ผู้สอนวิชาชีววิทยา ขอความกรุณากรอกข้อมูล และส่งกลับมายังสถาบันหรือส่งทางโทรสาร ภายในวันที่ 7 กุมภาพันธ์ 2546 ด้วย เพื่อผู้วิจัยจะได้มา ดำเนินการเก็บข้อมูลตามที่โรงเรียนและผู้สอนได้อนุญาตต่อไป

จึงเรียนมาเพื่อโปรดพิจารณา สถาบันหวังเป็นอย่างยิ่งว่าจะได้รับความร่วมมือจากท่านด้วยดี จึงขอขอบพระคุณเป็นอย่างสูงมา ณ โอกาสนี้

ขอแสดงความนับถือ

(ผศ.สิงห์ชัย อัศวมณี)

คณบดีคณะวิทยาศาสตร์และเทคโนโลยี

ปฏิบัติราชการแทนอธิการบดี

คณะวิทยาศาสตร์และเทคโนโลยี

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